

INSTRUMENTS OF LIGHT. DAYLIGHTING IN SPACES FOR MEDITATION.**VALGUSE INSTRUMENDID. PÄEVAVALGUSE KASUTAMISE VÕIMALUSED MEDITATSIOONI RUUMIDES.**

MASTER'S THESIS

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Tallinn 2020

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TABLE OF CONTENTS

FOREWORD	6	ATMOSPHERIC LIGHT	23	10.3 SPIRITUAL SEARCH HUT – ATMOSPHERIC LIGHT.....	71
ABSTRACT.....	7	SCULPTED LIGHT	24	10.4 EFFORTLESS PRESENCE HUT – COREOGRAPHED LIGHT.....	77
ABSTRAKT	8	STRUCTURED LIGHT	25	10.5 TRAUMA RECOVERY HUT - SCULPTED LIGHT.....	83
1 INTRODUCTION.....	11	MATERIAL LIGHT	26	10.6 NATURE OBSERVATION HUT – INTEGRATED LIGHT.....	89
1.1 <i>RELEVANCY OF THE TOPIC.....</i>	11	INTEGRATED LIGHT	27	11 BIBLIOGRAPHY	95
1.2 <i>PROBLEM STATEMENT.....</i>	11				
1.3 <i>OBJECTIVE</i>	11	4 MASTERPIECES OF ARCHITECTURE IN QUANTITATIVE EVALUATION... 28			
1.4 <i>RESEARCH METHOD AND THEORETICAL SOURCES.....</i>	11	4.1 <i>DAYLIGHT FACTOR – SPACES BATHING IN DAYLIGHT</i>	28		
1.5 <i>MAIN TERMS AND DEFINITIONS.....</i>	12	4.2 <i>MINIMUM VIEW – CONNECTING INSIDE AND OUTSIDE</i>	34		
2 DAYLIGHT AS AN ARCHITECTURAL MATERIAL	13	4.3 <i>INSOLATION – DRAMA OF CAST SHADOWS</i>	38		
2.1 <i>DEFINITION OF DAYLIGHT</i>	13	4.4 <i>GLARE – UNBEARABLE BRIGHTNESS</i>	42		
2.2 <i>DAYLIGHTING IN THE TOOLKIT OF ARCHITECT</i>	13	5 CONCLUSION OF THE ANALYSES..... 45			
2.3 <i>HUMAN BENEFITS OF DAYLIGHTING.....</i>	14	6 ANALÜÜSI KOKKUVÖTE..... 46			
3 EVALUATION OF DAYLIGHTING IN BUILDINGS..... 15		7 ARCHITECTURAL CONCEPT	50		
3.1 <i>QUANTITATIVE METRICS.....</i>	16	8 LOCATION AND THE COMPETITION	51		
DAYLIGHT FACTOR.....	17	8.1 <i>CLIMATE AND DAYLIGHT IN PORTUGAL.....</i>	51		
MINIMUM VIEW	18	8.2 <i>VALE DE MOSES YOGA RETREAT.....</i>	52		
INSOLATION.....	19	8.3 <i>COMPETITION.....</i>	52		
GLARE.....	20	9 PROJECT SITE..... 53			
3.2 <i>EVALUATION OF DAYLIGHT QUALITY.....</i>	21	9.1 <i>SITE PLAN</i>	58		
CHOREOGRAPHED LIGHT	22	10 MEDITATION HUT DESIGNS	59		
		10.1 <i>WELLNESS HUT – STRUCTURED LIGHT</i>	59		
		10.2 <i>SELF-AWARENESS HUT – MATERIAL LIGHT</i>	65		

FOREWORD

This Master Thesis has been written as a culmination of the architecture and urban studies in the Department of Civil Engineering and Architecture at Tallinn University of Technology.

I would like to thank everyone who contributed to writing this Master Thesis, especially my supervisor Kimmo Lylykangas and the professors of the Academy of Architecture and Urban Studies. Also I appreciate my friends, fellow classmates and family for supporting me during my studies and giving me advice when needed.

Keywords: architecture, daylight, Vale de Moses, Master Thesis

ABSTRACT

This Master Thesis focuses on the topic of daylighting, analyzing its quantitative and qualitative metrics, and how it can be used in buildings to create desired atmospheres. Most of the research about daylight focuses on the quantitative aspects and measure the amount of daylight. This thesis is focusing on the qualitative evaluation of daylight quality and its connections to the quantitative metrics, as it has not been researched much.

Daylight has been in the toolkit of many famous architects like Louis Kahn, Peter Zumthor, Steven Holl, Alvar Aalto, etc, who have experimented and incorporated it to their works. But the definition of the quality is different in quantitative and qualitative evaluations of daylighting. This research gives a brief overview of the four quantitative metrics in the Estonian (EVS-EN 17037:2019) and European (EN 17037:2018) standards of daylighting in buildings. Based on those quantitative metrics, which are daylight factor, minimum view, insolation and glare, this thesis analyses eight masterpieces of architecture and how they perform according to the EN standard. Each of the metrics compare two of them – one that is following the requirements of the EN standard and one that does not meet the requirements. The aim is to showcase that whether working towards the standard or against it, daylighting can create architectural qualities.

The methods for evaluating the quality of daylight are less established and is mostly expressed through creating typologies. The perception of architecture can be significantly changed by the daylight during a day. When sunlight is used to illuminate a space, it can greatly change our understanding of architectural space. This Master Thesis analyzes six types of qualitative daylighting profiles proposed by Mary Guzowski (Guzowski, 2018) and how those profiles can be utilized in architectural design. Those daylighting profiles are structured light, material light, atmospheric light, choreographed light, sculpted light and integrated light. Opposite to the quantitative metrics, which measure the amount of daylight, those qualitative metrics are unmeasurable and are based on the users experience and the desired qualities of the space.

The practical part of the Master Thesis is applying Guzowski's typology as a part of the architecture competition entry to design meditation cabins as instruments of daylighting in Vale de Moses retreat in Portugal. Each of the cabins demonstrate a different type of atmosphere created by daylight to support the desired meditation type. There are six huts, of which each presents one daylight profile proposed by Guzowski and the connections between different meditation types that are focused on wellness, self-awareness, spiritual search, effortless presence and recovering from trauma. All the

designs are instruments of light that demonstrate the power of daylighting and how it can shape an atmosphere. The designs have minimized all means of expression in architecture except the materials, daylighting and how the buildings touch the ground. In that way, the aim of the designs is to achieve the desired atmospheres using daylight as the main tool of architectural expression. Also, each of the cabins are designed to be as ecological as possible and use local materials that can be found on the site like wood, stones, earth, etc.

ABSTRAKT

Käesolev Magistritöö keskendub päevavalguse teemale, analüüsides selle kvantitatiivseid ja kvalitatiivseid parameetreid ning kuidas seda kasutada hoonetes soovitud atmosfääri loomiseks. Suur osa päevavalguse kohta tehtud teadustöödest keskenduvad kvantitatiivsetele parameetritele ning mõõdetakse päevavalguse hulka. Antud magistritöö keskendub aga päevavalguse kvaliteedi mõõtmise võimalustele ning selle seostega kvantitatiivsete parameetritega, sest seda teemat pole piisavalt uuritud.

Mitmed kuulsad arhitektid nagu Louis Kahn, Peter Zumthor, Steven Holl, Alvar Aalto jne, on võtnud päevavalguse osaks oma töövahendina ning eksperimenteerinud ja kasutanud seda kui ühe osana oma tööst. Päevavalguse kvaliteet aga tähendab kvantitatiivsete ja kvalitatiivsete hinnanute juures erinevat asja. Käesolev töö annab põguna ülevaate neljast kvantitatiivsetest parameetrist, mis on välja toodud Eesti (EVS-EN 17037:2019) ja Euroopa (EN 17037:2018) standardites päevavalguse kohta hoonetes. Nende parameetrite põhal – päevavalgus tegur, miinimum vaade, insolatsioon, räigus – on lõputöös analüüsitud kaheksat arhitektuurset meistriteost ning seda, kuidas nad vastavad Euroopa standardis välja toodule. Iga parameeter võrdleb kahte meistriteost – üks, mis järgib Euroopa standardi nõudeid ning teine, mis ei vasta nõudmistele. Võrdluse eesmärk on näidata, et vaatamata sellele, mis suunas on liigutud, on päevavalgus lahendus selles hoolimata silmale ilus.

Päevavalguse kvaliteedi hindamine on kahtlemata vähem kindlaks kujunenud ning enamasti tehakse seda just tüpoloogiate abil. Arhitektuuri tajumine võib päeva jooksul oluliselt muutuda olenevalt päevavalgusest. Kui ruumi valgustamiseks kasutatakse päikesevalgust, võib see oluliselt muuta ka meie arusaama sisekujundusest. Selles magistritöös analüüsatakse kuute Mary Guzowski (Guzowski, 2018) poolt välja pakutud kvalitatiivset päevavalguse profiili ning seda, kuidas need omadused päevavalgusega saavutatakse. Nendeks profiilideks on struktureeritud valgus, materjalivalgus, atmosfäärvälgus, koreograafiline valgus, vormitud valgus ja integreeritud valgus. Vastupidiselt kvantitatiivsetele parameetritele, mis keskenduvad päevavalguse hulga mõõtmisele, on need kvalitatiivsed parameetrid mõõtmatus ja põhinevad kasutajate kogemusele ja ruumi soovitud väärustele.

Magistritöö praktilises osas rakendatakse Guzowski tüpoloogiat osana arhitektuurikonkursist Vale de Moses' e heaolukeskusele Portugalis, keskendudes meditatsioonimajakeste disainimisele, mis oleksid just kui valguse instrumendid. Iga maja demonstreerib erinevat tüüpi atmosfääri, mis on loodud päevavalgusega toetamaks soovitud meditatsioonitüüpi. Disainitakse kuus majakest, mis igaüks esindab ühte Guzowski pakutud päevavalguseprofiilidest ja nende seoseid erinevate meditatsiooni tüüpide vahel nagu heaolu, eneseteadlikus, vaimne otsing, vaevatule kohalolu ja traumast toibumine. Kõik disainid on valguseinstrumendid, mis

demonstreerivad päevavalgust ja seda, kuidas see suudab kujundada atmosfääri. Arhitektuurist lahendusest on eemaldatud kõik väljendusvõimalused välja arvatud materjalid, päevavalgus ja see, kuidas ehitised maapinda puudutavad. Sel viisil on majakeste eesmärk saavutada soovitud atmosfäär, kasutades päevavalgust peamiseks arhitektuuriseks väljundiks. Iga maja kavandatakse võimalikult ökoloogiliselt kasutades selleks kohalikke materjale, mida leidub kohapeal nagu puit, kivid, muld jne.

I THEORETICAL PART – EVALUATION OF DAYLIGHTING QUALITY

1 INTRODUCTION

1.1 RELEVANCY OF THE TOPIC

Daylight has been a key component in architecture since the day that the first building was built. Since then it has been the primary source of light for centuries and many architects have experimented with the usage of daylight and how it can be incorporated into their work. Today daylight is often treated as a static and quantitative feature of space (Pallasmaa, 2016). But daylighting has both quantitative and qualitative dimensions (Guzowski, 2018, p. 8). "We have yet to see a method that can measure the spatial and temporal diversity of light within the visual field" (Rockcastle & Andersen, 2013). There are many researches about evaluating the quantity of light, but the evaluation of daylight quality is less established than the quantitative methods.

1.2 PROBLEM STATEMENT

In the field of daylighting in buildings, there is a different meaning to quality in quantitative and qualitative evaluation. Performing well in quantitative analyses, such as the metrics applied in the Estonian and European standards, does not go hand in hand with the daylighting quality in architecture. Therefore the masterpieces of daylighting do not necessarily perform well in quantitative analyses, but rather have qualitative aspects to them that people actually desire, such as the orientation of light, temperature, color and ability to reflect (Pallasmaa, 2016).

The purpose of the research is to provide further knowledge regarding potential causalities between quantitative and qualitative evaluation methods.

The two research questions that the theory part discusses are:

1. whether there are analytical methods for evaluating the quality of daylighting in architecture, and how these methods relate to the most advanced quantitative metrics; and
2. whether a qualitative analysis method can be utilized in architectural design.

1.3 OBJECTIVE

There are two main objectives for this Master Thesis:

1. To review and contrast quantitative and qualitative evaluation methods in order to specify a qualitative evaluation framework for daylighting in architecture; a method to be applied in the Vale de Moses architectural competition which is part of this Master Thesis.
2. Applying the selected method to design meditation cabins as instruments of daylighting in Vale de Moses retreat in Portugal. Cabin are designed to demonstrate different types of atmospheres that light can create to support various kinds of meditating.

1.4 RESEARCH METHOD AND THEORETICAL SOURCES

Quantitative and qualitative approaches can be used to evaluate the daylighting in interior spaces. It is apparent that many architectural masterpieces do not perform well in quantitative analyses. This research aims to provide more information on the contrasting indications from quantitative and qualitative evaluation.

To appraise the quantitative methods, Estonian and European Standards of Daylighting in Buildings are examined and applied. The quantitative metrics are based in numeric modelling of various aspects related to visual perception and the functions of the openings of the building envelope. Even though the methods in the standards are numeric, the target levels are based questionnaires on user satisfaction, which may be subjective. Quantitative approaches tend to indicate, whether there is enough daylight in a space to provide healthy environment and assure the users well-being. This research reviews the four methods introduced in the Estonian standard EVS-EN 17037:2019 and European standard EN 17037:2018 of Daylighting in Buildings.

The methods to evaluate the quality of architectural daylighting are less established than the quantitative methods. The most adequate approach for systematic qualitative evaluation appears to be creation of typologies, which shows in categories the qualities achieved by daylighting. However, there is no proven method for selecting interiors, which are considered to represent high quality of daylighting in architecture. Marilynne Andersen and Mary Guzowski apply widely recognized masterpieces of architecture in their typologies. This research applies the qualitative typology on architectural daylighting by 6 profiles as in Guzowski, M (2018). The Art of Architectural Daylighting. London: Laurence King Publishing Ltd.

The design part of this thesis applies the qualitative typology of Guzowski in a competition entry for Vale de Moses meditation cabins in Portugal. The task of the competition is to design meditation huts. The project

proposes six variations of a meditation hut with different atmospheres for various meditation types. The designs are aimed to be instruments of light, demonstrating the power of daylighting as a shaper of atmosphere and architectural space by minimizing all means of expression except material, daylighting and how the buildings touch the ground. The atmospheres are connected to the six categories proposed by Guzowski to support the various types of mediations. In that way, the aim of the design is to achieve the desired atmosphere making daylight the main mean of architectural expression.

1.5 MAIN TERMS AND DEFINITIONS

Atmosphere – "mindful physical presence in space"
(Böhme, 2013)

Daylight – "visible part of global solar radiation" (EN 17037:2018)

Daylighting – "lighting for which daylight is the light source" (EN 17037:2018)

Daylight factor – "ratio of the illuminance at a point on a given plane due to the light received directly or indirectly from a sky of assumed or known luminance distribution, to the illuminance on a horizontal plane due to an unobstructed hemisphere of this sky, excluding the contribution of direct sunlight to both illuminances." (EN 17037:2018).

DF – Daylight factor

Discomfort glare – "glare that causes discomfort without necessarily impairing the vision of objects" (EN 17037:2018)

DGP – Daylight Glare Probability

EL – Europa Liit

EN – European

Glare – "condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance, or by extreme contrasts" (EN 17037:2018)

Potential duration of sunlight or insolation – "sum of the time (hours) (e.g. on a given day) within a given period during which the sun is above the actual horizon with a cloudless sky" (EVS-EN 17037:2019)

SAD – Seasonal Affective Disorder

2 DAYLIGHT AS AN ARCHITECTURAL MATERIAL

2.1 DEFINITION OF DAYLIGHT

Daylight is a dynamic environmental occurrence and an architectural material that changes as the time goes on, whether the period is an hour, a day or a season, and captures the changes as it keeps moving. In digital era that keeps us constantly indoors, daylight and its changes in time help us to connect with nature and acknowledge the time and space dimension of a particular location. Daylight can provide environmental benefits and at the same time increase human comfort level, health and overall wellness. (Guzowski, 2018, p. 6)

It is something that we can see during the day as it keeps changing but not physically touch or feel. Light is considered to be the most essential material for architecture but at the same time the least touchable out of all (Rose, 2015). We can witness how it touches different building materials and how it works in combination of them. As beautifully expressed by Louis Kahn, "The sun never knew how great it was until it hit the side of a building". The variety of atmospheric effects of daylight touching various materials can awaken our senses and help to understand the connection between humans and the world (Guzowski, 2018, p. 6).

2.2 DAYLIGHTING IN THE TOOLKIT OF ARCHITECT

Light is the strongest conditioner of the atmosphere and the most extensive principle to characterize a space and its essence (Pallasmaa, 2016). According to Pallasmaa there are two different systems resulting from light, which

both are equally important but need different qualitative and quantitative measures of light:

1. vision, that locates us in space
2. the circadian rhythm, which coordinates metabolic functions with time and the world.

Pallasmaa highlights the importance of holistic, multi-sensory perception of space and architecture in many of his writings, often referring to the phenomenological theoreticians and philosophers such as Maurice Merleau-Ponty. (Pallasmaa, 2016)

Leonardo da Vinci identified three types of different shadows:

1. attached shadow,
2. shading and
3. cast shadow.

Schielke explains attached shadow as something that falls on the body by itself, like a roof that casts shadows to the façade. He argues that shading has bright and dark contrasts, which belong to the specific form and depend on the source of light, like a dome shape pavilion, which even under a overcast sky forms a darker area in the lower part. The cast shadows are the result of for example a tall building casting shadows on a street because of the projection of the building's outline. (Schielke, Light Matters: Louis Kahn and the Power of Shadows, 2013)

Louis Kahn states that light makes material: "the purpose of the material is to cast a shadow". He argued that the building plans should be read all together as a harmony of space in daylight. A space that is intended to be dark

should at least have one opening so that we can tell that it is supposed to be dark and mysterious. Space should be defined by the structure and different kinds of natural light and it's in the hands of the architect make the space have secret and drama with just lighting and shadows. (*ibid*)

Kahn argues that architecture is about making a room, but a room is not a room when there is no natural daylight (Uddin, 2008, p. 728). A space without natural light can never reach its potential and there is no artificial light that can replace that (*ibid*). He defines material as a manifestation of spent light and believes that architecture doesn't exist on its own and there is only the spirit of architecture which cannot be divided into categories (Kahn, 1972).

Steven Holl is known for his typological and phenomenological design approach integrating the human experience to location-driven design. The phenomena of the space, the sun entering the room through windows and the reflection of the materials are all integrated and work together forming a whole. (MacLeod, 2019)

Daylight is not only about creating an atmosphere in buildings and enhancing its sensual approach to the users. People tend to underestimate the psychological and health aspect of light but architects have the power to emphasize those matters and remind the importance of them. Holl has taken up the challenge and uses daylight in rooms, where it is not thought to be found. He focuses on every space whether it is a bedroom, office, or a gallery because he believes that daylight is important for all of these spaces and you need to be able to see how the

daylight passes and changes throughout the day. (Schoof, 2017)

Peter Zumthor underlines two ideas about light that he always comes back to when designing a building:

1. "plan the building as pure mass of shadows then, afterwards, put in light as if you were hollowing out the darkness, as if the light were a new mass seeping in; (Zumthor, 2006, p. 59)
2. to go about lighting materials and surfaces systematically and to look at the way they reflect the light." (*ibid*)

He argues that you can choose and combine all kinds of materials, even the ones that are similar, but when light hits them, all of them look completely different. When comparing daylight and artificial light and how it is on things, only natural light has the spiritual quality to shine differently. Sun comes up every morning but he still finds it marvelous that it does that every day, and how it casts its light on things almost as if it belongs to some other world. And because of that, light feels like it's something beyond human power and understanding. Zumthor concludes that for an architect, there is no substitute to natural daylight which is "a thousand times better than the artificial light". (Zumthor, 2006, pp. 59-61)

Plummer argues that light is not just an instrument of transparency, it helps to illuminate forms and to express details, and that there are times when a swelling light can penetrate through the structure of objects, brightening them from within to glow translucently. We can sense this shift in the state of matter and the balance between light

and form has to be mutual, instead of material and immaterial challenging each other. (Plummer, 1987, p. 9)

2.3 HUMAN BENEFITS OF DAYLIGHTING

People spend 90 % (European Commission, 2003) of their day indoors, whether it's staying at home, working in an office or at school. Therefore it's important to have good indoor conditions when it comes to daylight. It is directly linked to our health and mental-health.

Light has an ability to influence human body in two ways. It affects the metabolism and hormone system through the retina and vision system. Also, it helps to produce vitamin D by photosynthesis, influencing the body through the skin. (Boubekri, 2008, p. 53)

Proper light during the day and darkness at night is necessary to regulate our internal clock, circadian rhythm and overall health. Light in the morning helps us to be more alert, therefore increasing the performance at the early hours of the day. Higher levels of daylight from mid-morning to early evening help us to balance the amount of hours that we need to stay awake during the day. (Andersen, et al., 2014)

The lack of daylight may lead to many physical and mental problems such as Seasonal Affective Disorder (SAD). There is no artificial light that can entirely replace daylight, and therefore up to 30 % (Molloy, 2014) of the world's population suffers from SAD. It mostly affects people living in the Northern latitudes exposing them to sleepiness, fatigue, melatonin-induced effects, negative emotions and poor performance (Boubekri, 2008, p. 56).

3 EVALUATION OF DAYLIGHTING IN BUILDINGS

Daylighting has quantitative and qualitative dimensions. According to Guzowski, light can be touchable, measurable and certain but at the same time light can be fairly unpredictable and immeasurable. Daylight and its movement can be determined and luminous attributes can be measured based on the standards metrics like daylight factor, glare, insolation etc. She argues that elements of intuition and experimentation are required to understand the qualities of daylight as it changes in time due to the changes in sky and surroundings. And the process of discovering is fundamental to the art of designing the daylight. (Guzowski, 2018, pp. 8-9)

Today daylight is often treated as a static and quantitative feature of space. But we actually desire the qualitative aspects of light such as the orientation of light, temperature, color and ability to reflect. Pallasmaa argues that our buildings tend to have too much light weakening the atmosphere, intimacy and mystery of the place. Evenly lit and shadow-less spaces tend to cause nausea and alienation. (Pallasmaa, 2016)

3.1 QUANTITATIVE METRICS

The European and Estonian standards on daylighting in buildings propose that the amount of daylight should be significant in buildings. Windows and roof-lights should be big enough to provide daylight all year around. (EN 17037:2018)

The Estonian standard is a translated version of the EN standard, with minor changes to match Estonian circumstances.

Daylight can provide a lot of light indoors, which ensures a high level of spectral quality and variability, changing with the day and the seasons. Windows and openings offer views and connection to the outside environment and contribute to the mental well-being of the people in the room. Windows also provide the insolation indoors, which is important, for example, in dwellings, hospitals and children's institutions. The standards deal with the presence of daylight during the year. Daylight should illuminate rooms for a significant proportion of the annual daylight hours. (EN 17037:2018)

The EN standards propose a variety of metrics to measure the quantity of daylight. The EN standard specifies the minimum requirements of lighting to achieve an adequate amount of light indoors and decent view out. Also the recommendations for exposure to direct solar radiation (insolation) are given. (EN 17037:2018)

In both standards daylight evaluation has been divided into 4 quantitative metrics that provide indications on the use of daylight (EN 17037:2018):

1. daylight factor;
2. minimum view;
3. insolation, and
4. glare.

DAYLIGHT FACTOR

Daylight factor (DF) is given in percentage and indicates the amount of daylight inside in relation to the outdoor daylight level over an overcast sky. Higher DF means that there is more diffuse daylight available in the room, and spaces with an average of 2% are considered to be daylit (Andersen, et al., 2014, p. 70).

The EN standard suggests that daylight should make an significant impact to the lighting in buildings and not only rely on the artificial lighting. It means that façade windows and roof-lights should have enough areas to provide proper daylight during the year. Therefore, the calculation of daylight should take into consideration the availability of daylight at the site in addition to taking account the properties of the site and the room (exterior interference, glazing transmittance, wall and roof width etc.). (EN 17037:2018)

A room is considered to have adequate daylight access if a minimum illuminance level is reached for at least 50 percent of the daylight hours across a percentage of the relevant space area (EN 17037:2018).

The EN standard proposes that the criteria for the minimum daylight provision should be (EN 17037:2018):

1. within the year and over half the daylit hours, a target daylight illuminance level should be surpassed over a fraction of the admissible area of the room (requirement for windows),
2. within the year and over half the daylit hours, a minimum target daylight illuminance level should

be surpassed over the whole admissible area of the room (requirement for windows),

3. within the year and more than half of the daylit hours, a target daylight illuminance level should be surpassed over the entire admissible area of the room (requirement for roof-lights).

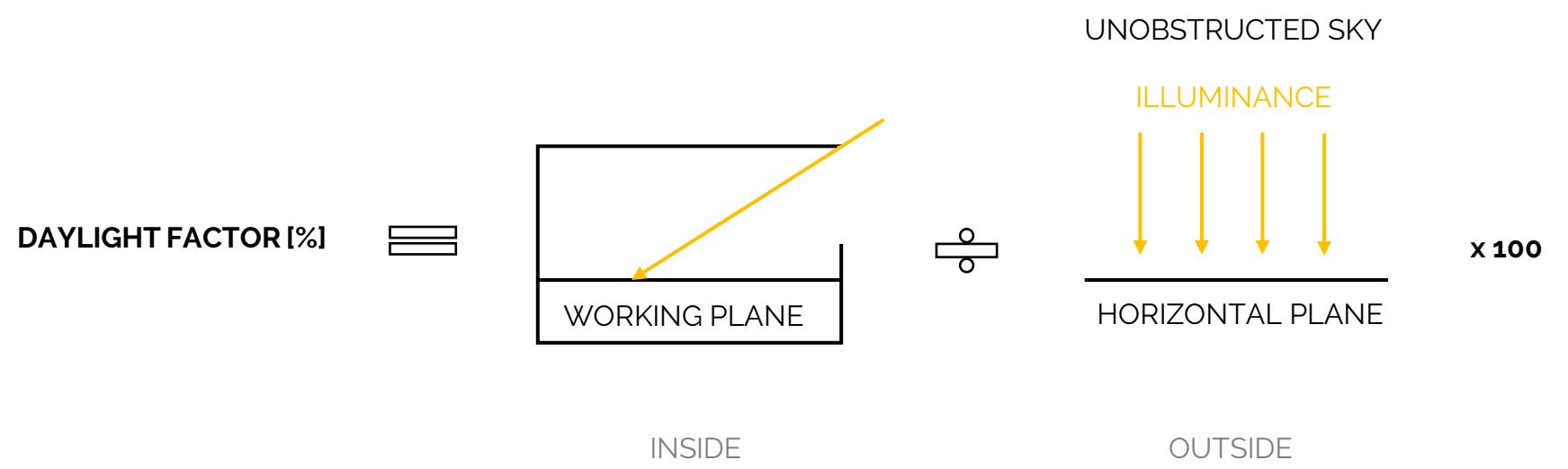


Figure 1. Calculation of daylight factor. (Thesis author)

MINIMUM VIEW

The view from the window helps to understand and sense the surrounding environment. It provides information about orientation, weather conditions and can help to tell the time by light and dark hours. Such a connection can alleviate fatigue caused by staying indoors for too long. Everyone in the room must have the opportunity to refresh and relax by changing the scene and focusing on other objects further away when looking out of the window. (EN 17037:2018)

View is divided into 3 general layers, that should be provided by the minimum view (EN 17037:2018):

1. sky,
2. landscape/ city,
3. and ground.

According to standard, the quality of the view depends on the size of the openings (windows), horizontal angle of the view, distance of the view, amount of layers, and view's environmental information quality. (EN 17037:2018)

Windows should be neutral in color, and transparent enough to provide an adequate view without any disturbing factors. To ensure that, the EN standard proposes:

1. at least landscape layer should be seen from inside (at least 75 % of the utilized area),
2. horizontal sight angle should be higher than the required minimum (at least 14 degrees),
3. the outside distance of the view should be higher than the minimal value (at least 6 meters)

4. windows should be minimum dimension of 1 m in width and 1,25 m in height. (EN 17037:2018)

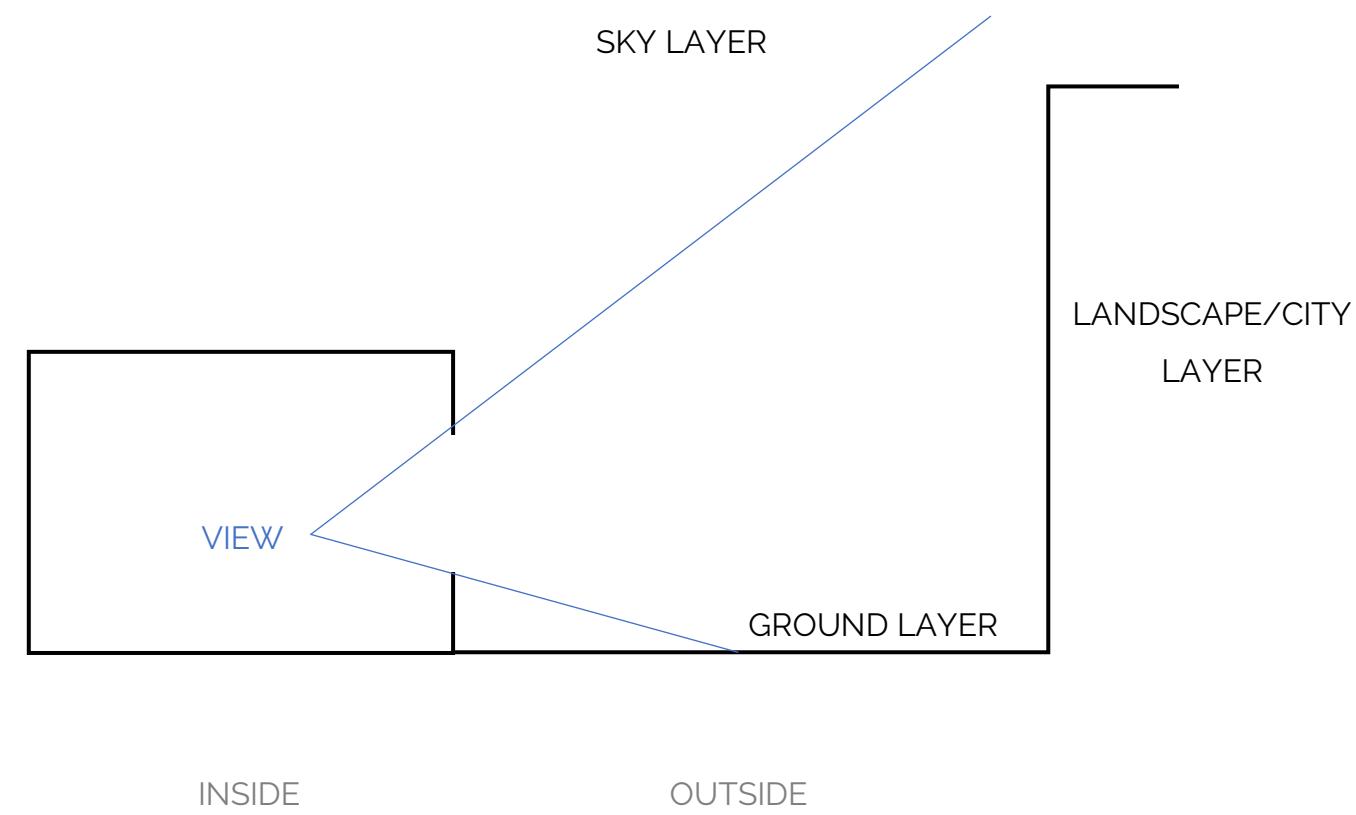


Figure 2. Layers of minimum view. (Thesis author)

INSOLATION

Direct sunlight exposure (insolation) is a significant quality criteria, mostly during winter, in dwellings, particularly for residential spaces where people spend the most time. It is especially important for the Northern European people. Most of the Northern countries have a low amount of daylight in winter. And because direct sunlight contributes to human health and well-being, it is important to use it as much as possible. (EN 17037:2018)

The EN standard specifies minimal hours for a space to obtain solar radiation for specific days throughout the year. It is more focused on spaces that people live in and spend the most of the time. "For a specific reference day in the year, the minimum recommendation is that a space should receive sunlight for a duration higher than minimum duration of sunlight, in hours per day (h)." (EN 17037:2018)

Insolation requirements take into account the geographical location, sunlight conditions and altitude, therefore it is location-based and needs to take in count all the aspects of a specific location. (*ibid*)

The EN standard states, that "minimum exposure to sunlight in at least one habitable room of a dwelling, all patient rooms in hospitals and play rooms in nurseries should be at least 1.5 h on the March 21st." (EN 17037:2018)

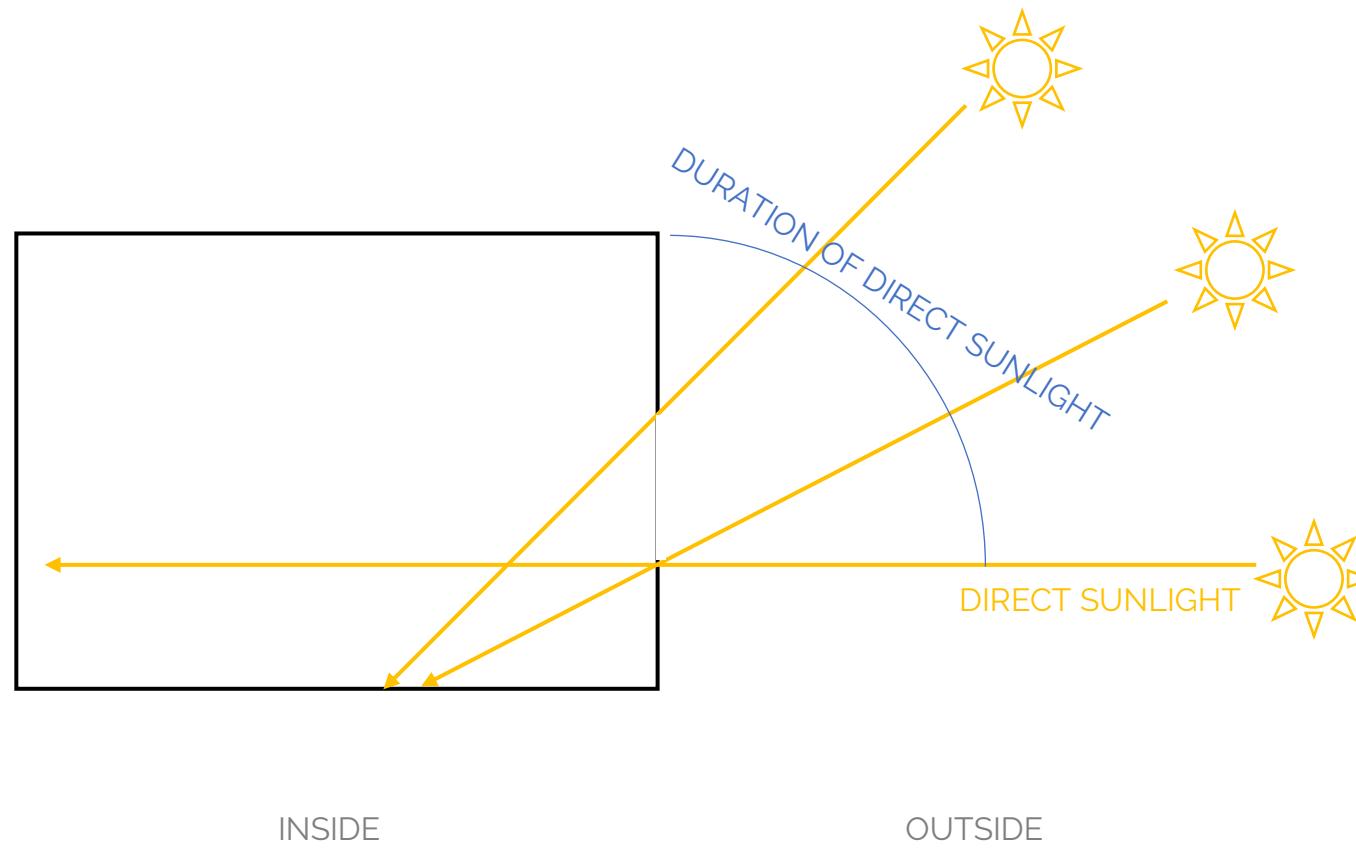


Figure 3. Insolation. (Thesis author)

GLARE

Glare is a negative sensation caused by exceptionally bright light or intense brightness contrast in the sight of eye (Yilmaz & Vissenberg, 2018). It means that bright areas and surfaces with higher luminance than the luminance to which the eyes are adapted to, irritates the eye and affects the vision (EN 17037:2018). It also depends on the physical parameters like the viewer's age, sensitivity to light, etc. (Yilmaz & Vissenberg, 2018).

Main sources for glare inside the room are windows and glossy finishes (*ibid*). Daylighting design often aims at providing right amount of light with minimal glare (Benya, 2010). Glare can be limited by shading that blocks the direct view towards the sun or possible material reflections due sun (EN 17037:2018). The EN standard also points out that it is important to choose right materials that do not reflect too much light, but at the same time do not reduce daylight during overcast days on the other (EN 17037:2018).

Glare caused by natural daylight is different from the glare caused by artificial lighting, even though the size of the natural glare source (sun) is much bigger. People tend to accept glare caused by daylight much likely. (EN 17037:2018)

Daylight can vary in brightness and in color over time. Indoor daylight depends on the size of the openings and how they are placed (EN 17037:2018).

The EN standard instructs to evaluate the annual occurrence of glare for assessment of daylight glare and

to apply the Daylight Glare Probability (DGP) metric. (EN 17037:2018)

To reduce glare caused by daylight, shading devices can be used (EN 17037:2018):

1. avoid the direct connection with sun and its reflection,
2. shading devices should be used, but their material characteristics should be taken into account,
3. shading devices should be adjustable

According to EN standard, the minimum criteria for protection from glare is guaranteed when the DGP is not exceeding the maximum value for more than X % of the usage time of the space. (EN 17037:2018)

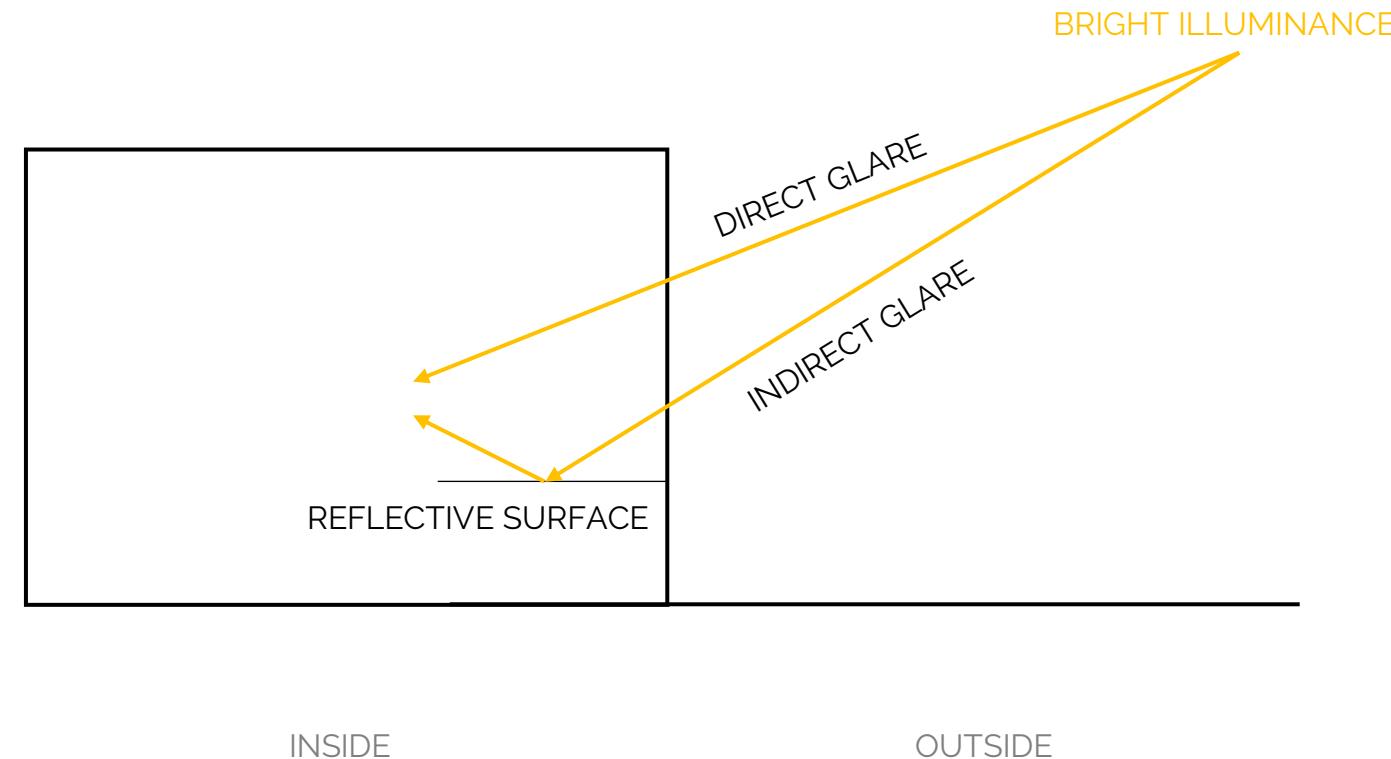


Figure 4. Glare. (Thesis author)

3.2 EVALUATION OF DAYLIGHT QUALITY

The evaluation of daylight quality is undoubtedly less established than the quantitative methods. It seems that the most useful approach for evaluating daylighting quality is creating typologies. Typologies consist of categories that show the qualities achieved by daylight. Whereas the quality is unmeasurable, there is no proven method for selecting interiors, which are considered to represent high quality of daylighting in architecture. "We have yet to see a method that can measure the spatial and temporal diversity of light within the visual field" (Rockcastle & Andersen, 2013).

The perception of architecture can be significantly changed by the daylight during a day. When sunlight is used to illuminate a space, it can greatly change our understanding of the architectural space. According to Rockcastle and Andersen, designing daylight has to be specific to a location and within the context of each architectural work. They have developed a typology, a matrix of contrast, where the scale goes from high to low contrast. It showcases the composition of perceptual luminosity within a specific space, helping architects to compare the daylighting conditions within a space. (Rockcastle & Andersen, 2013)

Guzowski proposes six types of qualitative daylighting profiles which illustrate a cross-section of daylight designs. All of these profiles approach daylight as a "building material" and a phenomenon (Guzowski, 2018, p. 8):

1. choreographed light,
2. atmospheric light,
3. sculpted light,
4. structured light,
5. material light and
6. integrated light

The following is using Guzowski's qualitative typology for evaluating daylight quality, as it appears more suitable for this project which aims to create different types of atmospheres through daylighting. The typology of Guzowski is also less connected to measurable aspects than the typology of illumination contrasts proposed by Andersen et al.

CHOREOGRAPHED LIGHT

"Choreographed light considers how daylight can be used to create a sequence of spatial and luminous events to celebrate the experience of place, climate, and program. Whether intentionally meandering or tightly composed, light can be scripted much like the choreography of music and theater." (Guzowski, 2018, p. 8)

When using choreographed light, Guzowski proposes (Guzowski, 2018, p. 10):

1. it should support the concept of the building, room layout and also the desirable lighting qualities,
2. it takes into account the time dimension to express the seasonal and circadian cycles,
3. different dimension layers should correspond (human body, light, time, etc.)

According to Guzowski, the relationship between daylight and the architectural design is essential to choreographing light. It is an intentional use of desired luminous qualities and architectural elements, such as materials, structure, etc. all together. It also takes advantage of the time dimension as the sky is always changing and interacting with the architectural form, materials and space. Although the movement of the sun and time is predictable, it still has an unpredictable side that introduces elegance that is always spontaneous and temporary luminous phenomena. (Guzowski, 2018, pp. 10-11)

"Architecture is a three-dimensional experience of the body in space, brought to life by the fourth dimension of

time through the changing rhythms of day and night and the cycles of the seasons. Light can be used to encourage

wandering, to gently guide, or to draw people through architecture and space." (Guzowski, 2018, p. 12)

This kind of approach to daylighting is unique to every building, as it highlights the specific location and climate characteristics. "Greek architecture taught me that the column is where the light is not, and the space between is where the light is. It is a matter of no-light, light, no-light, light. A column and a column brings light between them. To make a column which grows out of the wall and which makes its own rhythm of no-light, light, no-light, light: that is the marvel of the artist." – Louis Kahn.

ATMOSPHERIC LIGHT

"Atmospheric light celebrates the qualities and moods of light particular to a geographic location and latitude for a given program. The desired atmospheric qualities of light and darkness are intimately related to design intentions, experiential concepts, and practical program goals." (Guzowski, 2018, p. 8)

According to Guzowski, atmosphere in its essence is very abstract and subjective. It is linked to human feelings, moods, personality and existence. The desired qualities of atmosphere are usually emotional qualities like calmness, serenity, safety, steadiness, etc. When using this kind of approach to daylighting, the user is in the center of the design. It takes into account the human experience, but also architectural composition. And when combining these two, it guides the process of developing desired qualities in a space. It helps to identify the need for different kinds of tones and moods in a space. (Guzowski, 2018, p. 54)

People look for comfort and the satisfaction of a right feeling in a room. Those sensibilities go hand in hand with the beauty and the atmosphere of a space. When using atmospheric light in design, Guzowski proposes to think about what is the intention of the room and what are the activities that are being done there. Because the user is in the center of designing this kind of light, the desired feelings should be very well thought through. She also incorporates the time and seasons dimension into this lighting design, so the solution should consider what does it add to the overall design. Different hours of day and

seasons can elevate the use of light, and add a valuable dimension to the atmosphere. (Guzowski, 2018, p. 56)

SCULPTED LIGHT

"Sculpted light explores how architectural form can be shaped to support daylighting program and performance goals. The building massing, section, spatial organization, envelope, and window detailing are inseparable from the quality, quantity, distribution, effectiveness, and ecological benefits of natural light." (Guzowski, 2018, p. 8)

Many architects have been inspired to use architectural form as something that adds value and beauty to the interior daylighting. The use of different form shapes in interior has a potential to make great daylighting design (Guzowski, 2018, p. 86). "Architectural form is the point of contact between mass and space. Architectural forms, textures, materials, modulation of light and shade, color, all combine to inject a quality or spirit that articulates space. The quality of the architecture will be determined by the skill of the designer in using and relating these elements, both in the interior spaces and in the spaces around buildings." (Bacon, 1967)

Form gives light the movement and determines the quantity and quality. But it works the other way around too, so that light is the one that gives shape to the form. If we have a blank wall then the movement of light give a second dimension. Windows, openings and other details are also considered to be a building form, because they determine how the light comes in, how much and how deep it penetrates. Although architects usually don't start with designing the form of a building, it is still an important aspect of designing daylight. (Guzowski, 2018, p. 89)

"Form and light are inseparable from the activities and purposes of architecture. Whether poetic or pragmatic in nature, an inherent beauty and aesthetic comes from finding the appropriate form for the architectural context and aspirations." (Guzowski, 2018, p. 89)

STRUCTURED LIGHT

"Structured light considers the relationship between light and structure as it expresses design intentions and desired atmospheric qualities. The choice of daylighting strategies, form, and detailing are inseparable from a selected structural system and material palette."

(Guzowski, 2018, p. 8)

Architectural structure elements can be used to define the character of light and give an interesting pattern to daylight. According to Guzowski, when you choose a material, it is also a choice of structure, as they go hand in hand. A structure also limits the use of windows and openings. It depends on the structure and its material, which kind of characteristics can be used in openings. "If loads are carried internally, then the building envelope has great flexibility and freedom in the choice of window form, size, and placement. The resulting pattern and quality of light may or may not reinforce the structural expression."

(Guzowski, 2018, p. 118)

In today's world, we have developed ways that different materials can be used as structure. In the past, it has been limited so the use of windows and openings had to be strategic and the location and size had to maintain the structure of the wall. Now we can use those materials, like brick and stones, to create patterns and intentional openings. We are able to use the combination of structure elements and the materials to create interesting daylighting solutions. "More delicate, yet structurally strong, frame systems such as wood, steel, and aluminum provide the freedom to open much larger expanses of glazing between load-bearing frames" (Guzowski, 2018, p.

119). The choice of structural elements and their materials give the light a chance to work with them and create a situation, where structure is the giver of light. (*ibid*)

MATERIAL LIGHT

"Material light explores natural light as a dynamic and ephemeral building material that interacts with architectural space and material surfaces to influence the resulting luminous quality of space in time." (Guzowski, 2018, p. 8)

When combining the qualitative characteristic with a specific location and its environmental properties, we get an interaction between daylight, the materials and surrounding environment. "A place can be defined by the special qualities of its natural light: the shimmering liquid light of Venice; the soft, diffused light of a misty morning in London; The brilliant sunlight and high contrast of light and shadow on a summer day in Lisbon, or the dramatic seasonal transition from light to darkness in Helsinki." (Guzowski, 2018, p. 156)

According to Guzowski, daylight is considered to be a momentary building material which can be shaped like any other building material. As light moves throughout the day, it interacts with the materials creating qualities that make the architecture to come alive. When using light as a material, Guzowski proposes that the light of the specific location needs to be researched before, to know how light acts and what are the characteristics of it. Also what kind of atmospheres can be created with that kind of lighting. (Guzowski, 2018, p. 156)

Material light is very location-based and considers the relationship between daylight attributes and architectural materials used in the building. It also takes into account the physical material properties like texture, color, size, hue,

etc. She is making the material choice number one aspect about this kind of lighting. The properties of the materials in combination with light, should work with the desired atmospheric needs. (Guzowski, 2018, pp. 156-159)

Marietta Milletta has said, that "light and materials are mutually dependent on each other. Materials are key to understanding light in architecture because they directly affect the quantity and the quality of the light. Two qualities of materials – their finish and their color – are most important in this regard. Specular materials, such as glossy finishes, reflect light as a mirror does, which can result in reflected images of the light source being visible 'on' the surface. Matte surfaces, such as natural stone, wood, and plaster, reflect light diffusely equally in all directions. Of the three aspects of color – hue, value, and intensity – value is the one that determines how much light is absorbed and how much is reflected. " (Miletta, 2016)

INTEGRATED LIGHT

"Integrated light explores opportunities to couple daylighting with architectural form, passive design, and innovative technological systems to integrate program, aesthetics, performance, energy, and sustainable design goals." (Guzowski, 2018, p. 8)

An integrated architectural design is a continuous conceptional process that take into account different dimensions, like culture, ecological system, humans, history, daylight etc (Cadima, 2007). It combines different design strategies for the sake of ecological system (Guzowski, 2018, p. 192).

According to Guzowski, daylight is only one dimension of the whole integrated design, but it is the one that influences the other parts of the design too. "Daylight is most effectively addressed through the configuration of the building massing, section, and spatial organization. It intersects with comfort in the design of the building envelope and spatial planning to enhance natural ventilation and passive heating and cooling. (Guzowski, 2018, p. 192)".

When integrating daylight with electric lighting and the whole energy system, it has the ability to lower the energy assumption. It means that integrated lighting approach should be beneficial to the whole building energy system. This kind of approach to using daylighting encourages architects to explore, how daylight can be use on the outside, and through that, be brought back to inside with integrated systems. (Guzowski, 2018, pp. 192-194)

4 MASTERPIECES OF ARCHITECTURE IN QUANTITATIVE EVALUATION

Daylight is most commonly evaluated in quantitative analyses, which are measuring the amount of daylight. The quantitative approach is very well established, as many standards have been developed about daylight. The following analysis shows that sometimes the interiors considered masterpieces of architectural daylighting may perform well in quantitative analyses - but sometimes they may work in the opposite direction with daylighting that performs poorly in quantitative metrics. The four quantitative metrics are applied to two masterpieces per quantification method: one that performs well and the another that appears to work in the opposite direction is not following what the standard is proposing, illustrating a different approach to daylighting.

4.1 DAYLIGHT FACTOR – SPACES BATHING IN DAYLIGHT

Daylight factor (DF) is given in percentage and indicates the amount of daylight inside in relation to the outdoor daylight level over an overcast sky. Higher DF means that there is more daylight available in the room, and spaces with an average DF of 2% are considered to be daylit (Andersen, et al., 2014, p. 70).

High daylight factor can be, for example, beneficial in museum architecture, where light has to be casted evenly on the exhibited art-pieces to understand their shape and details. Nonetheless, DF doesn't give any indication on distribution of light, for example contrast. Swedish designer Olle Anderson describes the importance of

contrast as follows: "If a uniform, diffuse light is applied to a whole space it communicates that no part or surface is worth emphasising or more important than any other. A space like this is usually experienced as boring and insignificant since it lacks the clearly defining contrasts, borders and gradients that the gaze always searches for." (Anderson, 1988, p. 27)

Louis Kahn stated that "light is the one that makes material, and the purpose of the material is to cast a shadow". He argued that the building plans should be read all together as a harmony of space in daylight. A space that is intended to be dark should at least have one opening so that we can tell that it is supposed to be dark and mysterious. Space should be defined by the structure and different kinds of natural light. (Schielke, Light Matters: Louis Kahn and the Power of Shadows, 2013)

DF is not capable of giving any indication of contrast, which according to Schielke and Kahn is essential for daylighting in architecture. In some cases, i.e. Alvar Aalto Riola Church, a masterpiece of architecture can have a high daylight factor, but in other cases, for example Peter Zumthor's Bruder Klaus Chapel, the general lighting level can be very low and the performance measured by DF would remain below any recommendations.

A masterpiece with high DF: Alvar Aalto's Santa Maria Di Assunta Church in Riola Parish, Italy

Riola Parish Church, which is designed by Finnish architect Alvar Aalto, is an extraordinary concrete building that resembles the shape of the Italian landscape and the surrounding environment. It is located eight kilometers south from the city of Bologna, Italy, in the town of Riola. Aalto's expressive modern architectural piece captures the surrounding and from inside to outside expresses the divinity of faith and place. (Edwards, 2011)

Aalto designed Riola Church without any windows on the eye level. There are 4 rows of skylights above on the roof that reflect light from north hitting the walls with different shapes. The interior of the building is entirely finished with white plastic wall panels that reflect the light and increase the brightness. The northern light is transmitted across vertical, asymmetric ribs, forming a glorious soft light grid that extends down to the worshipper where it is



Figure 5. Skylights. (Franco di Capua: <https://bit.ly/35qAhbm>)

the brightest (Edwards, 2011). The intense light transcends the individual beautifully into a saintly state (*ibid*).

The intense focused light around the altar is meant to establish a close connection between the functioning spaces of the altar, choir and organ. (Edwards, 2011)

A flow of delicate north light reaches from above through the massive beveled windows, which are then further decolorated and muffled by reflections within the rooftop structures and ultimately emitted into every hollow of the church as a peaceful white mist. This air-like light penetrates the secluded recesses that would otherwise be left dark, so that the entire vessel is a cloud of whiteness. (Plummer, 1987, p. 95)

Aalto uses simple means to modify and transform the light in Riola church, therefore improving the sense of the space. He uses a fan shaped design that narrows towards the altar. From east to west, the taperings are supported by rounded concrete arches that are repeated.

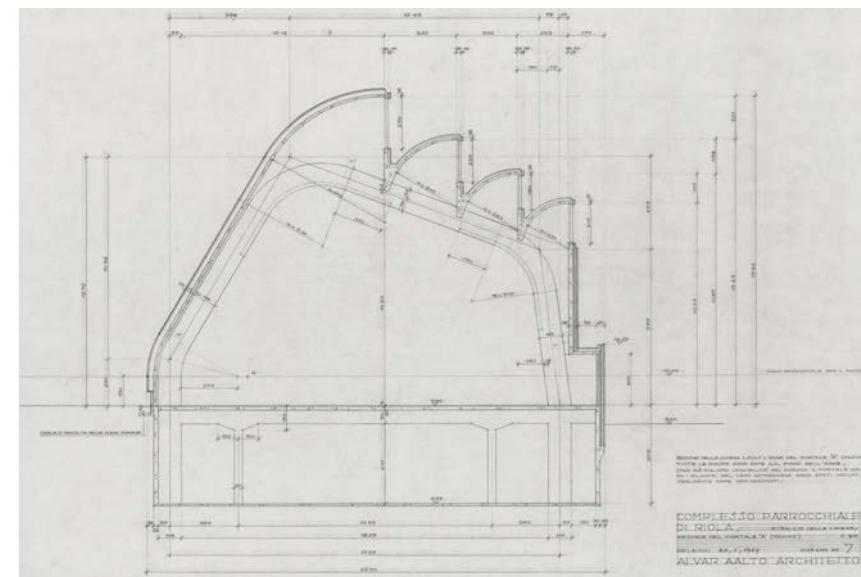


Figure 7 Section of the Hall. (Alvar Aalto Foundation: <https://bit.ly/2xvo4pp>)

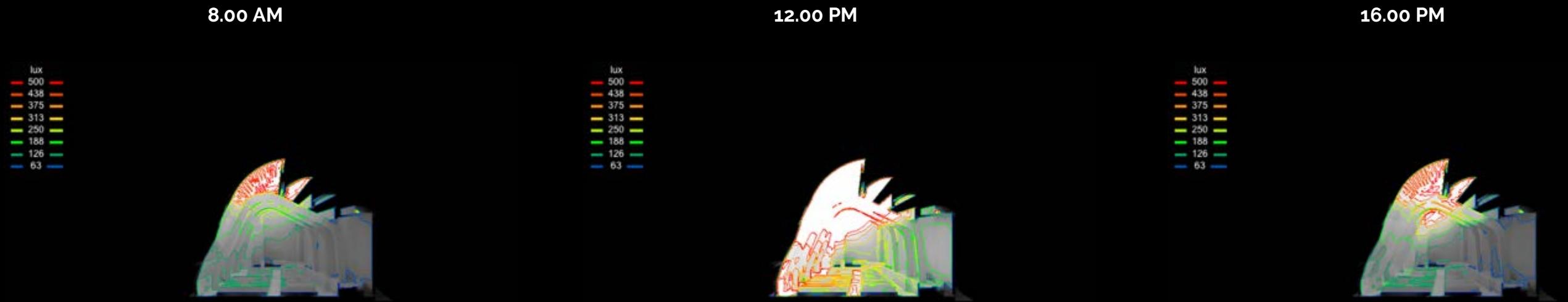
Those arches gradually get smaller in size near the altar. (Heffron, 1986)

As shown on the light analyses, Riola Parish Church is undoubtedly a very well-lit space and meets all the requirements for daylighting when measured as DF according to the EN-standard. As the standard proposes for the roof-lights, the analyses shows that within one year, more than half of the daylit hours, the required daylight illuminance level is surpassed. Aalto has based his whole architectural conception around the generous light coming from above. Those openings with the choice of materials, provide high levels of diffused light, which is what DF measures in interior.



Figure 6. View to the altar. (Franco di Capua: <https://bit.ly/2YqqFWB>)

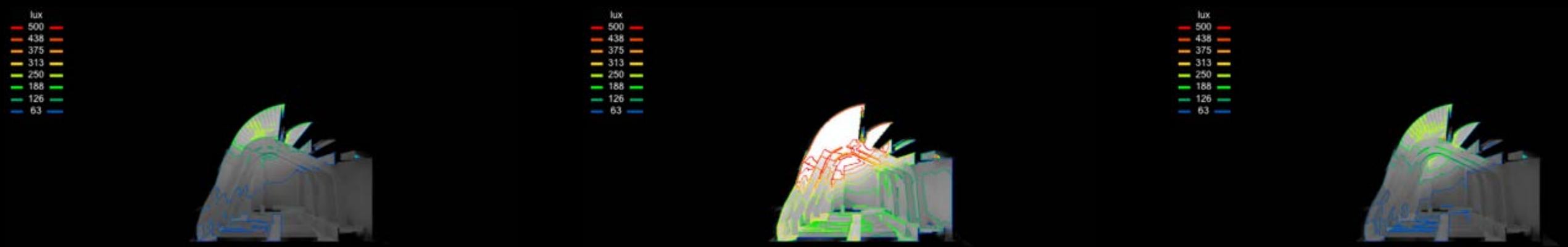
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A masterpiece with low DF: Peter Zumthor's Bruder Klaus Field Chapel, Germany

Peter Zumthor's Bruder Klaus Field Chapel, completed in 2007, is known for its stunning reverence for the materials used to create the seductive space. The chapel's center is a dark cavity which has been achieved by burning 112 tree trunks from concrete cast walls. There are 24 layers of concrete surrounding the wood making a blunt contrast between the concrete on the outer façade. (Ziliacus, 2016)

Many small holes were left behind in the walls after the framing was removed, creating an effect symbolizing the night sky. The "beautiful silence" of the chapel and the combination of the surrounding landscape make it a poetic and popular destination. Although the chapel is very strong from the outside, it doesn't stand out as brutal according to Ziliacus. (*ibid*) The interior remains mysterious as the burning of the tree trunks has left it darker inside, meaning that there is a higher contrast in light between the smooth concrete and the burned inside.



Figure 8. Exterior of the Chapel. (Samuel Ludwig <https://bit.ly/2LfsLXK>)

The floor of the chapel is covered with lead, melted on the site and put manually to the floor (Etherington, 2009). On top of the chapel, there is a small opening, which resembles the flare of a star (Sveiven, 2011). This oculus is the only opening in the building allowing daylight to come inside and light up the whole chapel. Because of the shape of the chapel and the curved walls inside, this contrasted light is distributed throughout the building. Zumthor based the experience on the intense contrast between daylight and darkness (Schielke, Light Matters: Sacred Spaces, 2014).

In a quantitative study this opening is considered to be a roof-light, and the standard says that within one year and within more than half of the daylit hours, a target daylight illuminance level should be surpassed over the entire admissible area of the room. As shown in the analyses, the chapel doesn't surpass the criteria.

Despite that, this masterpiece is unique for its solution for daylight, which creates a mystic atmosphere that Zumthor



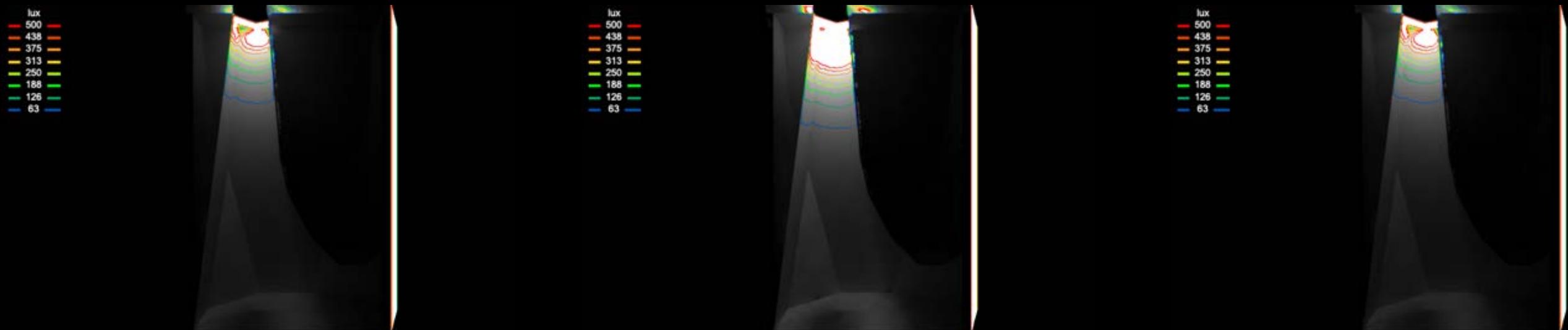
Figure 9. Roof opening. (Samuel Ludwig <https://bit.ly/2LfsLXK>)

was aiming for. The atmosphere is created with low lighting levels and high contrasts. A rather obvious finding is that a quantitative analysis applying DF indicates poor performance for the unique space. According to Guzowski, the desired qualities of atmosphere are usually emotional qualities like calmness, serenity, safety, steadiness, etc. which represent a darker and mystical atmosphere (Guzowski, 2018, p. 54).

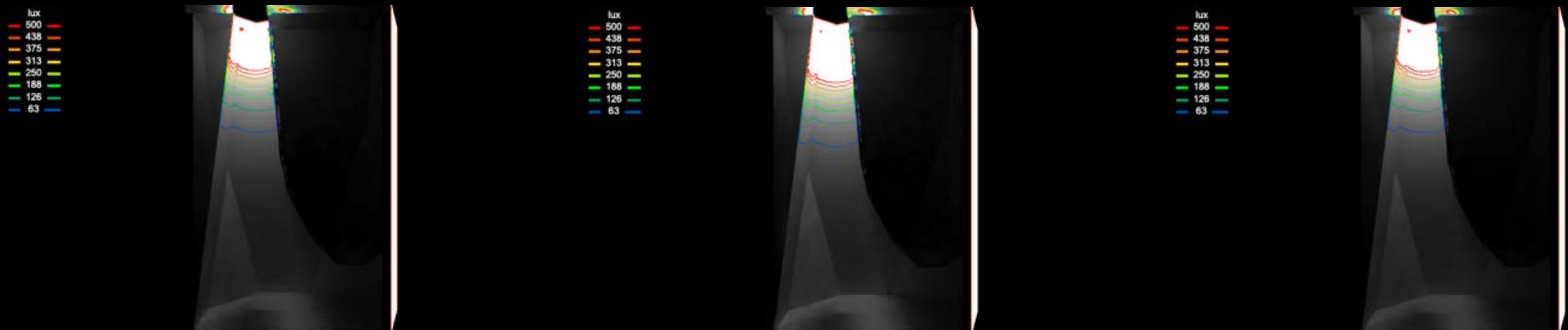


Figure 10. Interior view. (Samuel Ludwig <https://bit.ly/2LfsLXK>)

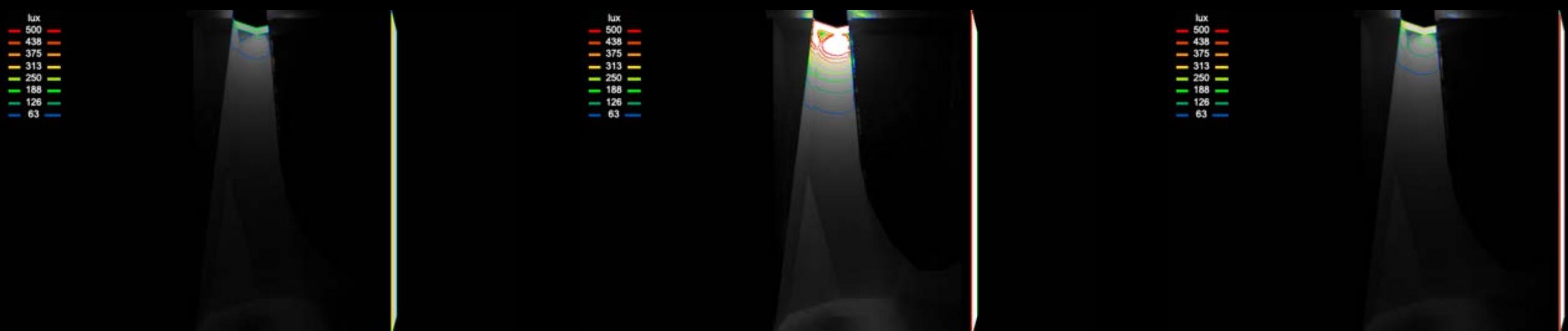
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4.2 MINIMUM VIEW – CONNECTING INSIDE AND OUTSIDE

According to EN Standard, view is defined by tree layers: sky, landscape/city and ground. The more layers are visible, the better is a view because we can then tell the location of the building, what's the weather outside and how nature changes during time. (EN 17037:2018)

Good view is preferred and beneficial in residential buildings, offices and where ever people usually spend a lot of time. "A natural view is preferred over a view towards man-made environment and a wide and distant view is appreciated more than a narrow and near view. (EN 17037:2018)". People preferer to sit in front of the window and have a look outside, the same goes in work places, where usually the window seats are occupied first. There is a connection between daylight and the quality of the view. "The more interesting a view, the less people experience glare from the window." (EN 17037:2018)

But the importance of the view is not always that necessary, as the windowless spaces aim at creating mystic atmospheres. Tadao Ando has said that, "I have always had a tendency to imagine architectural space as being enclosed and cave-like. It seems to me that clues to the origins of architecture are to be found below ground. Beneath the earth's surface, light is reduced, the sense of depth increases, and darkness is born. I have long imagined space as something into which one descends, until light is gradually reduced and one is wrapped in an atmosphere of cool tranquility." (Jodidio, 2006, p. 8)

A view aspect by itself is not capable of giving any measurements to the quantity of daylight. It rather represents the size of the windows as a light giver. Some masterpieces, like The Glass House, have utilized the view as a part of the design, but others, like The Daylight House, have limited it, and found other solutions to daylighting in buildings.

A masterpiece with a great view: Philip Johnson's Glass House, US

Philip Johnson's Glass House (1949), constructed on top of a hill in New Canaan, Connecticut, is a world-famous architectural masterpiece. The openness of the dwelling is intended to contradict almost every traditional residential concept. (Hawthorne, 2012)

The Glass House is best known as a pavilion for seeing the nearby scenery. This house is not visible from the road giving it the privacy aspect that it's lacking. It is overlooking a pond and nearby forest. The house is 1,7 meters tall and has a floor surface area of 169 m². Every wall has its own door in the center that can be used to open the space up onto the landscape. This iconic building introduced the International Style into American residential architecture, and is known for its innovative material use and ability to blend into the surrounding. (National Trust for Historic Preservation, 2015)



Figure 11. Exterior view. (Blake Robinson <https://bit.ly/3dwceKL>)

The Glass House became a nature observation area for Johnson. He built the translucent house to watch the tree's shift in color and how seasons and weather change. It was more so a landscape project, where the view was primary, therefore he planned it very carefully so that the interior-exterior relationship was the key element. He argues that the landscape is a spatial expansion of the inside. And because of that close connection, he has said that he has a very expensive wallpaper, referring to the floor to ceiling landscape view. (Poursani, 2016)

The translucent design provides invisible barrier for sunlight to come through during the day. No matter what is the sky condition or time dimension, it is a well-lit house no matter what. The adaption of daylight makes the atmosphere much calmer and more peaceful as the abundance of light provides a feeling of comfort. However there is a downside to the transparency of the walls, because there is no solar shading so it runs the risk of over-heating in summer time. (Asistin, 2018)



Figure 12. Interior view. (Fujiko Nakaya <https://bit.ly/3dpjvfU>)

Johnson's approach to this was surrounding the house with trees that provide shading and visual beauty. The trees are not only a decorative feature, they provide the continuation from the inside to outside, therefore being the connecting link to this design. They also help to regulate the amount of direct sunlight coming to the house, providing shading with the leaves. (Asistin, 2018)

Johnson's Glass house is a prime example of following all the requirements in the daylighting standard. All of the three layers of view are provided (sky, landscape, ground). The distance of the view is exceeded over 6 meters, which is the minimum requirement according to the standard. Also the size of the windows is larger than the minimum size proposed in the standard, which is 1 m in width and 1,25 m in height.

"...The only house in the world where you can see the sunset and the moonrise at the same time, standing in the same place." – Philip Johnson



Figure 13. Interior view. (Blake Robinson <https://bit.ly/3dwceKL>)

A masterpiece with limited view: Takeshi Hosaka Architects' Daylight House, Japan

The Daylight House by Takeshi Hosaka Architects located in Yokohama, Japan (2011) is a one story private residential building for a family of four. The main element of the design is the natural illumination of the interior which has been achieved by 29 roof-lights and a system of curved acrylic panels that diffuse the light coming into the space. (ArchEyes, 2016)

There is a constructed grid of $1,5 \times 1,6$ meters over the ceiling of the house serving as a construction element (Frearson, 2011). There are curved acrylic sheets that fixed in between. This kind of structure is seen and felt from each room in the house (*ibid*). There is a space between the roof and the acrylic, which regulates the temperature. In summer, hot air is extracted from the house, but in winter the air circulation is stopped to maintain a stable thermal atmosphere inside. (ArchEyes, 2016)



Figure 15. Interior view. (Koji Fujii <https://bit.ly/3dvllvc>)

The site is surrounded by many tall office and apartment buildings, therefore the decision was to use the skylighting system to bring light in from the roof. This kind of solution lets the user feel the changes and expressions of the sky very delicately and the feeling of outside becomes the main point of attention. The floor is made out of mortar and the walls are from plywood. (Frearson, 2011)

Each room has a window sized $0,9 \times 0,7$ m on the eye level. The purpose of these windows is to circulate air. Because of the location, those windows do not have a purpose to be looked outside, all that can be seen is the side of the other building. When entering the house, the amount of daylight is surprising considering that the site is in a dark valley that is created by the tall buildings around. Daylight does not mean only the direct sunlight but rather refers to the light that changes throughout the day. Meaning that it takes into account the color of the sky, brightness, time dimension, shadows of the clouds, etc. Similar to the sun, the moon light is also seen from the house as it reflects in night. It



Figure 14. The visible roof-light. (Koji Fujii <https://bit.ly/3dvllvc>)

means that from inside, the users can see the changes 24 hours a day while staying in. (ArchEyes, 2016)

The daylight House presents a very different idea of good daylighting than the EN standard. It doesn't meet the requirement for the minimum size of the windows ($1 \times 1,25$ m). Also from the inside, it does not follow the idea of the tree layers of view. The only layer that is seen is the sky layer, but the standard proposes that at least 75 % of the landscape layer should be seen. Also the minimum criteria for the distance of the view is not met, as the standard says that it should be at least 6 meters. "Inward-looking architecture is a very Japanese concept. The reason for this is the absence of space and the high population density of big urban centres such as Yokohama. (Floornature, 2013)". That explains the absence of windows and the choice of making daylighting the priority.



Figure 16. Outside view to the roof. (Koji Fujii <https://bit.ly/3dvllvc>)

4.3 INSOLATION – DRAMA OF CAST SHADOWS

The EN-Standard states that sunlight is a necessity in interiors. Some rooms need the sunlight more than others, so it depends on the function. At least habitable rooms should have direct sunlight. It is an important element of daylighting as it brightens a space and has a thermal quality. Nonetheless it has to be controlled, so that it doesn't create glare, which is uncomfortable for the occupants. When used properly, it is welcome in most buildings. (EN 17037:2018)

Sunlight is beneficial in residential buildings, hospitals, schools, etc. According to EN Standard, "solar gains can contribute positively to the reduction of energy consumption for heating. In warmer months, sunlight should be restricted by solar shading devices or by strategically constructed shading elements, either as a static or a moveable device." (EN 17037:2018)

In Europe, sunlight with the right kind of shading, is mostly welcome, especially in wintertime. Shading devices also add another dimension to the sunlight making it interesting from inside. Krautter and Schielke have said, that "shadows help to render forms and textures. Façades are a fascinating canvas for the sun during the course of a day. The balance of light and shadow is a core element of creating spaces." (Krautter & Schielke, 2009). But considering the climate differences, in some parts of the world, direct sunlight is avoided.

A masterpiece with high level of insolation: Louis I. Kahn's Jatiya Sangsad Bhaban, Bangladesh

The Jatiya Sangsad Bhaban, or best known as the National Assembly Building of Bangladesh, is located in Dhaka city, Bangladesh (Akhter, 2012). Completed in 1982, it is considered to be one of Louis Kahn's masterpieces when it comes to daylighting.

The abstract geometric openings seen on the façade, provide a dramatic effect to the building's overall design. The shapes used in the building are abstract forms that are unique to the Bangli culture. They are designed to create a link between old and new cultural values and also act as light openings providing sunlight into the interior. Kahn used his way of thinking about light as an important design aspect in this building. Light is not only something to illuminate space, but it is more so a conception, that creates a space. (Souza, 2010)



Figure 18. Interior view. (Joe Blogs <https://bit.ly/3fvtC4t>)

"In the assembly I have introduced a light-giving element to the interior of the plan. If you see a series of columns you can say that the choice of columns is a choice in light. The columns as solids frame the spaces of light. Now think of it just in reverse and think that the columns are hollow and much bigger and that their walls can themselves give light, then the voids are rooms, and the column is the maker of light and can take on complex shapes and be the supporter of spaces and give light to spaces. I am working to develop the element to such an extent that it becomes a poetic entity which has its own beauty outside of its place in the composition. In this way it becomes analogous to the solid column I mentioned above as a giver of light."

- Louis Kahn

The entire building is constructed out of concrete with stripes of white marble running through (Souza, 2010). When combined with sunlight, those materials create a stunning pattern on a wall, making it seem like sunlight is a part of the wall design. It showed the power of the modernism, but more so it was a tribute to local resources



Figure 17. Interior view. (AKDN <https://bit.ly/2AhaPd3>)

and traditions (*ibid*). The building is surrounded by an artificial lake, which acts as a natural source of insulation and also cooling system (*ibid*). Because of the reflection, it creates interesting lighting situations inside the building.

Although the standard is focused on the living spaces, this masterpiece makes use of insolation and in that sense follows the performance targets proposed by the EN-standard on daylighting. This building has windows in every possible direction and they are carefully placed to highlight the important elements of the building. Being that the main religion in Bangladesh is Islam, sun is an important element. In Islamic cultures sun symbolizes God, and God is the light of the heaven and earth (Fullton, 2009). The praying room (Figure 16) shows how carefully the direction of the sun is thought through, as the sunlight hits the altar.



Figure 19. Interior view. (BayanBox <https://bit.ly/3bf8UT3>)

A masterpiece with high level of insolation: Aedas' Al Bahar Towers, UAE

Located in Abu Dhabi, UAE, Al Bahar Towers (2012) are considered to be a masterpiece when it comes to adaptive architecture. The design of the building is inspired by Islamic architecture, where traditional shading screens are often used. In this kind of climate, the main concern is to provide shading to direct sunlight and solar radiation. (Buffoni, 2017)

Due to the shape of the building, the shading system is made out of triangles, which close when the sun hits the side and open when there is no direct sunlight (Buffoni, 2017). This kind of pattern is very traditional to the culture.

Usually in this type of climate, window glasses need to be tinted, which reduces the amount of daylight. Because of the shading solution, it was possible to use more naturally tinted glasses, which allow daylight to come inside. (Cilento, 2012)

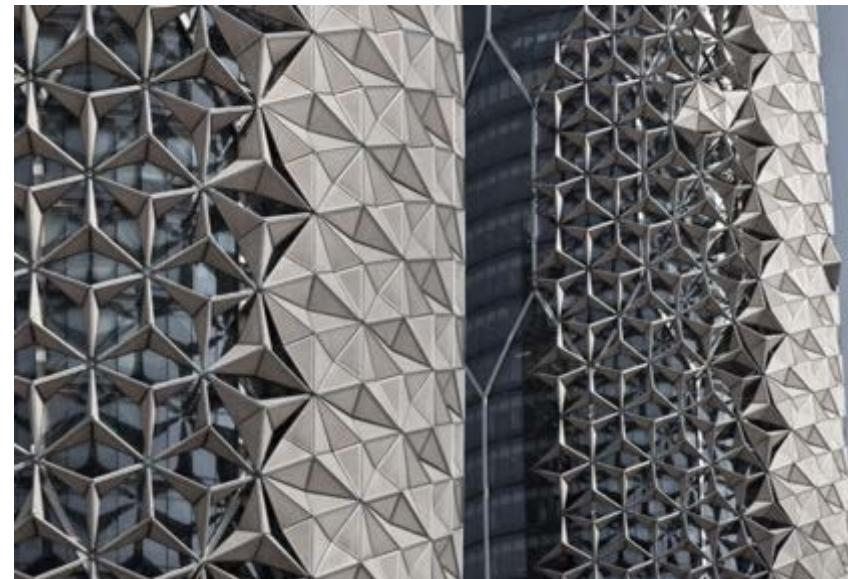


Figure 20. Shading devices. ([Intelligent Glass Solutions https://bit.ly/3dscnij](https://bit.ly/3dscnij))

Even though the direct sunlight is blocked on all times, this kind of shading, due to its shape, casts interesting shadows inside, similar to the authentic Islamic mashrabiya (shading) (Figure 20). When the duration of direct sunlight would be measured, it definitely would not pass, as the sunlight is block entirely. The whole concept of the building is to highlight the Islamic architecture, where shading has been used for hundreds of years.



Figure 21. Triangular shading elements. ([Designboom https://bit.ly/2SRMiBp](https://bit.ly/2SRMiBp))



Figure 22. Outside view. ([Designboom https://bit.ly/2SRMiBp](https://bit.ly/2SRMiBp))

4.4 GLARE – UNBEARABLE BRIGHTNESS

Glare is a negative sensation caused by exceptionally bright light or intense brightness contrast in the sight of eye (Yilmaz & Vissenberg, 2018). It means that bright areas with higher luminance than the luminance to which the eyes are adapted too, irritates the eye and affects the vision (EN 17037:2018).

For most architecture, controlling the glare is essential. Minimizing glare is beneficial for residential buildings and offices, where people usually spend a lot of time in one place. But glare can also be beneficial, i.e. in spiritual buildings, to highlight the supernatural powers. According to Benya, glare is desirable when an architect wants to create a high contrast enhancing the visual experience of the space (Benya, 2010). It is used to highlight important elements of the design. This kind of concept is not used only in architecture, but has been used in art for hundreds of years already (Pantelic, 2016). "We understand objects based on their relationship to other objects. To understand contrast and how it can be utilized means you will know why a design works, or doesn't." (*ibid*)

It shows that glare isn't always a bad element to have in architectural design, as it can help to add a value to a space that otherwise would feel empty and have no meaning. In some cases, i.e. Tadao Ando's Church of the Light, glare is very welcome and is a big part of the design, but in other cases, it is an unpleasant sensation that should be avoided.

"Light is the origin of all being. Light gives, with each moment, new form to being and new interrelationships to

things, and architecture condenses light to its most concise being. The creation of space in architecture is simply the condensation and purification of the power of light." – Tadao Ando

A masterpiece with low levels of glare: Steven Holl Architects' Kiasma Museum of Contemporary Art, Finland

Located in Helsinki, Finland, The Kiasma Museum of Contemporary Art (1998) is considered to be a masterpiece when it comes to daylighting.

Holl has designed a building where light has a very functional role, but also plays with the emotions of the visitor. Because of the Nordic light that changes throughout the seasons, it enters the building from horizontal way. It is uncommon for the southern latitudes that the sun come in from that direction, making it a unique daylighting approach. "Thus the core of the building, a narrow internal space dominated by the long curved ramp connecting the lobby with the exhibition galleries, would be very dark if not illuminated by a glass ceiling which provides a vertical illumination that, also due to the curved wall enclosing the space, dramatically evolves during the times of the day." (Bianchini, 2019)

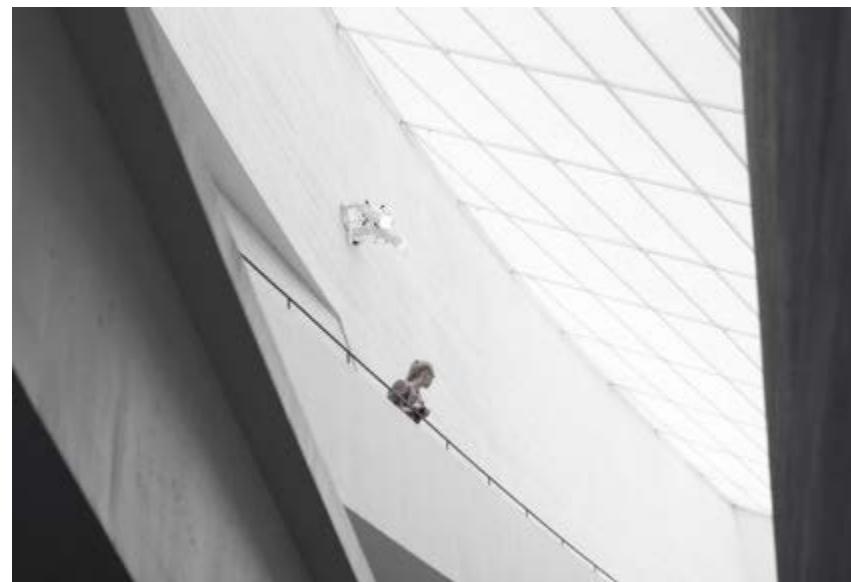


Figure 23. Skylight. (Pirje Mykkaenen <https://bit.ly/2Wk3q58>)

He worked with pure mass and windows to give every room its own uniqueness. Natural light played a significant part, because he was so fascinated with the Finland's daylight. Most of the windows are covered with a translucent glazing, that diffuses the light, so that it doesn't enter the building directly. The full façade windows on the north and south sides provide a view to the city. (Fiederer, 2016)

There are also series of skylights that light up the whole building. The aim of the skylights is to work with the curves of the building, so that light becomes a sculptural element. Those skylights also diffuse light and light up the space through multiple levels. (Fiederer, 2016)

"Space is oblivion without light. A building speaks through the silence of perception orchestrated by light. Luminosity is as integral to its spatial experience as porosity is integral to urban experience." (Holl, 2016)



Figure 25. Diffused light. (Petri Virtanen <https://bit.ly/2zv8QRE>)

The differences between northern and southern light has been illustrated in this building. Holl has chosen the soft and diffused northern light, which does not create sharp shadows. Also the choice of materials limits the possibility of high contrast between the light and the surfaces.



Figure 24. Light opening. (Pirje Mykkaenen <https://bit.ly/2Wk3q58>)

A masterpiece with high levels of glare: Tadao Ando's Church of the Light

"In all my works, light is an important controlling factor. I create enclosed spaces mainly by means of thick concrete walls. The primary reason is to create a place for the individual, a zone for oneself within society. When the external factors of a city's environment require the wall to be without openings, the interior must be especially full and satisfying." – Tadao Ando

Tadao Ando's Church of the Light (1989) is located in a small town of Ibaraki, Japan, 25 km from Osaka. It is considered to be one of Tadao Ando's signature architectural work. This masterpiece embodies Ando's philosophy between nature and architecture, where light has an ability to create new spatial conceptions, same as concreate structures that he uses in his buildings. He uses duality in his work, contrasting different elements like lightness and darkness. (Kroll, 2011)

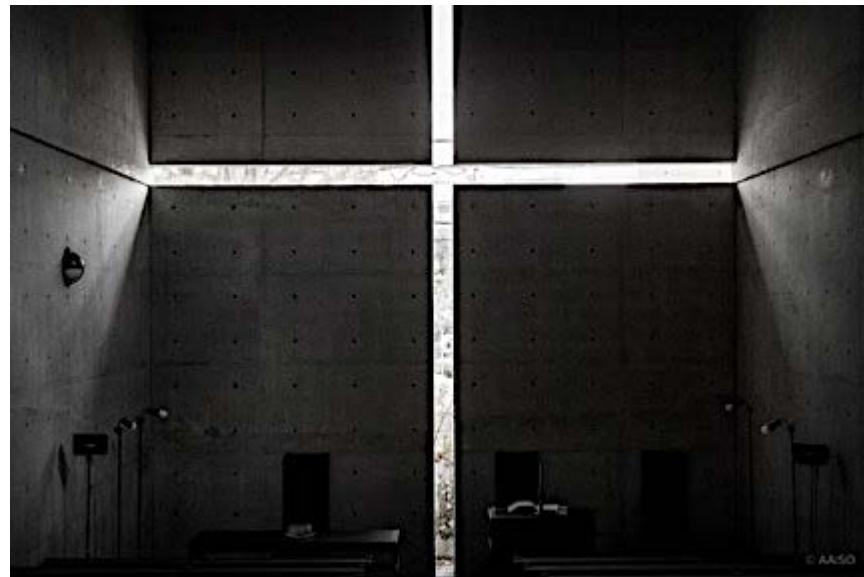


Figure 27. Interior view (AASO Photography <https://bit.ly/2yKgevA>)

The combination of light and solidness raises the awareness of spirituality within the occupants. His approach to light creates a dreamlike effect where material changes into immaterial, darkness changes into lightness and then lightness changes into space. (Kroll, 2011)

There is an L-shaped wall that comes from one side and then cuts through the main hall, acting like a diffuser that leads the light into otherwise closed room (Fredriksson, 2017). The light is reflected between that wall and the building so that this diffused light creates the illusion of a bigger and more open space (*ibid*). At the back wall, behind the altar, there is a cross shaped opening. The bright light that comes through the cross works in contrast to the calm and silent space, making it a metaphorical element. The light is never the same, it changes during the day and night, over seasons and even years, taking over the power of the space and filling up the void with shadows and rays of light (Fredriksson, 2017).



Figure 26. Interior view to the altar. (AASO Photography <https://bit.ly/2yKgevA>)

Due to the narrow opening and the choice of materials, the bright light coming from outside creates glare that is unavoidable. It is due to the luminance of the bright cross, which is higher than the luminance that human eye is adapted to. It creates high contrast between the light and the material of that specific wall. This masterpiece goes against the standard, but because of the concept of the whole building, the glare is much more acceptable because it acts like a supernatural element. There is no shading in this building and with that, it goes against the standard that proposes the use of shading devices to minimize glare. Also the materials (like the glossy wooden floor) used in this building are working against the standard, which limits the use of reflective materials to avoid glare. Nonetheless, it is arguably a great architectural masterpiece that showcases the use of daylighting in a different way.



Figure 28. Exterior view. (Masaru Tezuka <https://bit.ly/2zo66Wj>)

5 CONCLUSION OF THE ANALYSES

Analysis of eight masterpieces shows that there is no right or wrong way to incorporate daylight into architecture. Masterpieces of architecture are unique, and they cannot be used to set generic standards for quality in architecture. Use of daylight is an integral part of design approach, and therefore cannot be examined as an independent solution or strategy. This appears to be the key finding also in Guzowski's typology.

It is important to notice that more daylight without glare does not equal to more architectural quality. The EN standard proposes rather sophisticated methods for evaluating the amount of daylight and visual comfort, but it is easy to find examples of powerful architecture where quality means bad performance in the standardized assessment.

The function of the building has an impact on our expectations of acceptable daylight condition – a sacral building (church, chapel etc.) calls for a totally different kind of atmosphere and daylighting than a home or an office. If EN standard requirements were applied in all types of buildings, one of the most powerful tools of architectural expression would be disabled.

The study shows that the quantitative metrics in EN standard are rather meant for evaluating buildings, not architecture, and those two are not the same. Therefore the standard cannot be used as an indicator for good architectural design as it focuses on other aspects. We do not have a scientific evaluation method to evaluate any artwork – music, theater etc. – the same applies in

architecture. So far typology appears to be the best way to provide some kind of framework for analytical understanding of the components of quality and design intentions. However, all typologies of architectural daylighting will remain somewhat subjective as everyone perceives space in a unique way.

This applies also in Guzowski's typology, which may seem logical at first glance; yet the differences between proposed daylighting profiles remain obscure. Andersen's typology, which aims at describing the contrasts as an indicator of quality, appears to be less subjective but also less holistic than Guzowski's typology.

It is apparent that the daylighting profiles have no correlation with the quantitative metrics. However, it is interesting that the quantitative metrics are based on the subjective perception of daylight quality.

6 ANALÜÜSI KOKKUVÕTE

Kaheksa meistriteose analüüs näitab, et päevavalguse integreerimiseks arhitektuuri pole õiget ega valet viisi. Arhitektuuri meistriteosed on ainulaadsed ja neid ei saa kasutada arhitektuuri üldiste kvaliteedistandardite kehtestamiseks. Päevavalguse kasutamine on disainilahenduse lahutamatu osa ja seetõttu ei saa seda käsitleda iseseisva lahenduse või strateegiana. See näib olevat peamine leid ka Guzowski tüpoloogias.

On tähtis tähele panna, et suurem hulk valgust ilma räigust tekitamata ei näita arhitektuurset kvaliteeti. EN-standard pakub välja pigem keerukamaid meetodeid päevavalguse ja visuaalse heaolu hindamiseks ning on kerge leida näiteid võimsatest arhitektuuri meistriteostest, kus kvaliteet tõttu on vastavalt EL standardile tegemist halva lahendusega hoonega.

Hoone funktsioon mõjutab meie ootusi vastuvõetava päevavalguse kohta - sakralhoone (kirik, kabel jne) nõuab teistsugust atmosfääri ja päevavalgust kui kodu või kontor. Kui igat tüüpि hoonetes rakendataks EL standardi nõudeid, tähendaks see seda, et üks võimsamaid arhitektuurilise väljenduse vahendeid oleks kaotatud.

Analüüs näitab, et EL standardi kvantitatiivsed mõõdikud on pigem mõeldud hoonete, mitte arhitektuuri hindamiseks ja need kaks pole samad. Seetõttu ei saa standardit kasutada hea arhitektuurilise kujunduse indikaatorina, kuna see keskendub muudele aspektidele. Meil ei ole teaduslikku hindamismeetodit ühegi kunstiteose - muusika, teater jne - hindamiseks. Sama kehtib ka

arhitektuuris. Siiani näib tüpoloogia olevat parim viis seadmaks raamistikku, et analüütiliselt hinnata kvaliteeti ja disaini kavatsusi. Kõik arhitektuurilise päevavalgustuse tüpoloogiad jäavad siiski pisut subjektiivseteks, kuna kõik tajuvalt ruumi ainulaadsel viisil.

Sama kehtib ka Guzowski tüpoloogia kohta, mis võib esmapilgul tunduda loogiline, kuid soovitatud päevavalgustuse profiilide erinevused jäavad siiski varjatuks. Anderseni tüpoloogia, mille eesmärk on kirjeldada kontraste kvaliteedinäitajana, näib olevat vähem subjektiivne, kuid samas ka vähem terviklikum kui Guzowski tüpoloogia.

On ilmne, et päevavalguse profiilidel puudub igasugune seos kvantitatiivsete mõõdikutega. Huvitav on aga see, et kvantitatiivsed mõõdikud põhinevad päevavalguse kvaliteedi subjektiivsel tajumisel.

II ARCHITECTURAL PROJECT – VALE DE MOSES YOGA RETREAT MEDITATION CABINS

7 ARCHITECTURAL CONCEPT

All six huts are based on the qualitative typology of Mary Guzowski. The designs are aimed to be instruments of light, demonstrating the power of daylighting as a shaper of atmosphere and architectural space by minimizing all means of expression except:

1. material,
2. daylighting, and
3. how the buildings touch the ground.

The atmospheres are connected to the six categories proposed by Guzowski to support the various types of mediations. In that way, the aim of the design is to achieve the desired atmosphere making daylight the main mean of architectural expression.

Each of the cabins are designed to be as ecological as possible and use local materials that can be found on the site like wood, stones, earth, etc, and also use recycled items like bottles and old fabrics. The retreat has already reached the maximum capacity of the energy consumption, meaning that all the huts are designed to be without any electricity and water. The huts are not meant for staying overnight, the purpose is to only meditate in them or enjoy the treatments.



LOCAL TIMBER



RAMMED EARTH



RECYLED TEXTILE



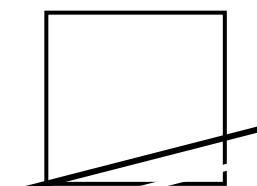
GRAVEL/STONES



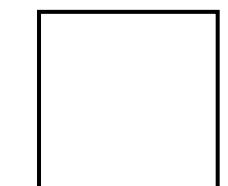
RECYLED BOTTLES



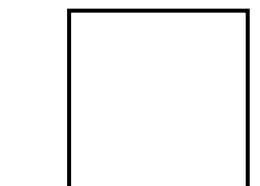
CLAY PLASTER



SLOPED GROUND



FLAT GROUND



WATER SURFACE

8 LOCATION AND THE COMPETITION

8.1 CLIMATE AND DAYLIGHT IN PORTUGAL

Portugal has a Mediterranean climate with a mixed oceanic climate along the northern half of its coastline, making it one of the warmest countries in Europe, with summer temperatures reaching as high as 40°C and winter temperatures dropping to below zero at night. Despite its constant human settlement, Portugal is still a territory rich in biodiversity.

Daylighting conditions in Portugal are showed in the diagram, where it can be seen, that in summer it reaches almost 75 degrees. The maximum solar angle in June 21st is 73 degrees. It can be concluded that shading is an important element in Portuguese architecture, because otherwise the sun would be too intense and unbearable. There is 13 hours of daylight in summer solstice.

In spring and fall equinox the maximum solar angle is 51 degrees. Considering that, most of the year there is great sun exposure and the necessary steps to provide enough direct sunlight (like in Northern countries), as suggested in EN standard, are not that critical. The maximum amount of light-hours in spring and fall is 11 hours.

In winter the maximum solar angle decreases significantly compared to the other seasons. The maximum solar angle is 27 degrees. On December 21st there is 9 hours of light-time.

It can be concluded that the amount of light-hours is consistent throughout the year fluctuating between a few hours.

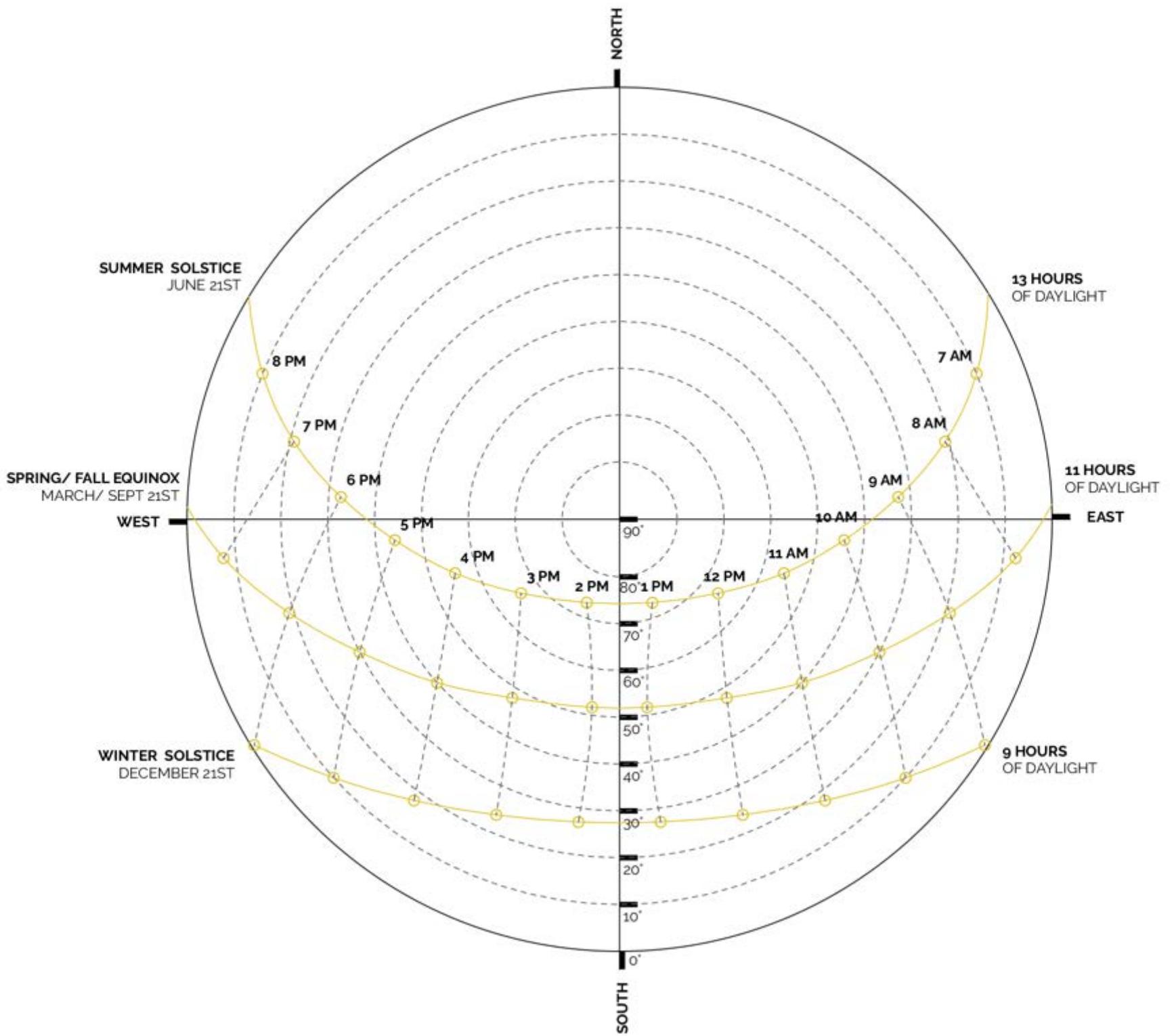


Figure 29. Sun Study. (Thesis author)

8.2 VALE DE MOSES YOGA RETREAT

Vale de Moses Yoga Retreat was founded by fate, when a British family stumbled upon a breathtaking region of central Portugal during a year-long trip around Europe. When venturing into a valley with the same name as their beloved family dog, the Winter family lost their way until Moses - their golden retriever - led them to their new calling to create a world-class yoga retreat. After taking five years to reconstruct a series of old stone cottages, the Vale de Moses Yoga Retreat offers guests from around the world the opportunity to reconnect with nature. Vale de Moses welcomes annually over 500 people from over 60 countries around the world to stay at their retreat. Guests at the retreat take part in the health and spiritual meditation practices of "forest bathing", known as Shinrin Yoku in Japan, in which they develop a sensual relationship with the non-human world. (Winter, 2020)



Figure 30. Vale de Moses yoga retreat main buildings. (Vale de Moses <https://www.valedemoses.com/portugal-retreat>)

8.3 COMPETITION

For the Vale de Moses Meditation Cabins competition, participants are asked to submit designs for a cabin that could be replicated and placed in any number of spots throughout the retreat. The cabin's main purpose is to enable guests and/or therapists to be as comfortable as possible during meditation sessions and treatments. Each cabin should comfortably accommodate a single guest and therapist, providing a therapeutic space in which the guest can relax and indulge in the healing treatments on offer at the retreat, all while connecting more deeply with the natural surroundings. In addition to the meditation cabins, participants should also think of how designs could be connected by gardens. Outdoor meditation spaces can be made with the living structures of plants, trees or hedges to frame valley views, and provide invitational spaces where people can find and feel that deep



Figure 31. View over the site. (Vale de Moses <https://www.valedemoses.com/portugal-retreat>)

connection with planet Earth. Sustainability is a key factor for all new construction at the retreat. Since the retreat is already at the limits of its energy capacity, all new buildings must be capable of producing their own energy, and all grey water produced from the sinks must be used to irrigate surrounding gardens. Designs for the new cabins should mean that they fit in visually with the forested mountain valley environment, being either made of natural materials or with modern, energy-efficient materials. (BeeBreaders, 2019)

The competition brief has been adjusted, meaning that instead of one hut, there are six huts in total, which are designed according to the Guzowski's typology.



Figure 32. Existing buildings. (Vale de Moses <https://www.valedemoses.com/portugal-retreat>)

9 PROJECT SITE

The site is located in the heart of Portugal, 200 kilometers from Lisbon and Porto, in a small mountain village called Amieira (39.9834907 N; 7.9186819 W). The site has a lot of unused potential as the existing buildings have all gathered in one area. Mainly because the site has a steep slope, existing buildings are placed on the areas that are more flat. The site analyses show that people use only the left side of the site, and also the riverside. It is due to the placement of the existing buildings, which are the creators of the paths.. The center of the site, where there are the best views to the mountains, is unused. With the placement of the new huts, it allows more usages of the site and gives the visitors more privacy when meditating,

because new huts are placed further from the main buildings. The location of each hut is carefully chosen, as one part of the concept of the building was how they touch the ground. Supporting that idea, every hut is placed according to the need of the meditation and what's the level of privacy needed in there. The placement allows people to discover more areas of the site and disperse the current overly concentrated center.

The maximum capacity of the retreat is 23 people at once. There is a main building (position 1), which serves the purpose of many functions – it's the home for the owners, reception, canteen and a place for some of the treatment (massages). Currently there is only one building (position 2) for all the treatments, meditation and yoga sessions.

There is no place for individual mediation purposes, which means that people usually use just the nature around the site to have some private time. There are two buildings (position 3 and 4) for accommodating the guests. The toilets and the bathrooms (position 5) are located in a separate building. The important element in the retreat is organic produce, so they have their own garden next to the main building, a barn (position 6) for the farm animals and a greenhouse (position 7) for fresh vegetables.

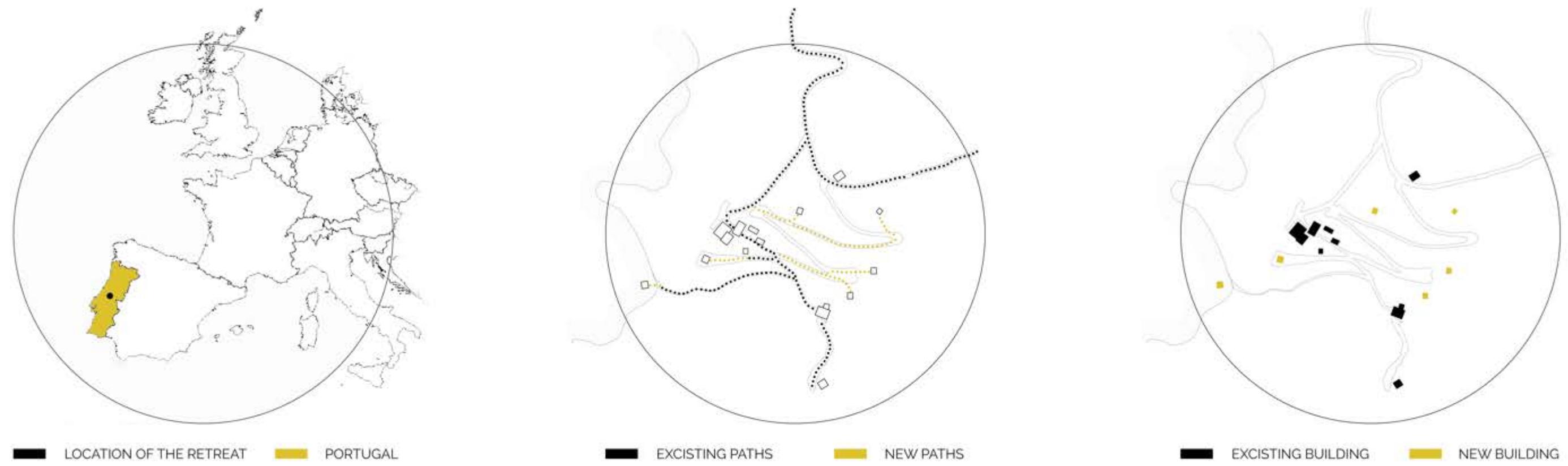


Figure 33. Site Analyses. (Thesis author)

- 1 - MAIN BUILDING
- 2 - WELLNESS CENTRE
- 3 - ACCOMMODATION
- 4 - ACCOMMODATION (MAX 23 PEOPLE IN TOTAL)
- 5 - BATHROOMS
- 6 - FARM ANIMALS
- 7 - GREENHOUSE

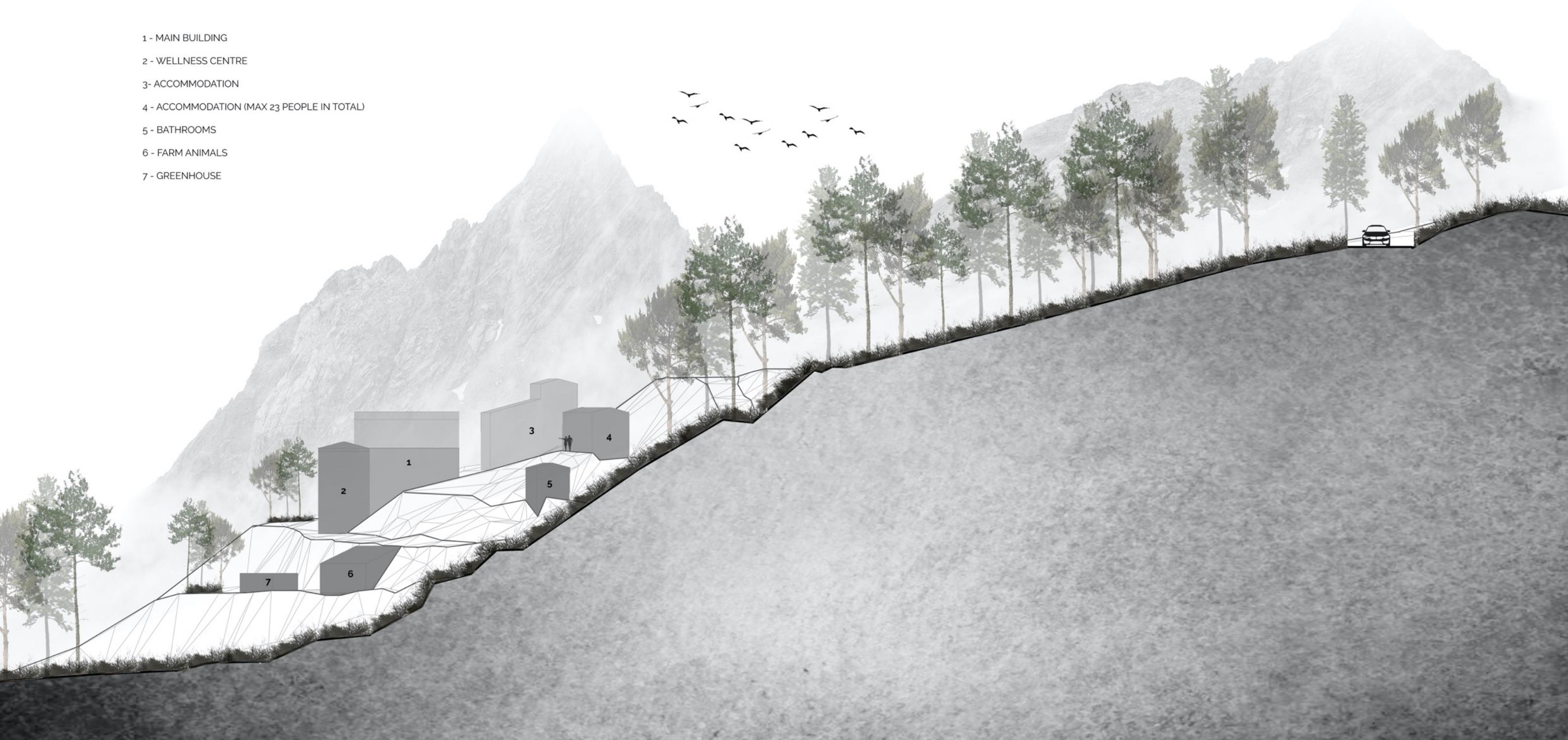
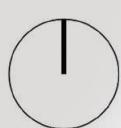


Figure 34. Landscape section.. (Thesis author)







9.1 SITE PLAN

The main elements of the site plan are 6 huts, which celebrate the locations landscape and use it as one part of the concept. When creating the site plan, the main priority was to ensure privacy to the visitors during meditation and also to disperse the current very dense center.

Parking spots on the site are located next to the main building.



10 MEDITATION HUT DESIGNS

10.1 WELLNESS HUT – STRUCTURED LIGHT



LOCATION

The wellness hut (position 1) is located near the center of the meditation center-complex. It is located on a slope, to give the second floor more lift from the ground as it needs the most privacy. The slope helps to raise the second floor from the road high enough, that seeing inside is impossible. There is a stair made out of natural stones that leads towards the entrance. Because of the steep slope and loose stones, it is impossible for others to climb the landscape without the stone stairs, giving the hut another dimension of privacy.

FLOOR PLAN

Floor plan is designed in a spiral form, which symbolizes a path from outer consciousness to the inner soul. This hut can be used alone, e.g. for doing yoga or it can be used to have healing treatments, such as massages, acupuncture, etc. First floor has a room for storing all the equipment needed for the treatments and yoga. Second floor has a main area, where two people can comfortably fit and where all the treatments are being done. The columns are placed denser in areas that need more privacy, meaning that the side parallel to the road has more rows of columns. The dimension of the hut is 6x6 meters.

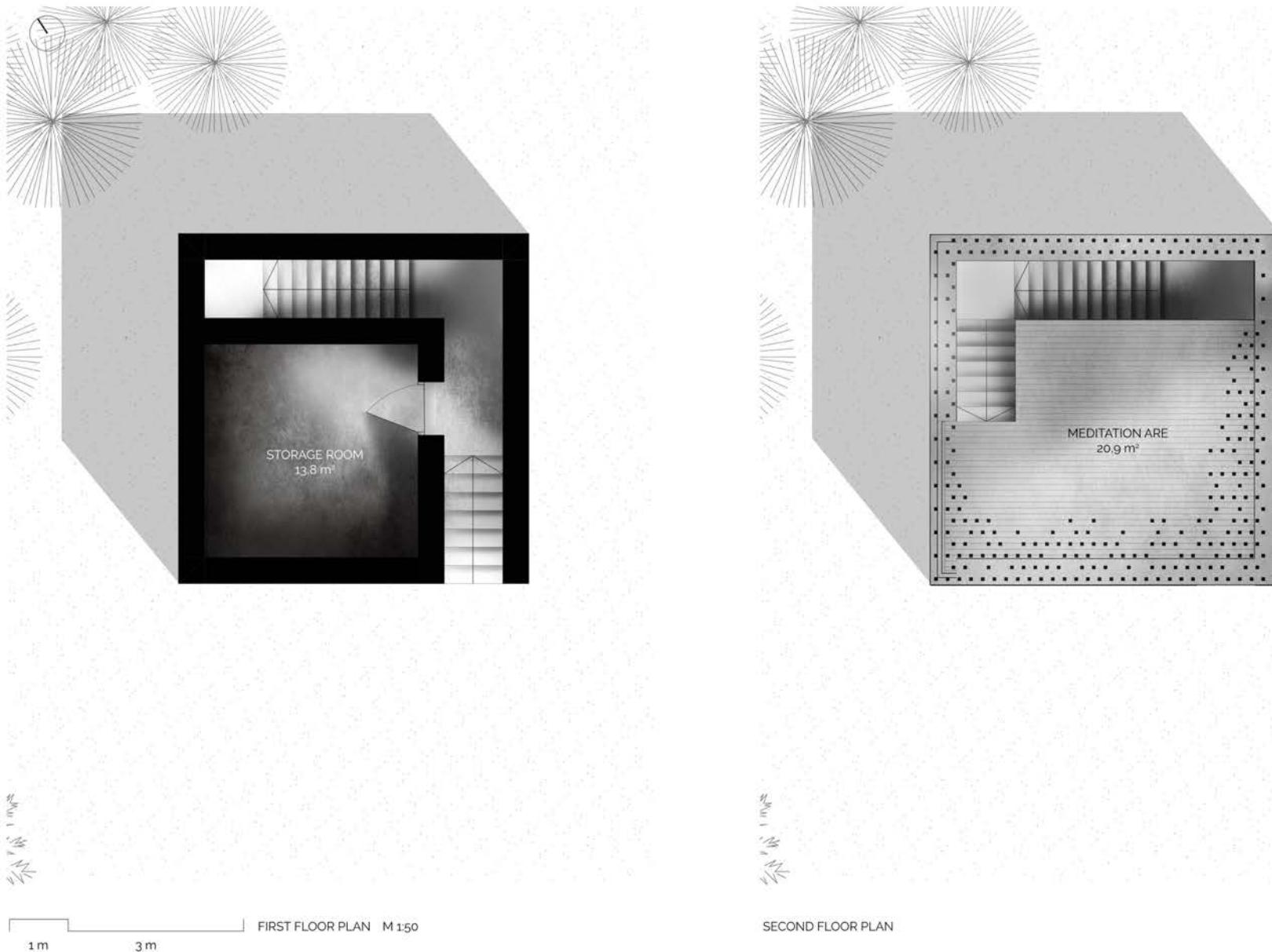


Figure 39. Floor plans. (Thesis author)

MATERIALS

The main materials used in the wellness hut are rammed earth and wood. First floor has been left with natural rammed earth look, with the exception of floors, which are covered with waterproof clay plaster. The second floor is finished all the way with wood and is left open on every side (no glazing).

ATMOSPHERE

The main desired qualities of the atmosphere are comfortable, stimulating, activating, warm and private,

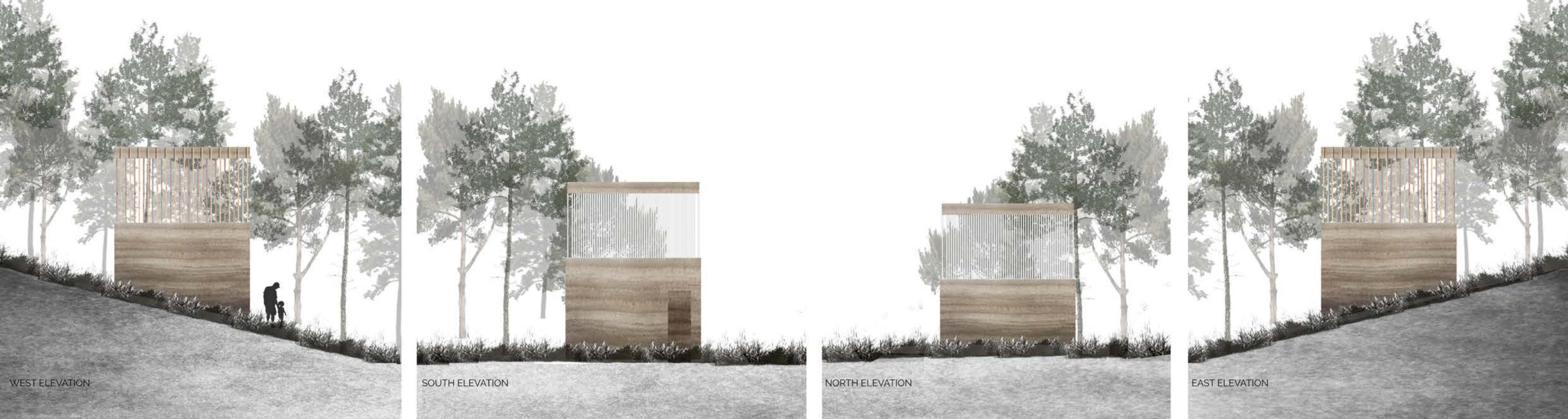


Figure 40. Elevations. (Thesis author)

DAYLIGHTING

As Guzowski says, structured light considers the relationship between daylight and structure. The choice of daylighting strategies, form, and detailing are inseparable from a selected structural system and material palette (Guzowski, 2018, p. 8). There are 50x50 mm wooden beams placed on the edge of the floor as structural elements supporting the roof. Those beams are placed in consideration to the daylighting situation on the site, meaning that the space between the columns takes in consideration the angel of the sun in different seasons and ensures that daylight can penetrate through them. The structure is used to define the character of light giving it an interesting pattern throughout the day, almost like a clock that tells the time. The created light pattern moves throughout the day, making it look different every day. The placement of the columns and their material give light the chance to work with them and be the giver of light.

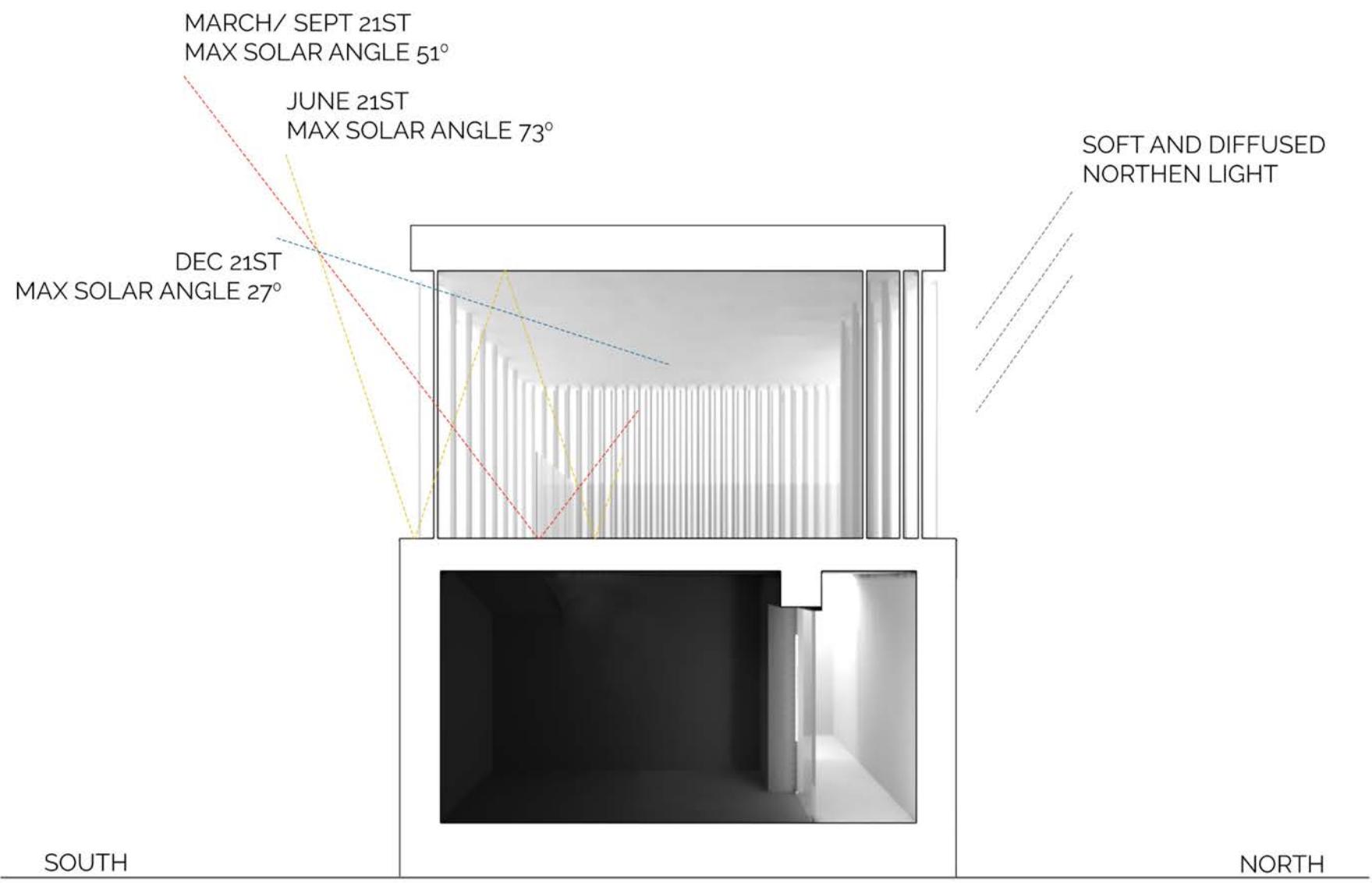
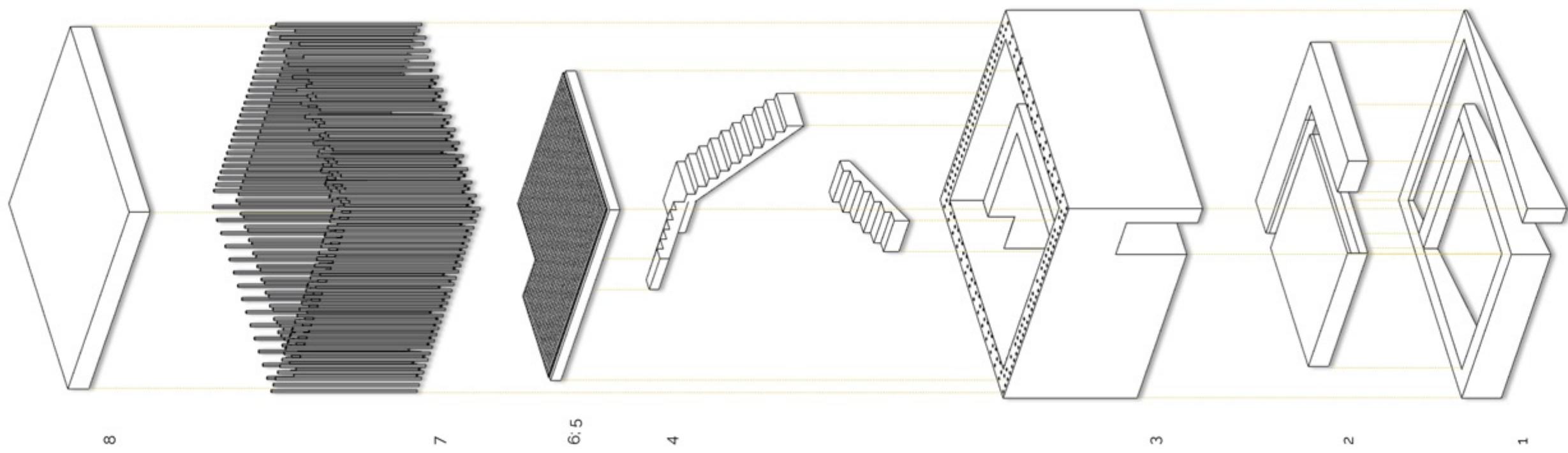
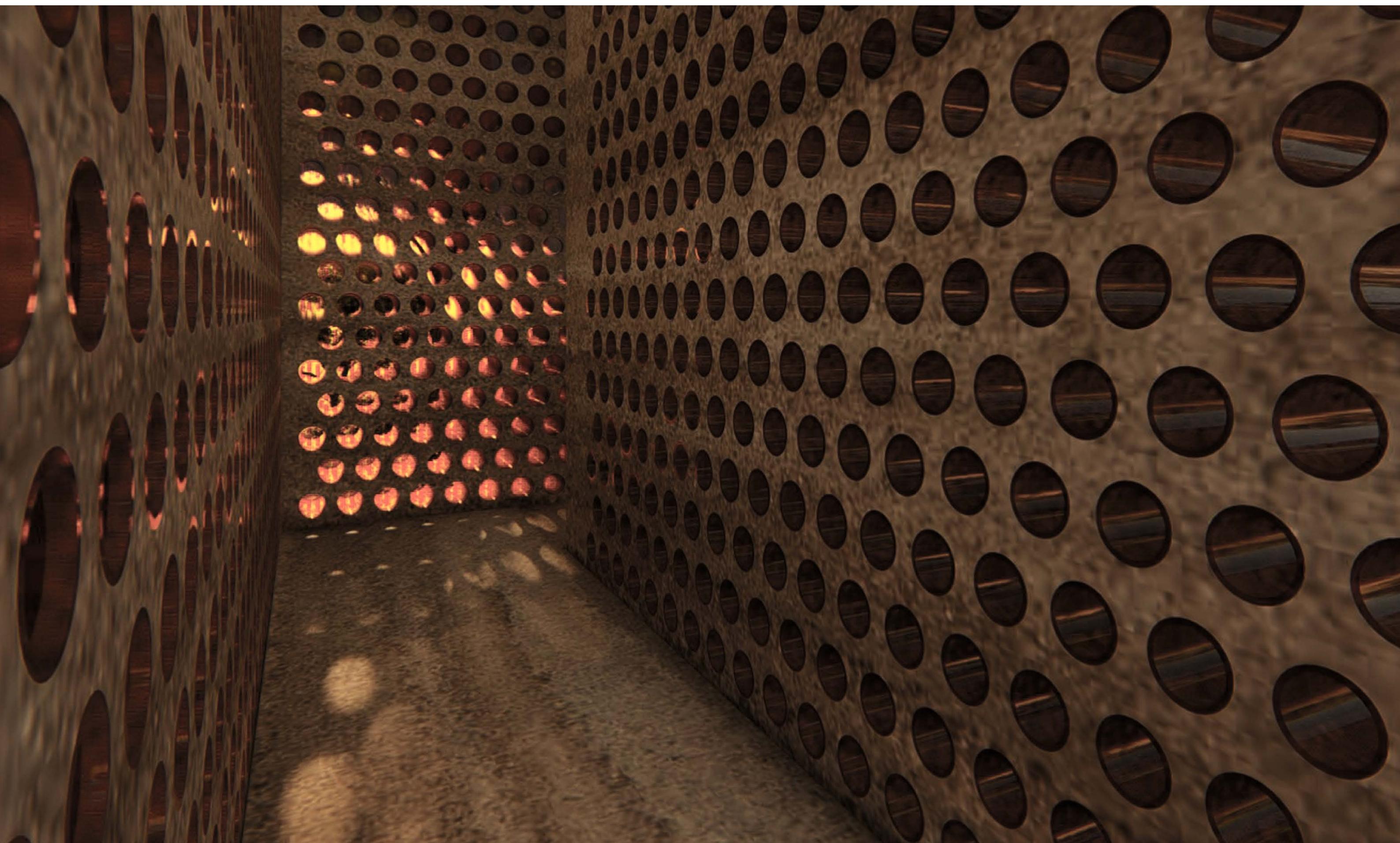


Figure 41. Light analyses. (Thesis author)



- 1 - STONE FOUNDATION (ROCKS FROM THE SITE)
- 2 - RAMMED EARTH SLAB FINISHED WITH WATERPROOF PLASTER
- 3 - RAMMED EARTH WALLS 450 MM
- 4 - RAMMED EARTH STAIRS FINISHED WITH WATERPROOF PLASTER
- 5 - SLAB WITH WOODEN STRUCTURE (WOOD FROM SITE)
- 6 - WOODEN PLANK FINISH
- 7 - WOODEN COLUMNS 50X50 MM
- 8 - FLAT ROOF WITH WOODEN STRUCTURE

10.2 SELF-AWARENESS HUT – MATERIAL LIGHT



LOCATION

The self-awareness hut (position 2) is located near the area, where in summer guests can camp in tents. It is located on a flat ground. The entrance is on the northern side of the building, so that sunlight can hit the other three walls that have the bottles imbedded inside. That way the hut gets the most possible sunlight to for the bottles to reflect sunlight through them and achieve the desired atmosphere.

FLOOR PLAN

Floor plan is similarly to the first hut, designed in a spiral form, which also symbolizes a path from outer consciousness to the inner soul.. In this case, the hut only has one story. The self-awareness hut is meant to be used by one person at a time. In the center, there is an open area for mediation. Privacy is achieved with the shape of the floor plan, meaning that from every side the person inside is not visible. The dimension of the hut is 5x5 meters.

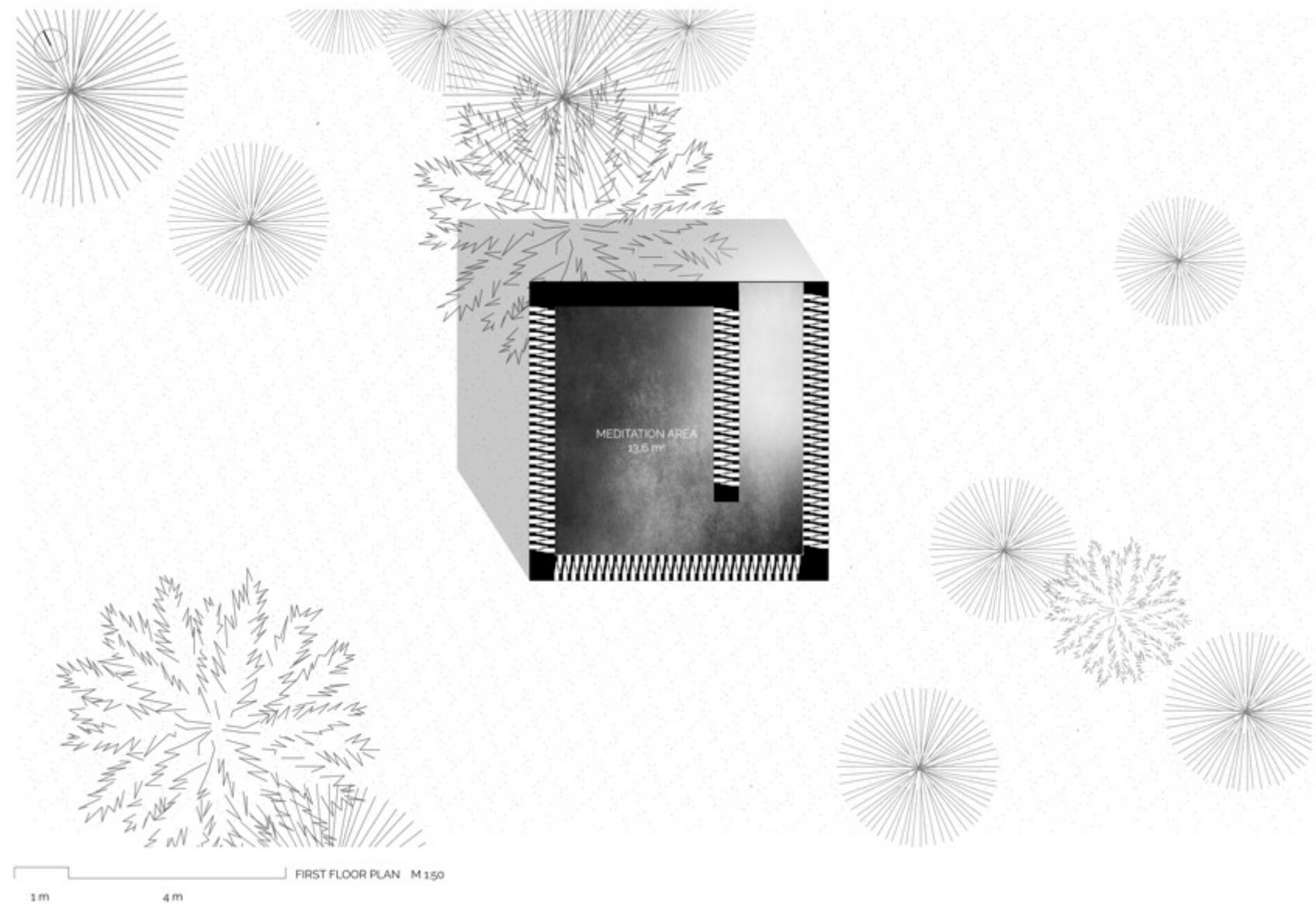


Figure 42. Floor plan. (Thesis Author)

MATERIALS

The main materials used in the self-awareness hut are rammed earth and recycled glass bottles. All the walls have a natural rammed earth look, which is combined with the recycled glass bottles from the site.. Floors are finished with the waterproof clay plaster to avoid water damage.

ATMOSPHERE

The main desired qualities of the atmosphere are safe, harmonic, healing, relaxing and private.

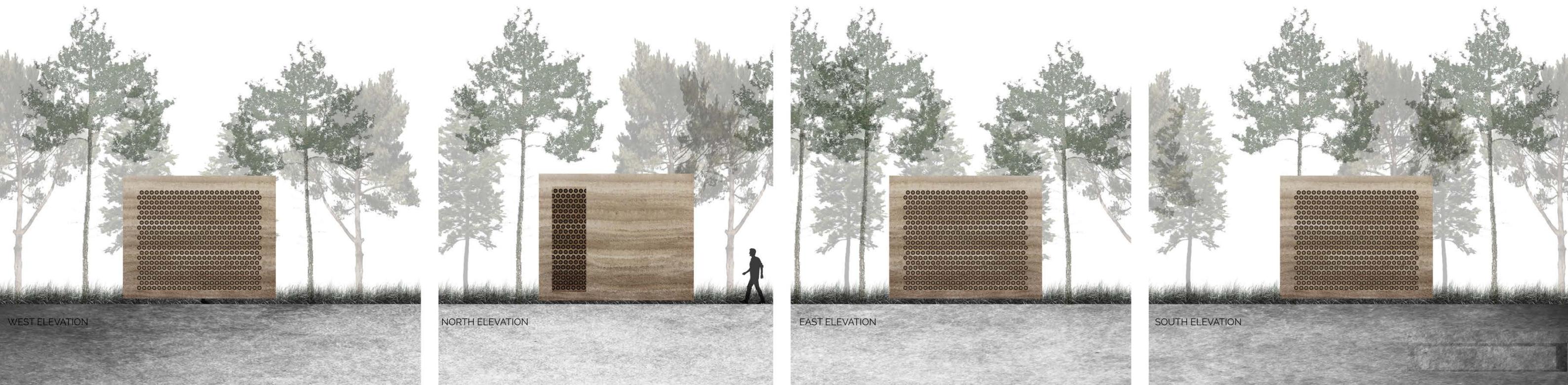


Figure 43. Elevations. (Thesis author)

DAYLIGHTING

According to Guzowski material light explores natural light as a dynamic and ephemeral building material that interacts with architectural space and material surfaces to influence the resulting luminous quality of space in time (Guzowski, 2018, p. 8). The hut is using recycled glass bottles as one of the elements in the walls. When sun hits the glass, it allows an interaction between daylight and the material, resulting in an interesting interior space. The result of the sun hitting the glass is as the inside of the hut is in fire, making it a very powerful atmosphere inside. No matter what is the time of the day, the sun hits one of the walls giving this effect until it goes down. Also because the walls are covered in bottles completely, it doesn't matter if it's summer or winter, it still gives the same effect.

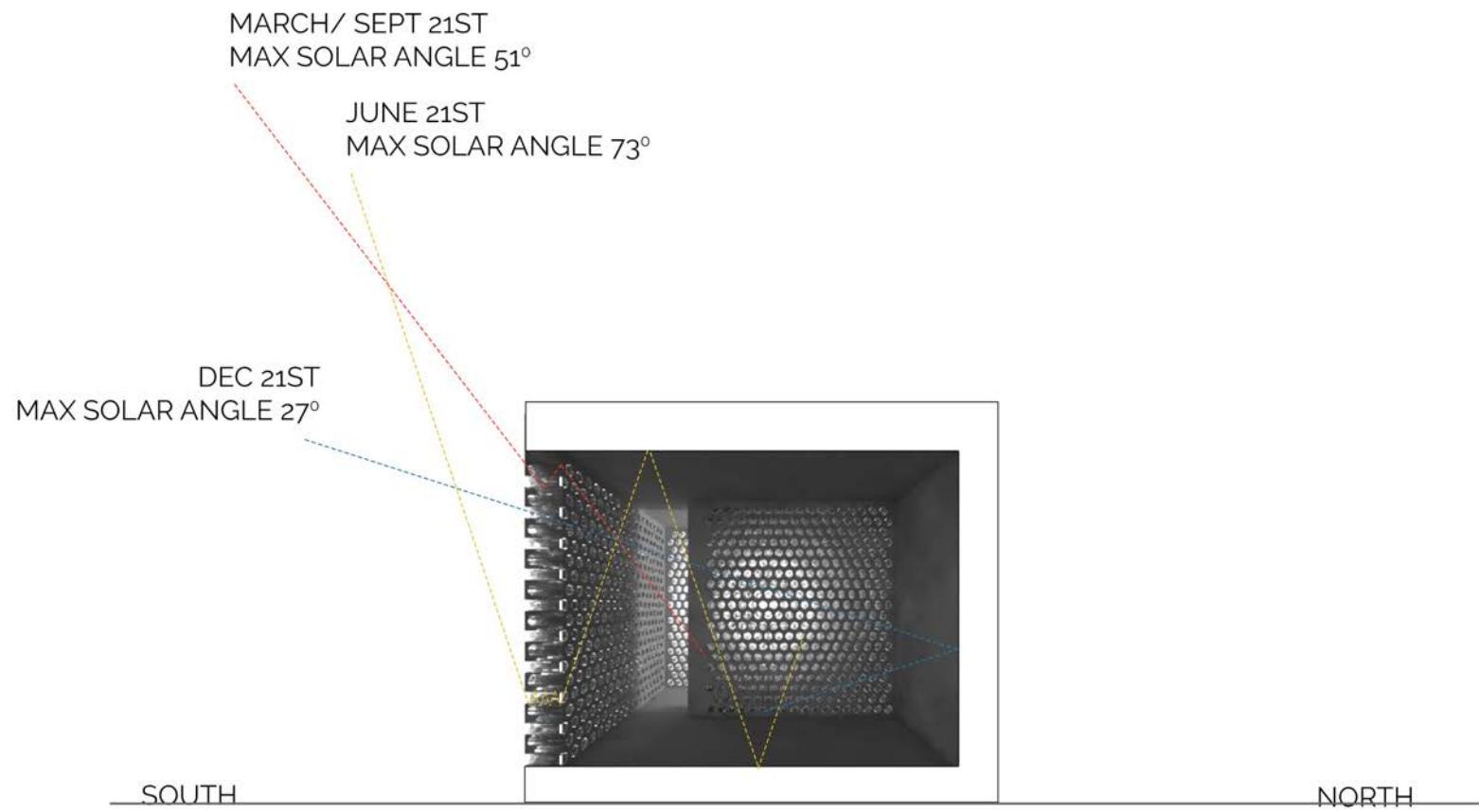
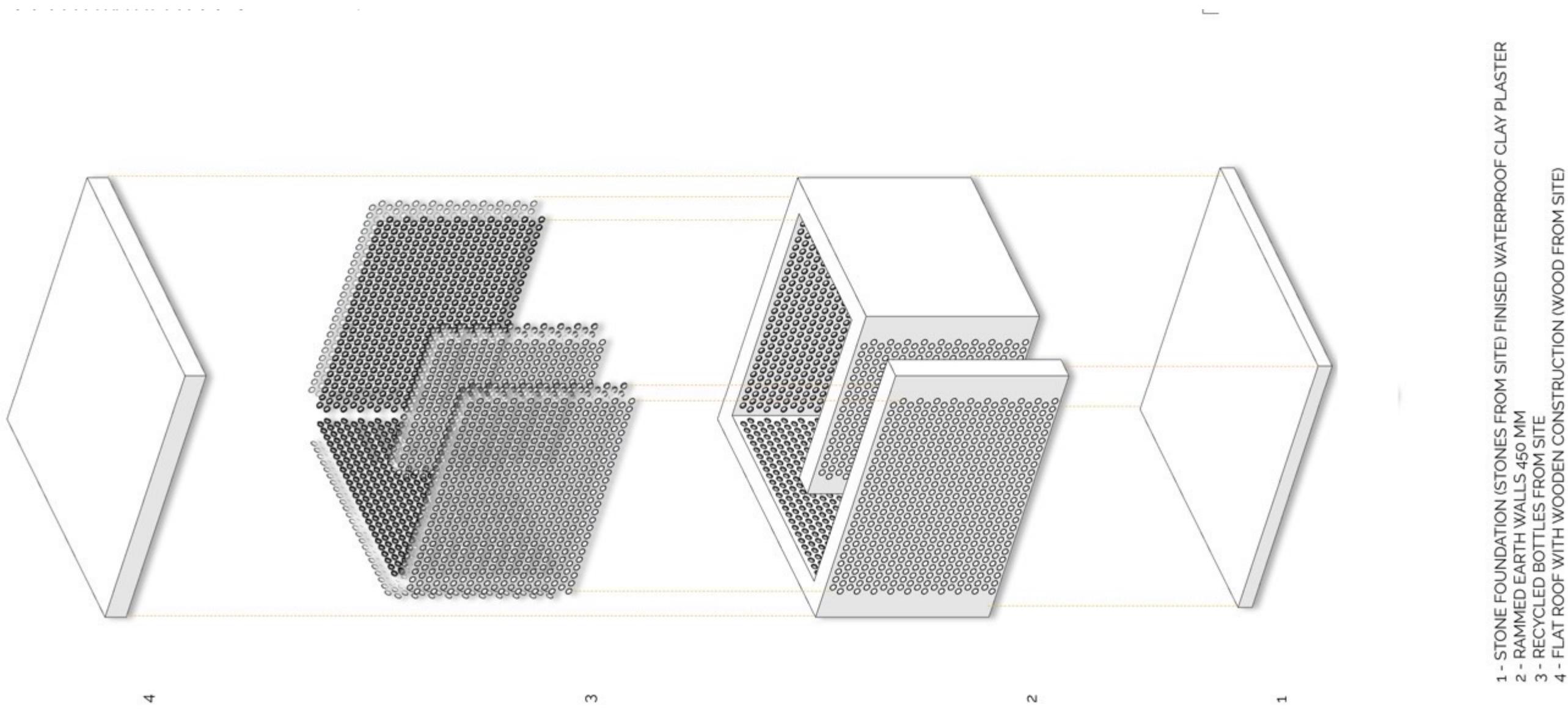


Figure 44. Daylight analyses. (Thesis author)



10.3 SPIRITUAL SEARCH HUT – ATMOSPHERIC LIGHT



LOCATION

The spiritual search hut (position 3) is located on the edge of the stone terrace near the center-complex. The ground in the area is flat and has the best view to the mountains and the river. The location is a good private spot, because there is nowhere to go from that direction. Therefore people will only go there when they want to meditate, meaning that it has enough privacy for the hut to be located there.

FLOOR PLAN

The floor plan consists of two squares which are put into each other. In the center, there is a meditation area, which has a darker inside and the desired atmosphere. The inner square has openings, covered with mirrors, all over the walls which allow daylight to come in throughout the day. Those openings light up very bright when the sun hits them. In between the outer and inner layer, there is a layer of gravel, except on the right side where the entrance to the inner square is, to limit people walking in there and giving the inside of the hut privacy. also the meditation area is slightly raised from the other parts to highlight the importance of the room. The dimension of the hut is 8x8 meters.



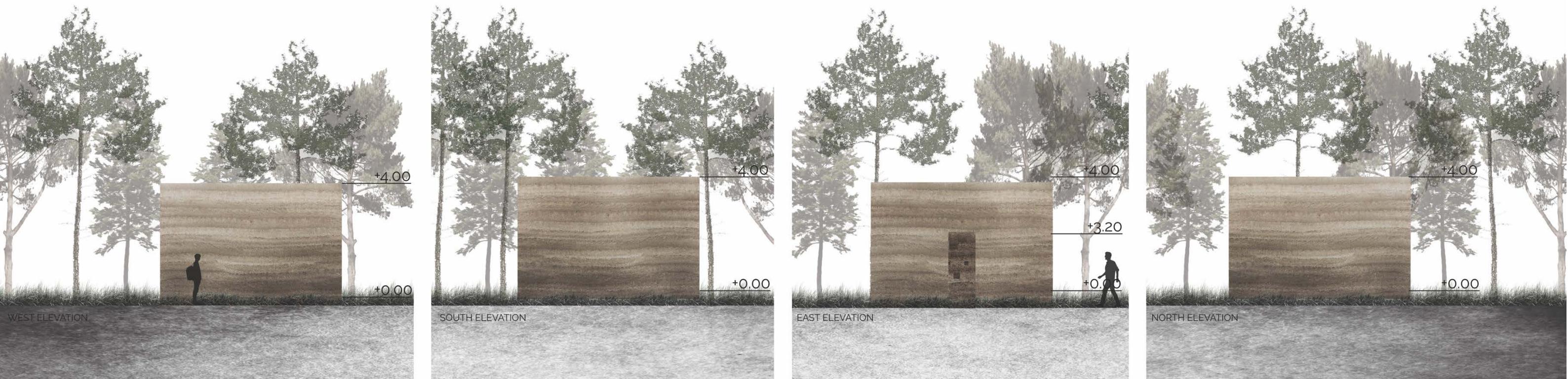
Figure 45. Floor plan. (Thesis author)

MATERIALS

The only material used in this hut is rammed earth. The openings in the inner layer are carved in with plywood moldings during the construction process. The openings have mirrors installed in the bottom and on top, so that daylight can bounce in through the thick walls. Floors are finished with clay plaster, which mimics the look of rammed earth.

ATMOSPHERE

The main desired qualities of the atmosphere are introverted, ascetic (monastery), safe, powerful.



DAYLIGHTING

As guzowski says, atmospheric light celebrates the qualities and moods of light particular to a geographic location and latitude for a given program. the desired atmospheric qualities of light and darkness are intimately related to design intensions, experiential concepts, and practical program goals (guzowski, 2018, p. 8). The design of the hut supports the desired atmosphere, as the inside of the mediation room gives a very mystic vibe with the bright openings all over the wall. as the light analyses show, the mirrors in the holes are necessary for the daylight to come in. Regardless of the season, light comes in from any angle that is not blocked by the outer layer walls. The entrance of the building also is used to illuminate the outer layer, because there is no door in this hut.

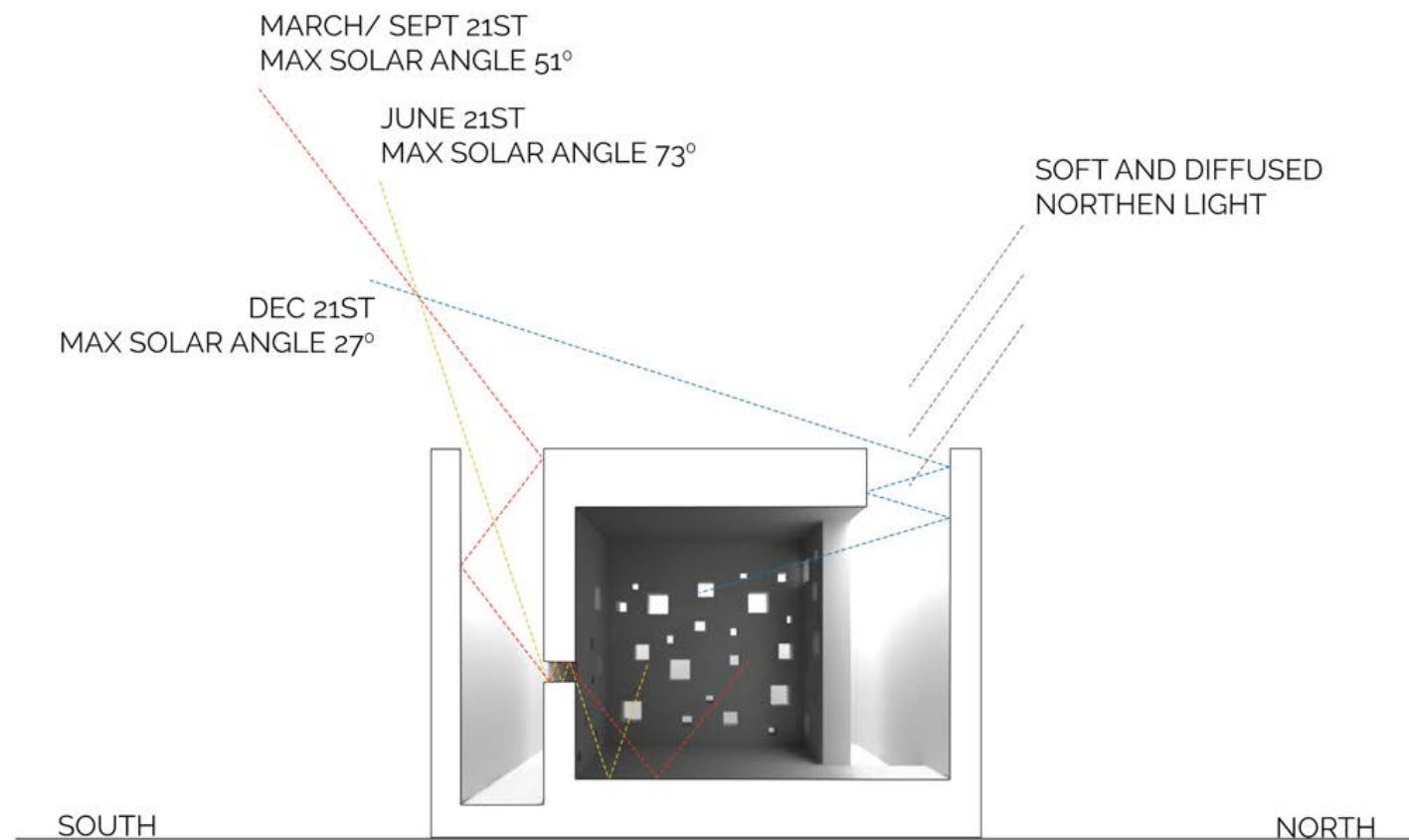
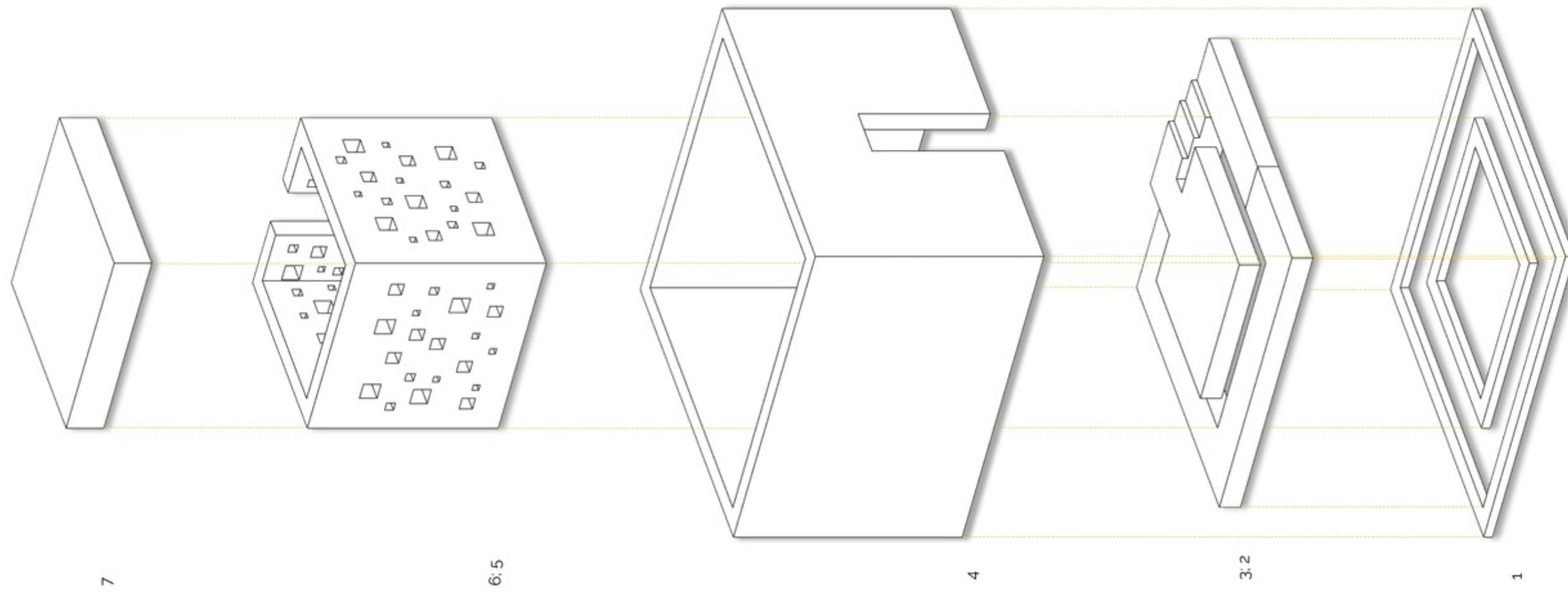
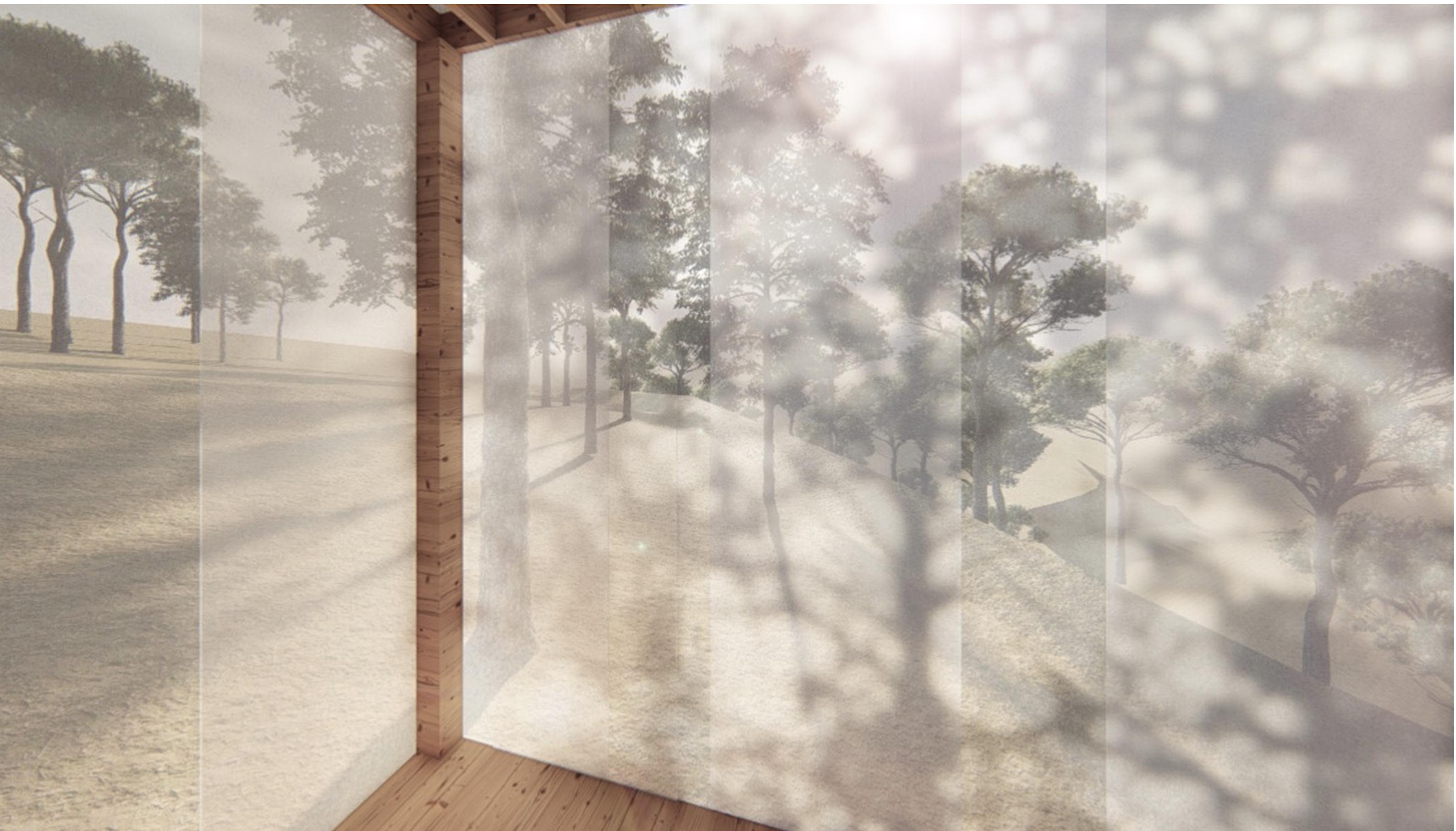


Figure 46. Daylight analyses. (Thesis author)



- 1- STONE FOUNDATION (ROCKS FROM THE SITE)
- 2- RAMMED EARTH FLOOR FINISHED WITH WATERPROOF PLASTER
- 3- RAMMED EARTH FLOOR FINISHED WITH SMALL STONES FROM THE SITE
- 4- RAMMED EARTH WALLS 450 MM
- 5- RAMMED EARTH WALLS 450 MM WITH OPENINGS
- 6- OPENINGS COVERED COVERED WITH MIRRORS
- 7- FLAT ROOF WITH WOODEN STRUCTURE (WOOD FROM SITE)

**10.4 EFFORTLESS PRESENCE HUT – COREOGRAPHED
LIGHT**



LOCATION

The effortless presence hut (position 4) is located in a denser part of the woods, furthest from the center-complex. As the textile is see-through it needs the additional shade of the trees to have a cool and cozy interior. Also for the privacy reasons, the hut is situated in the middle of the trees.

FLOOR PLAN

The huts floor plan is kept simple highlighting the textiles as the main giver of daylight. The entrance to the building is through the panels, which can be easily pushed aside. The inside is aimed to be relaxing and mimic the feeling of fresh laundry in the sun, which a lot of people find calming. It consists of a large meditation area, which is meant to be used alone. It can easily fit all the equipment that the visitor is bringing with them. The dimension of the hut is 4x4 meters.

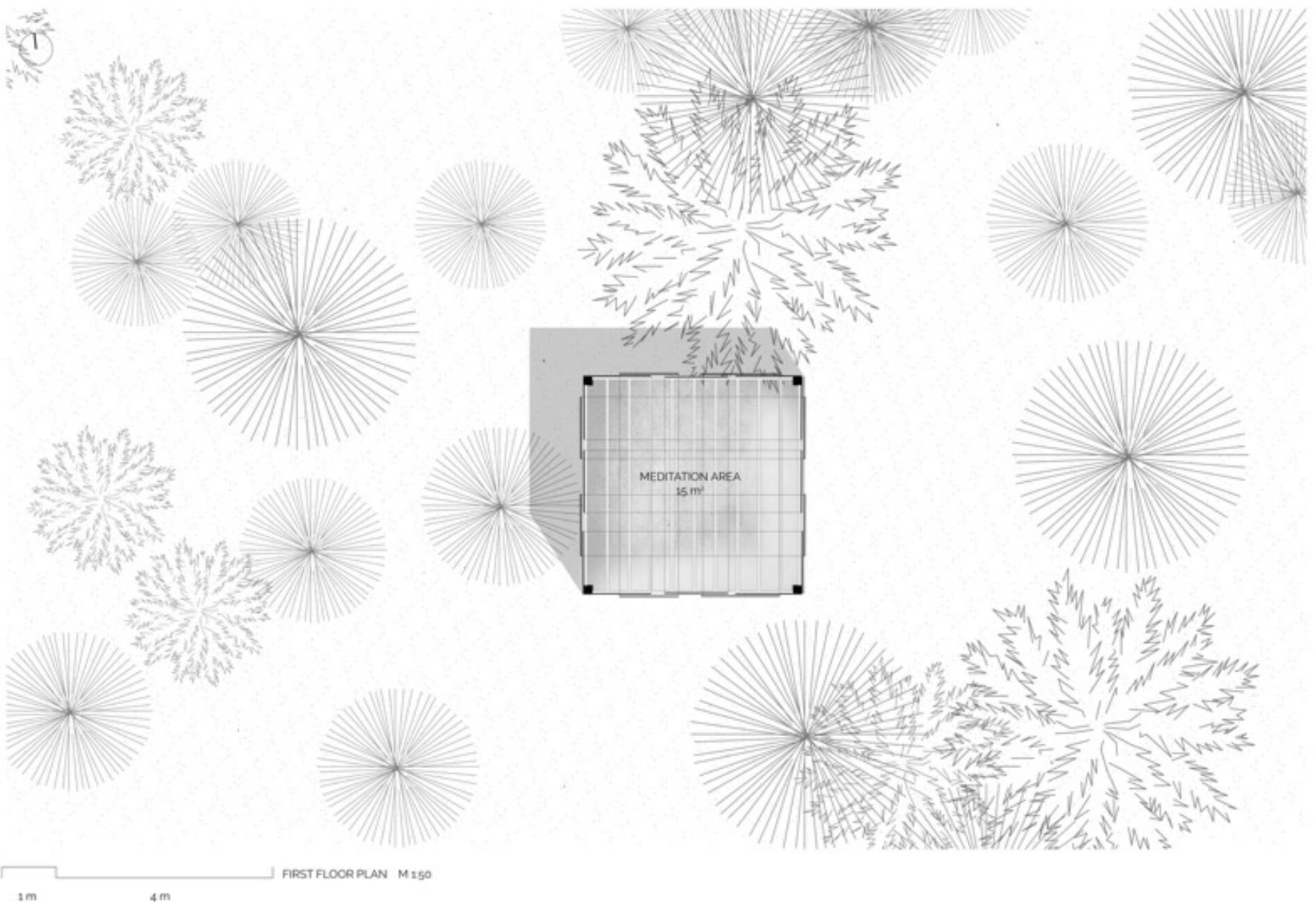


Figure 47. Floor plan. (Thesis author)

MATERIALS

Main materials used in the effortless presence hut are wood and old recycled textiles. The structure of the hut is four 150x150 mm wooden columns, which are placed on each corner. The ceiling is also made out of wood, using 50x200 mm beams. The textile is wrapped around that structure creating different levels of transparency. The textile is hung with a wire frame so that it stays in place.

ATMOSPHERE

The main desired qualities of the atmosphere are quiet, empty, steady, introverted, choice-less, pure, in the moment, light, airy.

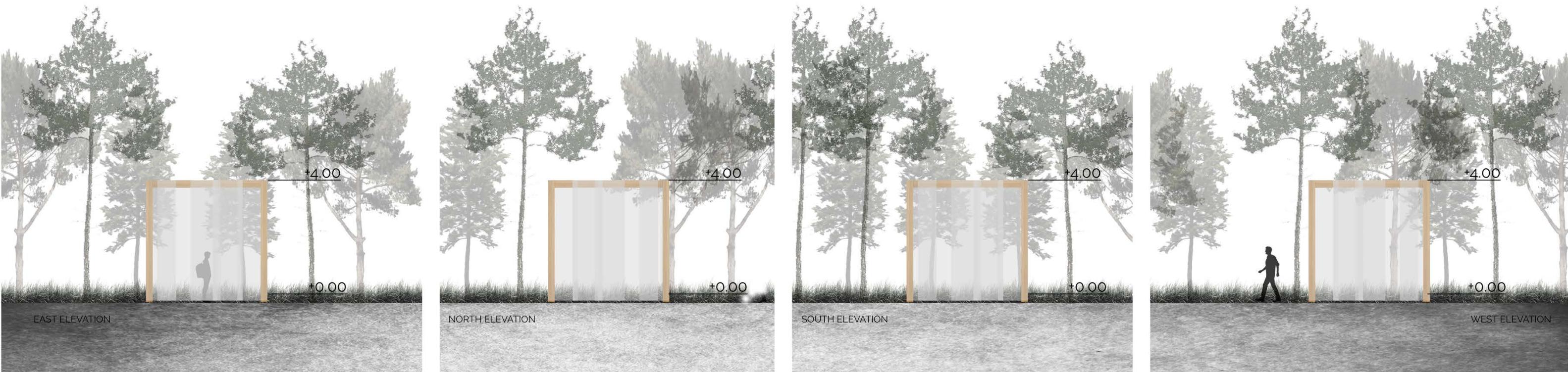


Figure 48. Elevations. (Thesis author)

DAYLIGHTING

According to Guzowski, choreographed light considers how daylight can be used to create a sequence of spatial and luminous events to celebrate the experience of place, climate, and program. Whether intentionally meandering or tightly composed, light can be scripted much like the choreography of music and theater (Guzowski, 2018, p. 8). This hut uses old textiles like bed sheets and curtains to create a choreographed daylighting situation in the hut. As the wind blows, the fabrics move and create a layered effect, where sunlight is always coming through differently. Sometimes it's more direct and sometimes its diffused, it depends greatly on the daylighting situation. With this kind of movement, it is almost like a choreographed piece of art that is carefully thought through and put together.

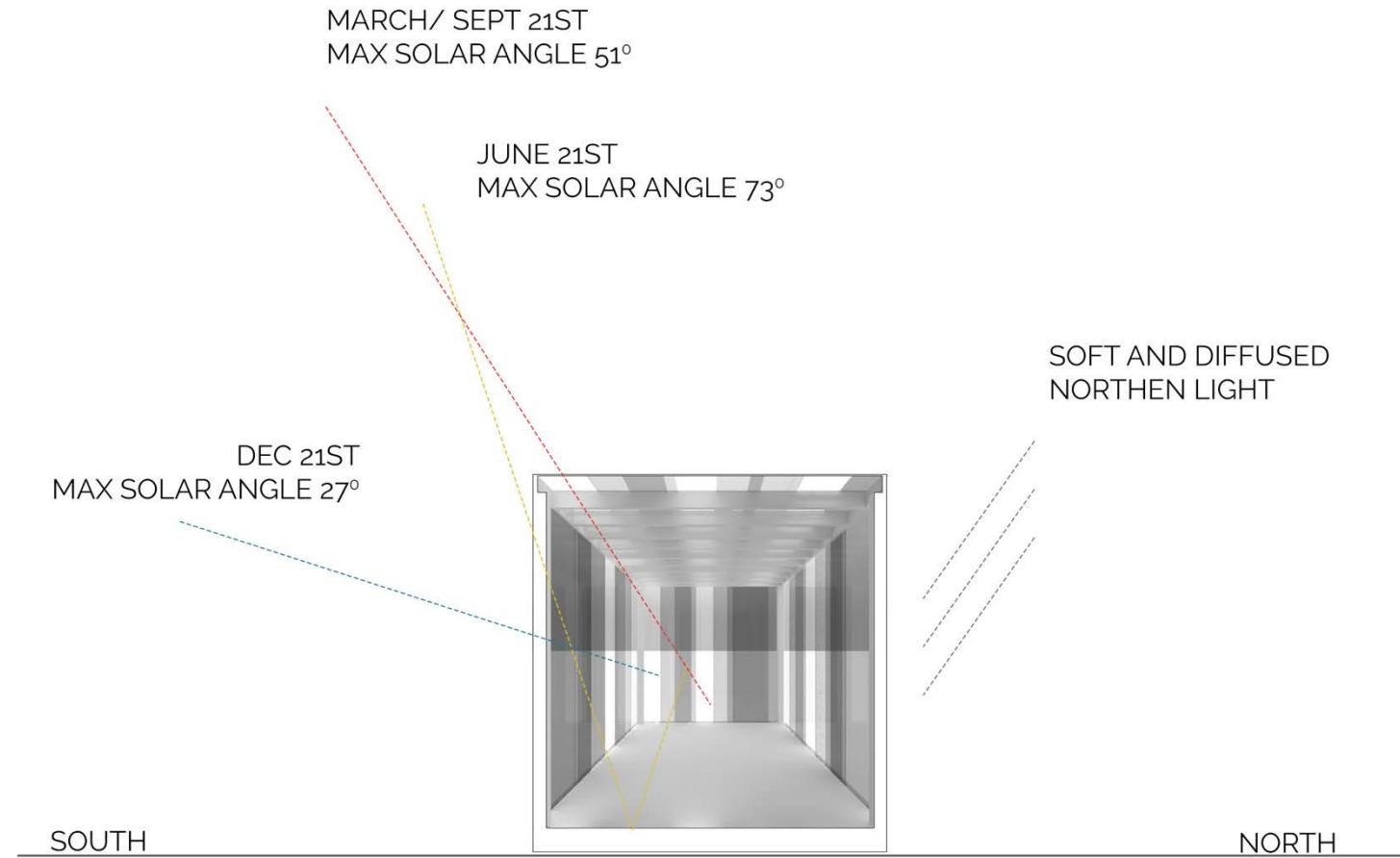
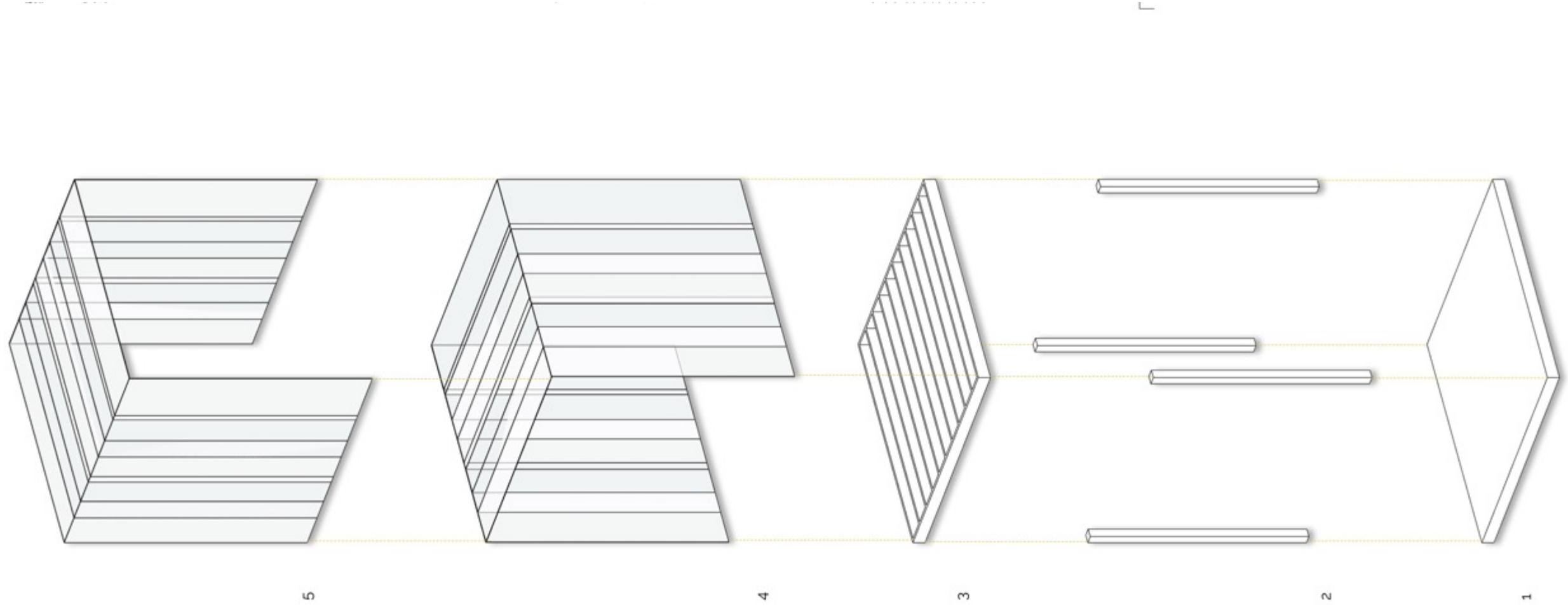
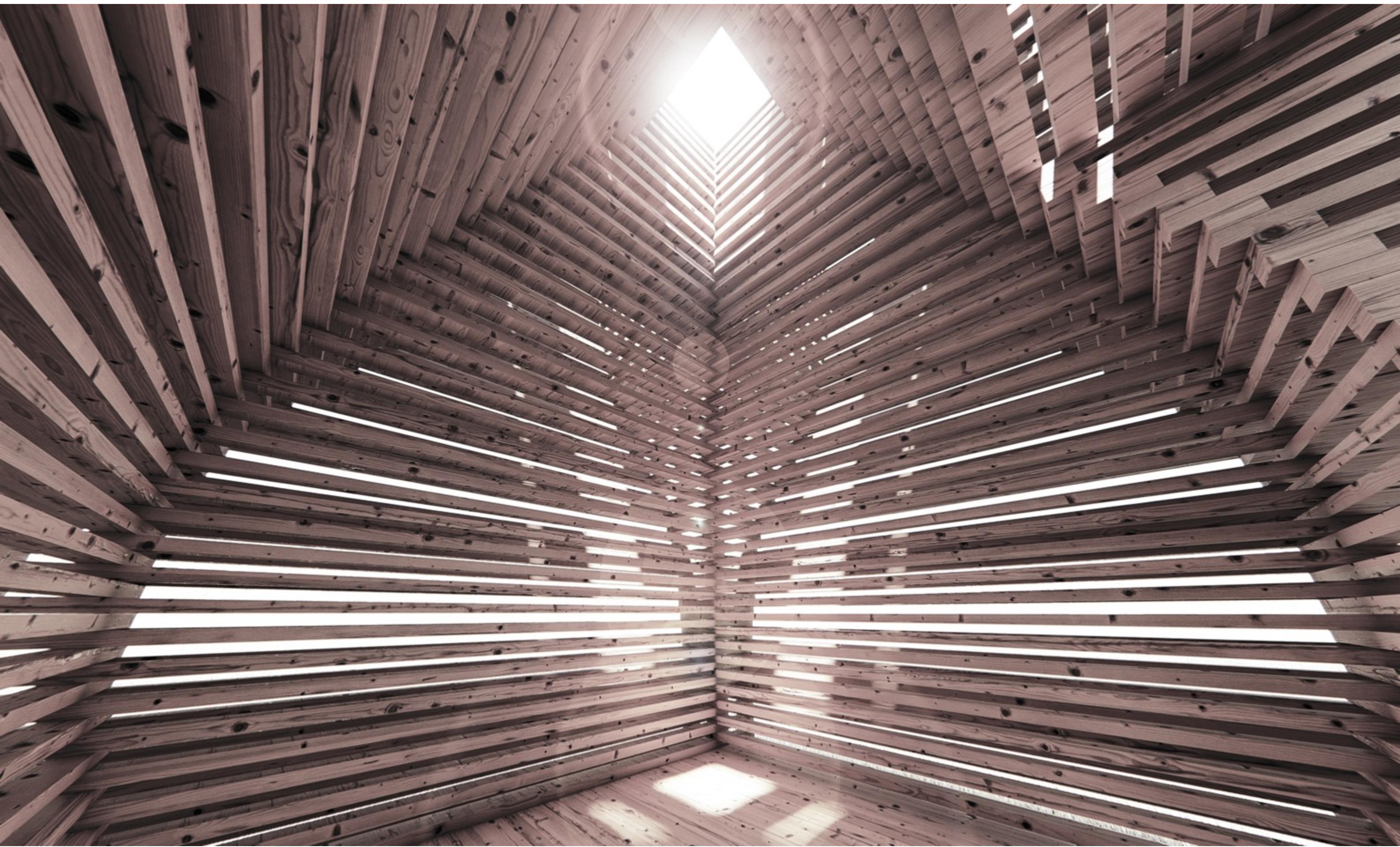


Figure 49. Light analyses. (Thesis author)



- 1 - STONE FOUNDATION (STONES FROM SITE FINISHED WITH WOOD PLANKS)
2 - WOODEN COLUMNS 150X150 MM (WOOD FROM SITE)
3 - WOODEN BEAMNS 50X200 MM (WOOD FROM SITE)
4 - OLD TEXTILE HUNG WITH WIRE FRAMING (WEIGHT AT THE BOTTOM)
5 - CROSSED OLD TEXTILE HUNG WITH WIRE FRAMING (WEIGHT AT THE BOTTOM)

10.5 TRAUMA RECOVERY HUT - SCULPTED LIGHT



LOCATION

The trauma recovery hut (position 5) is located near the trauma recovery hut. It is positioned on a flat ground with the entrance on the north side.

FLOOR PLAN

Floor-plan is kept simple and the opening of the hut is clearly noticeable. The aim of the design is to have a closed "cave" that people can come and meditate and close off from the world. This hut is meant to be used by one person at the time. Also it fits all the accessories and equipment the visitors bring with them. The dimension of the hut is 4x4 meters.

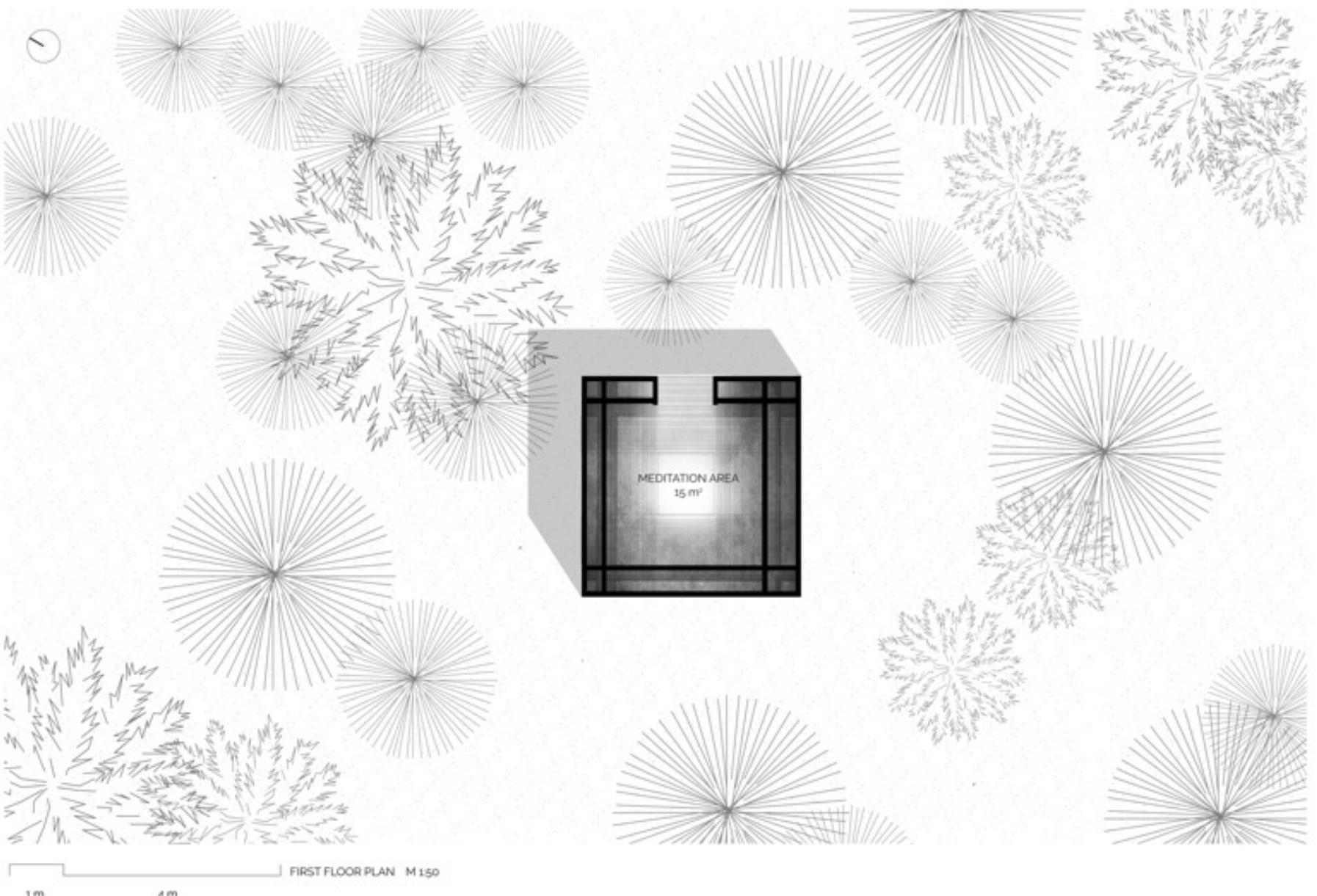


Figure 50. Floor plan. (Thesis author)

MATERIALS

The structure of the trauma recovery hut is made out of wooden beams sized 50x100 mm, which are staggered on top of each other. The length of the beam is always 4 meters making the outside look like a regular cube. Inner beams are placed in a curved pattern, which narrows on top of the hut. The small opening allows sunlight to come in. It is placed so that the high summer sun can peek through it just enough to give it some light. The hut is 4 meters in each side but the inner layers gives the viewer some knowledge what is the shape doing inside.

ATMOSPHERE

The main desired qualities of the atmosphere are safe, harmonic, healing, relaxing, private.



Figure 51. Elevations. (Thesis author)

DAYLIGHTING

As Guzowski says, sculpted light explores how architectural form can be shaped to support daylighting program and performance goals. The building massing, section, spatial organization, envelope, and window detailing are inseparable from the quality, quantity, distribution, effectiveness, and ecological benefits of natural light (Guzowski, 2018, p. 8). The hut is a simple cube from the outside, but the inside is curved so that the form can make beautiful daylighting situations reflecting light in different directions. Each layer is placed so that it skips one, that way the light can come in from any side as the gap allows it to enter. No additional layer is added to the roof to let more light in.

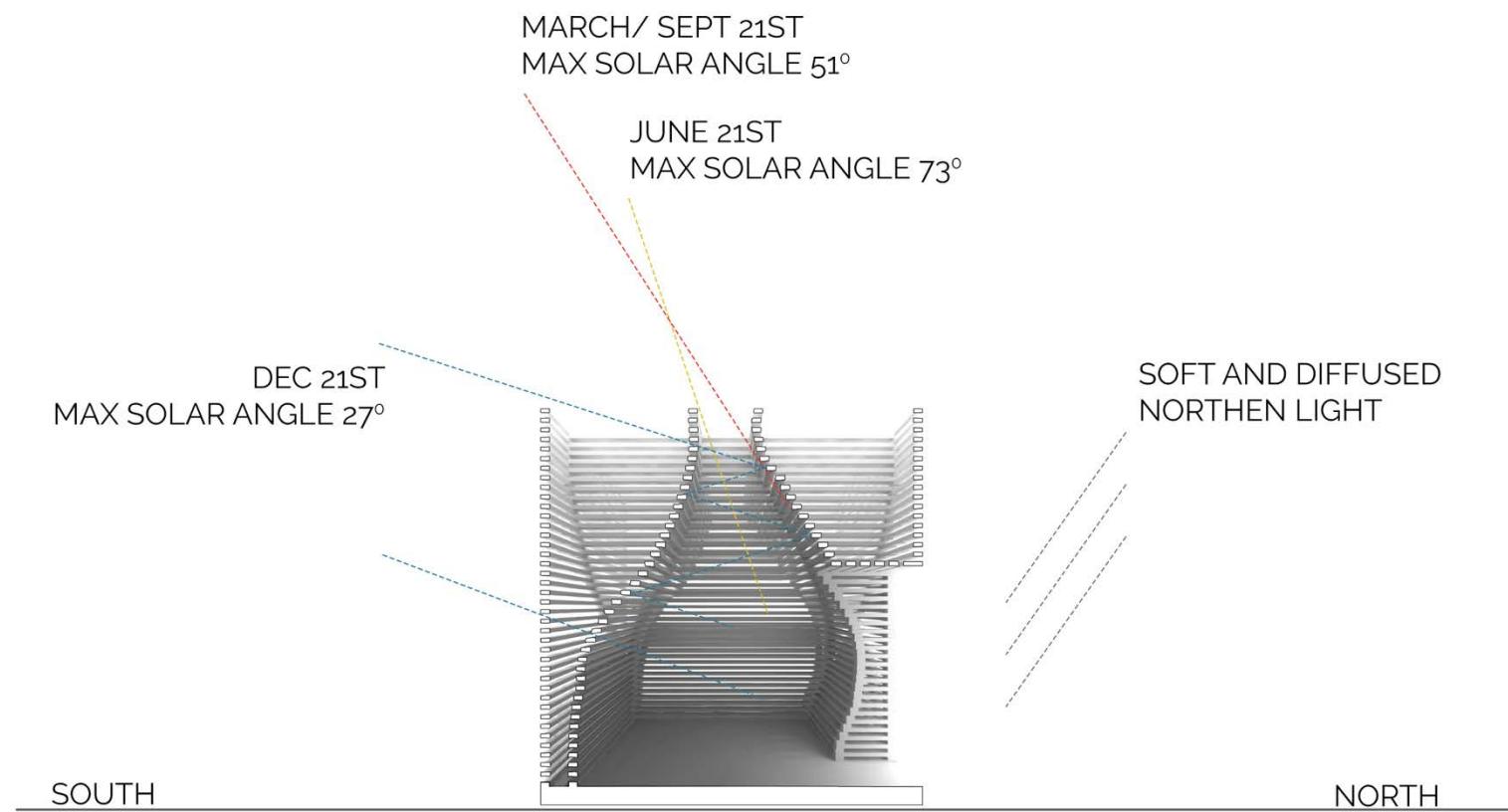
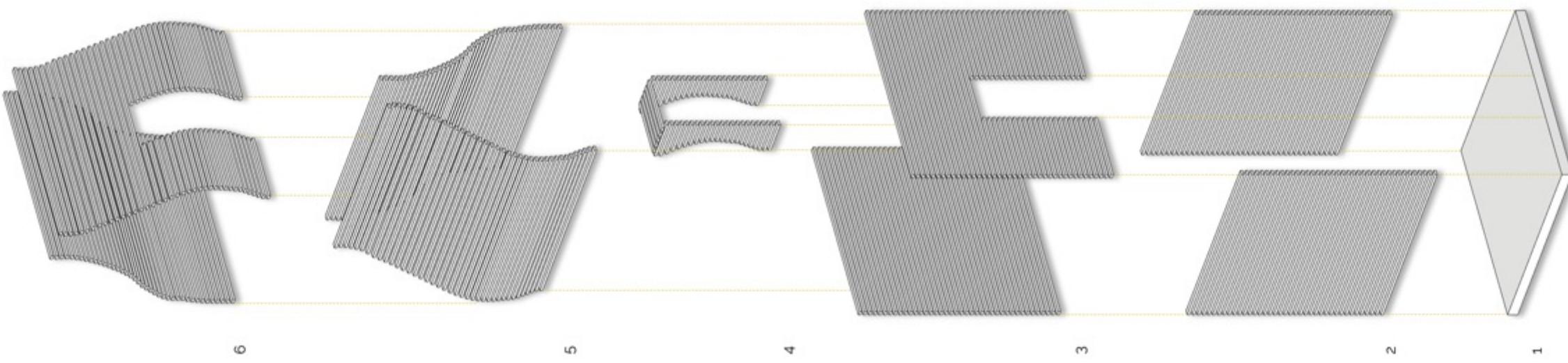


Figure 52. Light analyses. (Thesis author)



- 1 - STONE FOUNDATION (STONES FROM SITE)
- 2 - WOODEN PLANKS 50x100 MM (WOOD FROM SITE)
- 3 - CROSSED WOODEN PLANKS 50x100 MM (WOOD FROM SITE)
- 4 - DOOR OPENING 1000x2300 MM
- 5 - WOODEN PLANKS 50x100 MM STAGGERED IN CURVE
- 6 - CROSSED WOODEN PLANKS 50x100 MM STAGGERED IN CURVE

10.6 NATURE OBSERVATION HUT – INTEGRATED LIGHT



LOCATION

The nature observation hut (position 6) is located on a river down at the mountain valley. This location is often used by the visitors but only for a short period of time (for a swim, etc). The riverside has a beautiful view to the mountains and to the whole retreat from the down. The hut is placed on a river, so that it is more private and also can use water as a part of the hut's design.

FLOOR PLAN

The floor-plan is designed in the way that the human eye is on the same level as the water. The bottom of the hut goes beneath the water, allowing the user to hear the sound of the water, which in many find relaxing. It only has one room, which is the meditation area. This hut also has a walkway around the center part. There is a gap between the hut and the walkway so that the shelves can reflect the light into the hut.

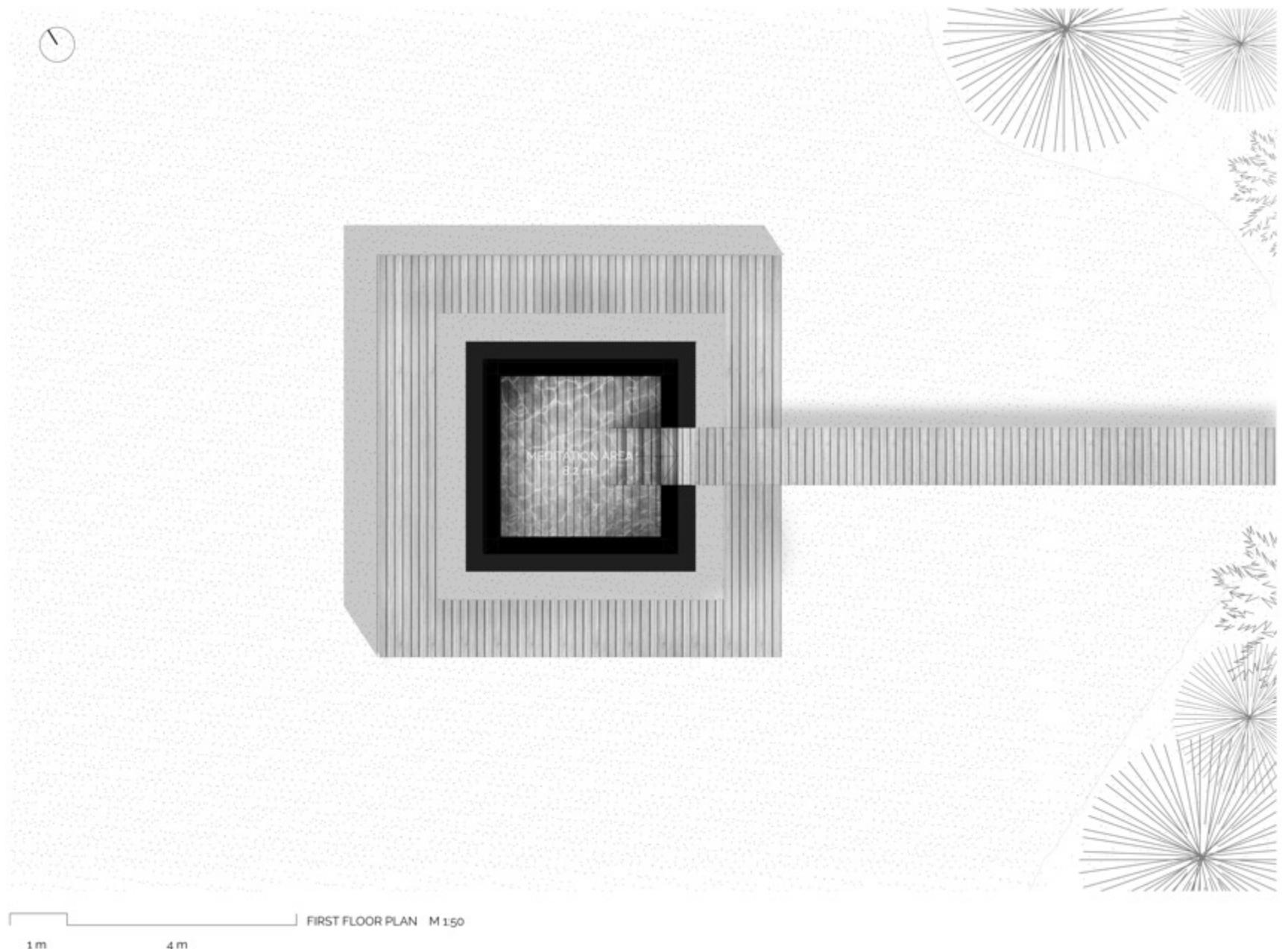


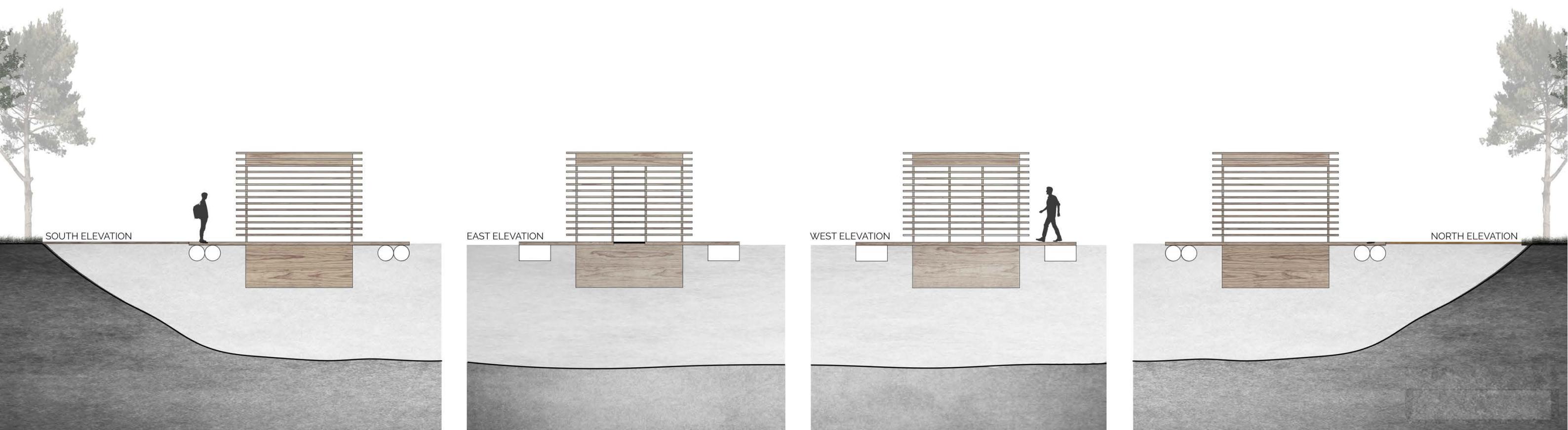
Figure 53. Floor plan. (Thesis author)

MATERIALS

The structure of the hut is made out of wood. The perimeter of the hut is covered with wooden shelves, which have mirrors under, so that the water can reflect from them and bring the effect to the inside. The bottom of the hut, that is under water, is covered with recycled plastic so that it would be waterproof. It also uses recycled materials such as old barrels underneath the hut, so that it would float.

ATMOSPHERE

The main desired qualities of the atmosphere are oriented to exterior and the nature.



DAYLIGHTING

according to Guzowski, integrated light explores opportunities to couple daylighting with architectural form, passive design, and innovative technological systems to integrate program, aesthetics, performance, energy, and sustainable design goals (Guzowski, 2018, p. 8). The design of the buildings envelope considers the humid climate and intense sunlight. The sides of the hut are left open so that the natural ventilation can occur. The hut also uses wooden shelves as a passive cooling system, not allowing sunlight to come in directly. The shelves reflect the water and make the inside "wave" as the reflection touches the walls and the ceiling.

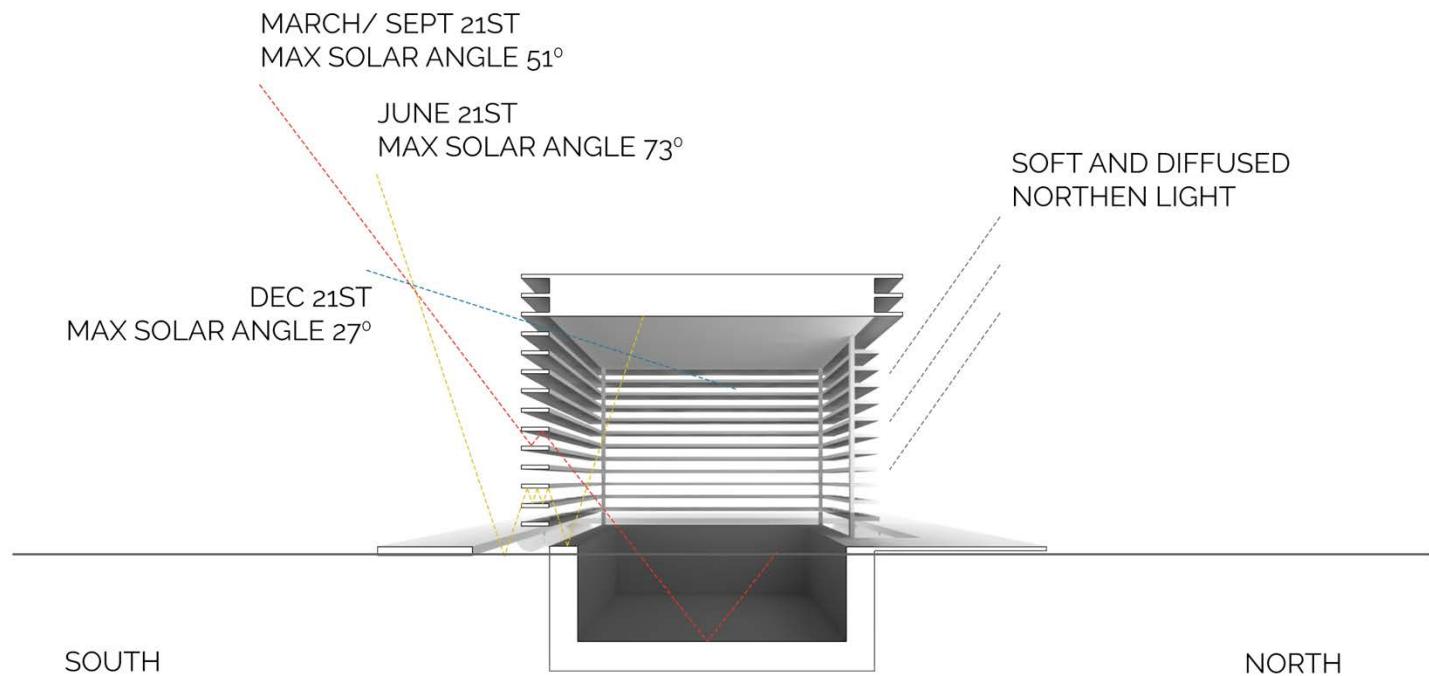
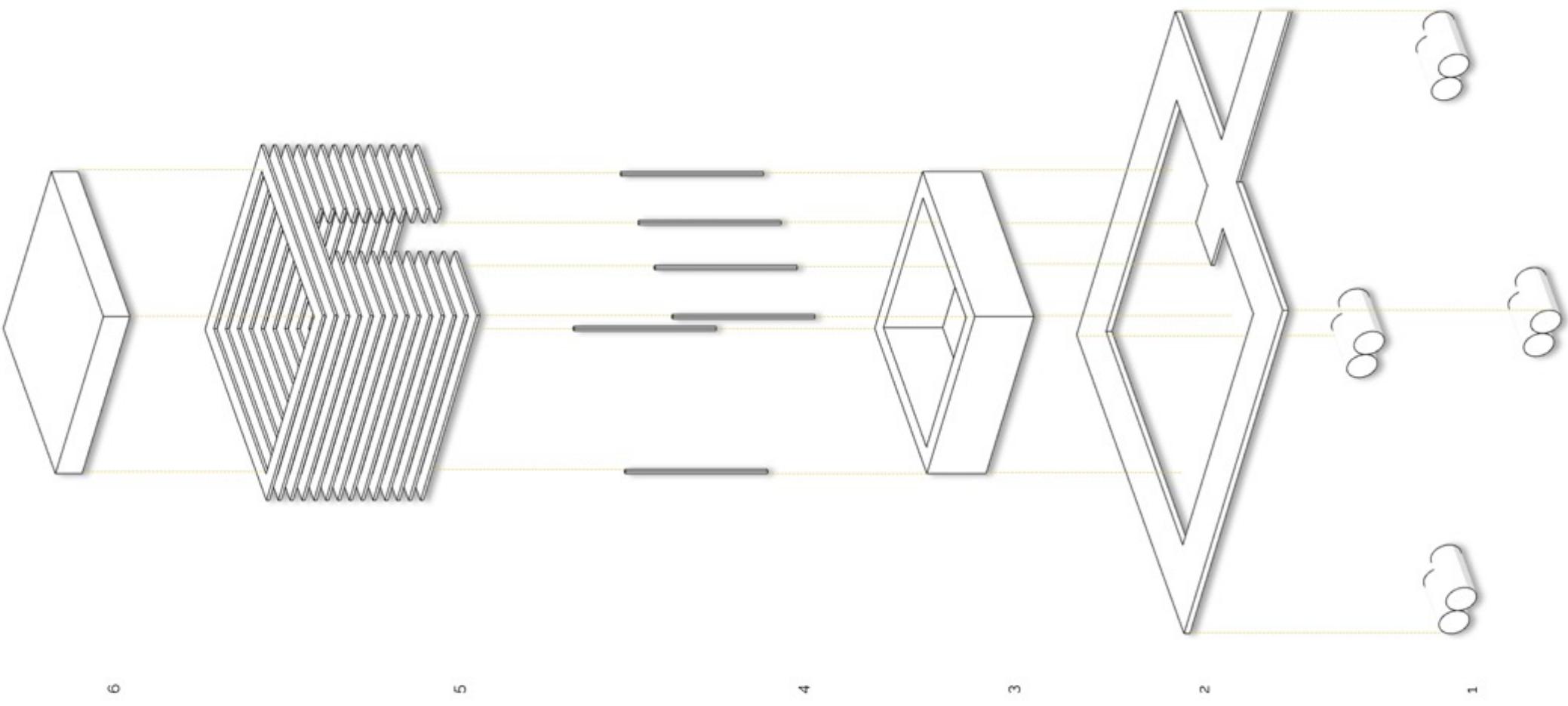


Figure 55. Light analyses. (Thesis author)



- 1 - UNUSED BARRELS
- 2 - WOODEN STRUCTURE AND PLANKS (50x200 MM)
- 3 - WATERPROOFED WOODEN UNDERWATER PART (WOOD FROM SITE)
- 4 - WOODEN COLUMNS (50x50 MM)
- 5 - PLYWOOD SHELVES WITH MIRRORS UNDERNEATH (LEFTOVER PLYWOOD)
- 6 - FLAT ROOF WITH WOODEN STRUCTURE (WOOD FROM SITE)

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III ARCHITECTURAL PROJECT – PANELS IN REDUCED SIZE

