

SHAMSAN MOUNTAIN GALLERY -ADEN
ARCHITECTURE IN EXTREME CLIMATE

Master Thesis in Advanced Architecture
Lund University

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LUND UNIVERSITY

School of Engineering

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CONTENT

Special thanks	7	Design Project.....	62
Introduction	9	project Site analysis.....	62
Abstract	12	Design Concept.....	63
Aden location		The Roof Design.....	64
About the city		Creating new track.....	66
The historical importance	18	Solar-responsive dynamic shading system.....	68
The most important landmarks of the historical city of Crater Aden	22	Grasshopper code.....	70
Site Location and analysis	26	Design Drawings.....	72
The Seven Tracks	29	Underground plan.....	72
The Tawila Tanks	30	Ground floor plan.....	74
The Pomis Caves	34	Sections.....	76
Tower of Silence	37	Sections.....	78
The most important historical landmarks Next to the project site	38	Renders.....	80
Stones in site	42	Site furniture.....	98
Vegetation	44	Mashrabia wall.....	98
Weatehr	47	Parametric benches.....	104
references	50	physical model.....	106
Louvre Abu Dhabi / Ateliers Jean Nouvel	52	Refrences.....	110
Doha Tower, by Jean Nouvel	45		
Messner Mountain Museum Coronos / Zaha Hadid	55		
Kuwait National Assembly Building / Jørn Utzon.....	57		
AL BAHR TOWERS BY AEDAS.....	58		

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First and foremost, I would like to thank my parents Ahmed and Qutah, how have always supported me in my different stages of live and everything I do, I am grateful for their support, constant encourage and love which makes me what I am now, they always believe in me and were always there for me, thank you for always looking out for me.

As I would like to thank my wife and soulmate Elham, for always supporting me and giving me a great helpful advices and thoughts and for being a constant source of love and inspiration.

Second, I would like to thank my teachers and professors for their support and guidance through the whole journey.

Finally would of course like to thank my brother Rami and his friend Ayman for their help in providing the necessary pictures by visiting the location.

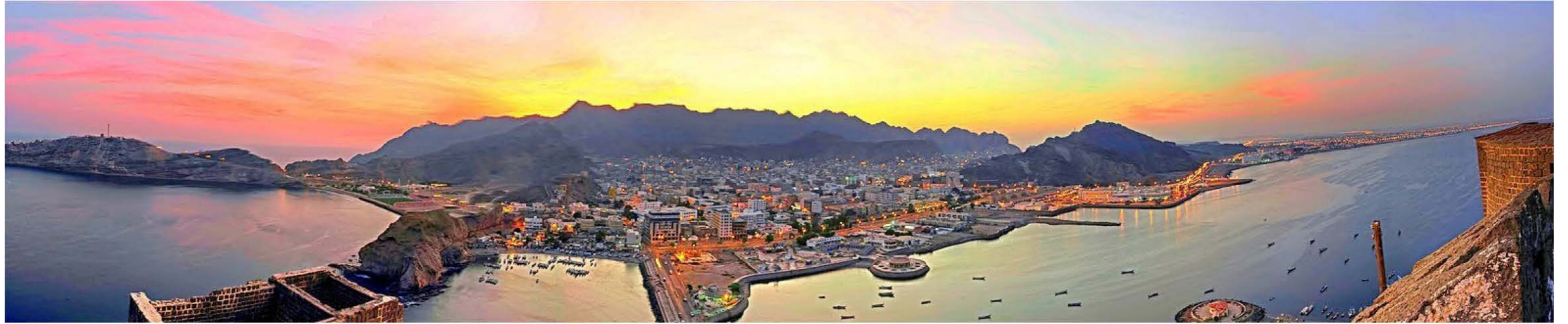
INTRODUCTION

Generally, in most architecture discussions the most important factor that architects take in to consideration is the climate factor it's one of the main factors that affects the type of architecture.

Designing an effective building is becoming more and more hard task, due to a growing demand to satisfy more ambitious environmental, societal and economic performance requirements.

The aim of this paper is to present a comprehensive review of research and design in field of climate adaptive shells in Aden with a design of museum, in Aden city which located in a hot and humid region.

This design has been produced by combining the beneficial aspects of the new design technologies and the traditional techniques in the local architecture.



ABSTRACT

The project is located in Aden City . Aden is a city in the Yemeni Coastal Plains, on the Gulf of Aden just at the Southern End of the Red Sea. It is a UNESCO World Heritage Site.

The city has a desert climate. During the year, there is virtually no rainfall in Aden. The hot weather and the humidity is a big challenge in this kind of cities.

The project is a kind of research and a design in climate adaptive building shells and how to modify the spaces in a way that creates comfortable areas for people.

Middle Eastern cities developed through the years different shading systems from Mashrabias to the new double-facades. These systems offered effective protection against intense sunlight for several centuries. Nowadays designers transformed the basic shading systems into a high-tech responsive daylight system. Through my thesis, we will discover new opportunities by merging the cultural, visual and technical aspects

and transforming local shading systems such as the (Barda) system into a totally new system enriched with a new technology. In addition to the climate challenges, another goal of this research is to solve and redesign the area making it more accessible and connected.

To address the problems and solve them, I designed a project by studying and analyzing the site with the Grasshopper program, which was a valuable chance to improve my skills in such techniques. It can serve as a tool to enhance the new technology in a way to help create buildings or structures that help to reduce the effect of the sun and humidity in the hot areas. It will also be a useful reference in similar projects.

The municipality announced the need for a seasonal museum or a gallery near the historical sites. The research can be a good starting tool to more studies and improvements.

1- ADEN LOCATION

Aden is a port city in Yemen, located by the eastern approach to the Red Sea (the Gulf of Aden), approximately 170 km (110 mi) east of Bab-el-Mandeb strait. Its population is almost 800,000 people. Aden's natural harbour lies in the crater of a dormant volcano, which now forms a peninsula joined to the mainland by a low isthmus. This harbor was first used by the ancient Kingdom of Awsan between the 5th and 7th centuries BC. The modern harbour is on the other side of the peninsula. Aden gives its name to the Gulf of Aden.

The is distinguished for its geographical location which is important for the inter-



national navigation lines. Aden has a wonderful tourist geography with its view on the Gulf of Aden. There are so many examples of Aden's historical architectural sites which prove the extent and depth of the city's architectural and cultural heritage. But we find that this architectural wealth and historical monuments are at risk of extinction and fading due to the negligence and carelessness towards them, which may lead to the obliteration of their historical identity. The failure to preserve them through destroying them and exploitation of their areas for the construction of strange buildings that are not related to the history of the city which leads to the depletion of these landmarks and their architectural heritage.



2- ABOUT THE CITY

Aden consists of a number of distinct sub-centres:

Crater, the original port city; Ma'alla, the modern port; Tawahi, known as «Steamer Point» in the colonial period; and the resorts of Gold Mohur. Khormaksar, located on the isthmus that connects Aden proper with the mainland, includes the city's diplomatic missions, the main offices of Aden University, and Aden International Airport (the former British Royal Air Force station RAF Khormaksar), Yemen's second biggest airport. On the mainland are the sub-centres of Sheikh Othman, a former oasis area; Al-Mansura, a town planned by the British; and Madinat ash-Sha'b (formerly Madinat al-Itihad), the site designated as the capital of the South Arabian Federation and now home to a large power/desalinization facility and additional faculties of Aden University.

the city encloses the eastern side of a vast, natural harbour that comprises the modern port. The volcanic peninsula of Little Aden forms a near-mirror image, enclosing the harbour and port on the western side. Little Aden became the site of the oil refinery and tanker port. Both were established and operated by British Petro-

leum until they were turned over to Yemeni government ownership and control in 1978.

It was the capital of the People's Democratic Republic of Yemen until that country's unification with the Yemen Arab Republic in 1990.



3- THE HISTORICAL IMPORTANCE OF ADEN CITY

Aden is strategically important not only to its strategic location but also to its geographical structure. Aden is located in the southwest of the Arabian Sea coast. Geographically, it is the southwestern border of Yemen. The city of Crater is almost volcanic, near the ancient direct from the route of the eastern part of the Mediterranean, Greece, Egypt and east Africa to India.

160 Aden is close to the door of the southern entrance of the Red Sea and east of it by about 160 km and therefore it oversees the entrance of the Red Sea and the Arabian Sea and the Indian Ocean and is considered the most appropriate port compared to other nearby ports. This important strategic location makes Aden the focus of attention of major countries across history ... The importance of Aden as we mentioned earlier came not only from its strategic location, but also from its geographical structure.

When choosing Crater to be the location of the city of Aden, it has been fortified from the land by the steep mountains that surround it. The Aden peninsula is an empty volcano and is now called Shamsan. Its height is (553 meter). In the eastern part there is an opening in the mountain the part facing Seerah mountain and there locates the main part of the city, population groups spread until near the sea.

The choice of the first person who settled in Aden was for its natural immunity and its protection from enemies, whether coming from the land or the sea. The history of human's first settlement in Aden is unknown, but there is no doubt that one glimpse of the city's

great monuments shows why many generations chose to build their homes and work in trade there. What is now known as the city of Crater in Aden is a magnificent natural fortress surrounded by the steep sides that stand to guard, leaving few easy defensive entrances towards the land.

The peninsula is linked to the mainland, behind the walls, by a narrow isthmus that serves as an obstacle to invaders.

In front of the fortified city is a port that is one of the very few and excellently natural ports on the southern coast of Arabia. .

The port had its natural defenses represented by the island of Sira, a lofty natural

fortress guarding the entrance and navigation from the looting and robbery carried out by those coming from overseas. The protection offered by the mountains of Aden is very steep for the residents in the city and across the history it helped the people keep



their wealth at their fortified homes away from the poverty that dominates the countryside.

Moreover, the size of the port was of the type that commensurate with the merchant ships, and that is after it started the use of iron and steel, which freed navigation from the imposed constraint which was imposed by the technology of the wood industry until the very near past .. The location of the city was excellent by all standards.

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Some historic areas have become waste dumps



A picture showing the neglect of historical monuments and their non-restoration



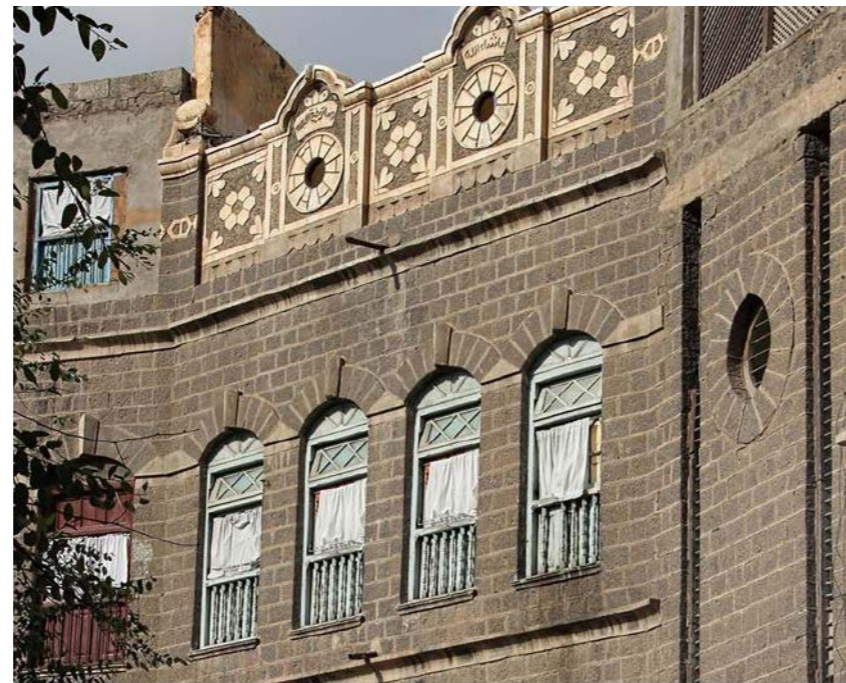
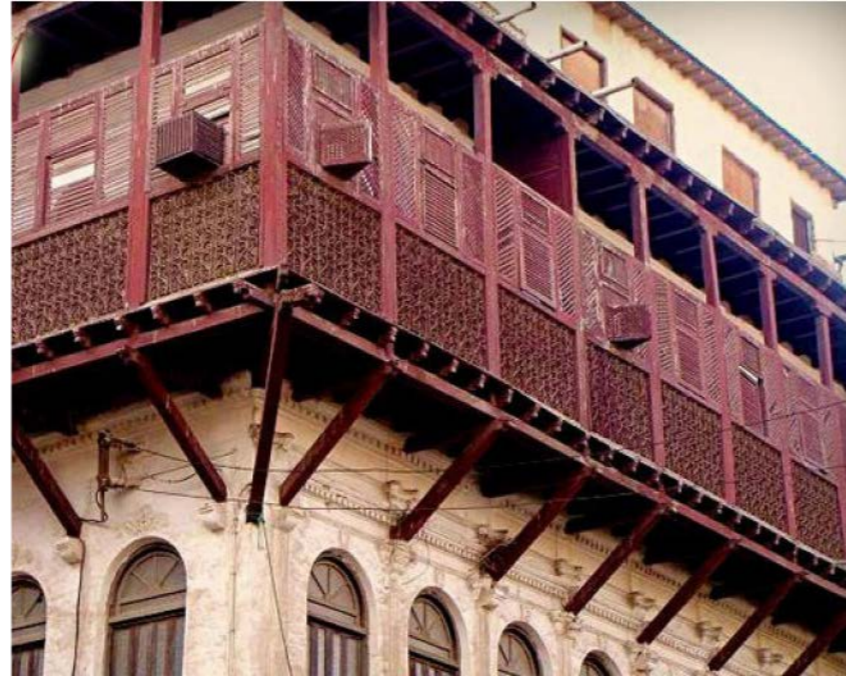
The extension of the slums within the historic Tawila Tanks



Use of historic buildings in some areas as habitation areas by some poor groups

4- THE MOST IMPORTANT LANDMARKS OF THE HISTORICAL CITY OF CRATER ADEN

The historical construction follower in Crater-Aden notices that there is no historical landmark that refers entirely with all its details to the pre-British occupation period without change, renovation or restoration and maintenance of the British authorities, although some of the monuments remained with their style /pattern of building as they were before, as the British have only restored them, such as: the lighthouse (almanarah) which is composed of a staircase organized and arranged since the Othmani rule on Aden, the British authorities did not change them, but they restored the lighthouse and removed the mosque which is followed by the lighthouse and made instead a training camp, which makes the viewers of the lighthouse doubt it was old, as the old coastal wall was located near the lighthouse, and the ascending stairway leading to the summit of Shamsan mountain was maintained by the British and neglected by the local authorities since the independence and this deterioration continues unfortunately. As for the walls and fortifications of Crater, they were rebuilt by the British in new forms and techniques.



Other historical monuments are:

Aswaraden on a castle and a door

Jabal al-Mansuri, including the green Aden (Aqaba)

and the fortress of turbidity.

Tunnels (Al - Bagdtan) Tunnel extending under Mount Mansouri from

Crater to Khormaksar

In front of the Directorate of Education building and the second tunnel (Al-Bajdah) that reaches Al-Burkh

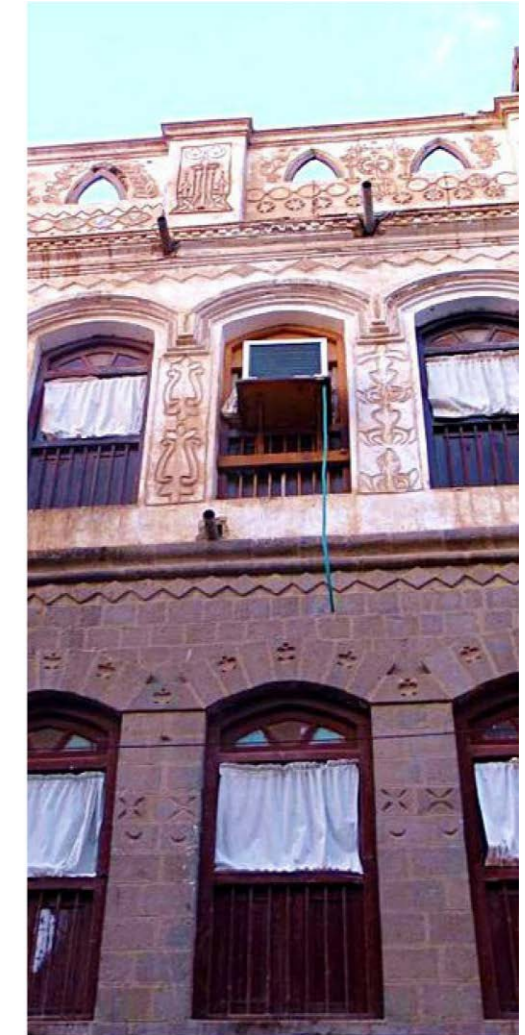
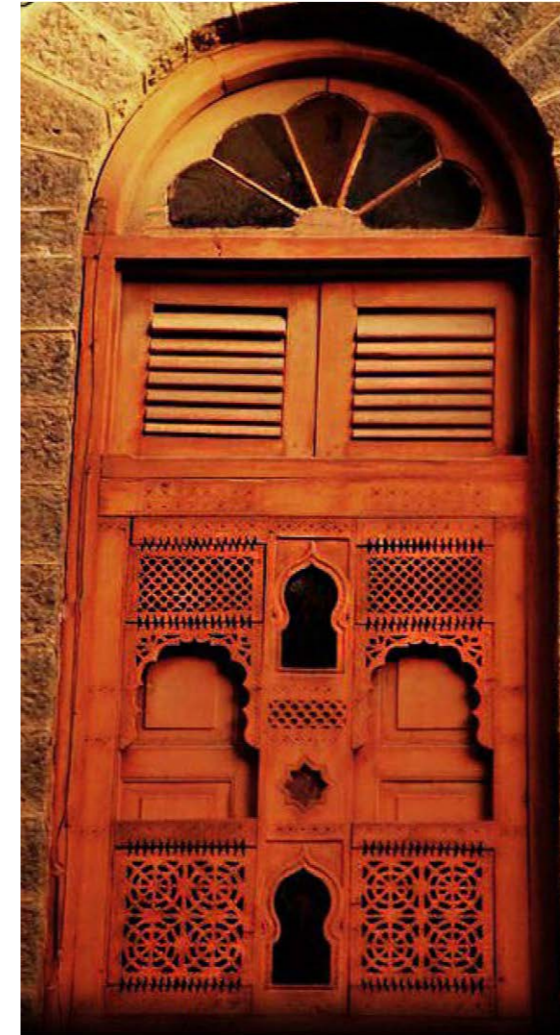
Al-Baghdadi.

Sorgbel Harat.

Venemashik.

Aden tanks.

In addition to some temples of Hindus and Persians.



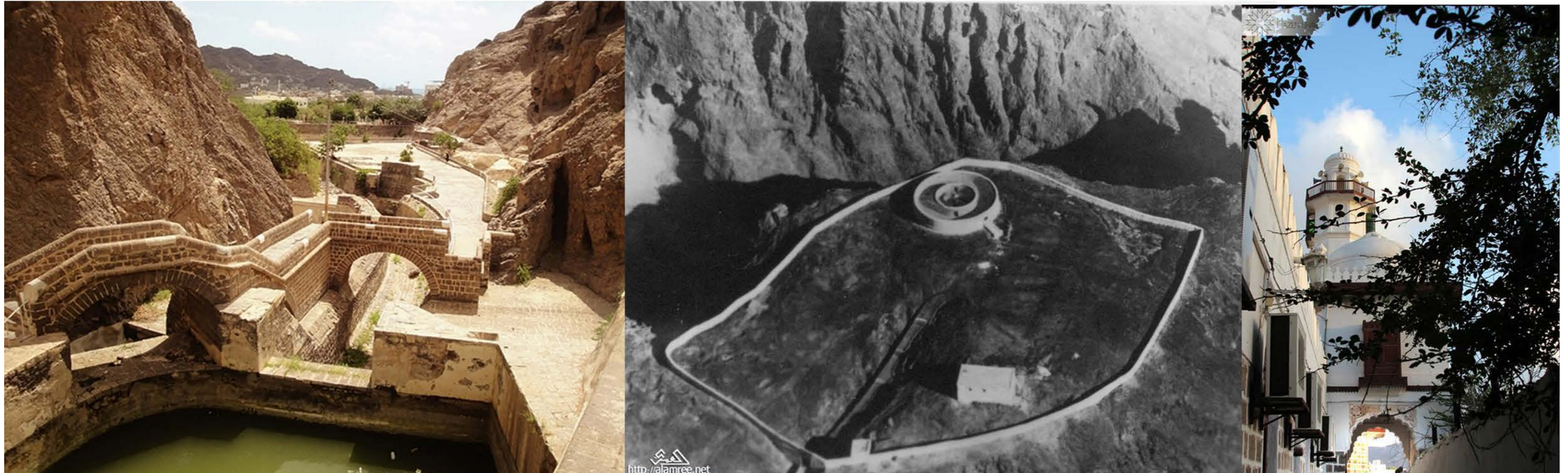
5-SITE LOCATION AND ANALYSIS

In the early stages of the project, there was a belief that Aden city needs a museum or a seasonal gallery for many facts which we mentioned before. So, I contacted the municipality of Aden and they said that there is an on-going planning for a museum. They said two potential sites in Aden. One is near Sira castle, and the other is near the entrance of Aden city. My location was chosen for many reasons. The most important one is its closeness to the most three historical attraction sites and scenery views of

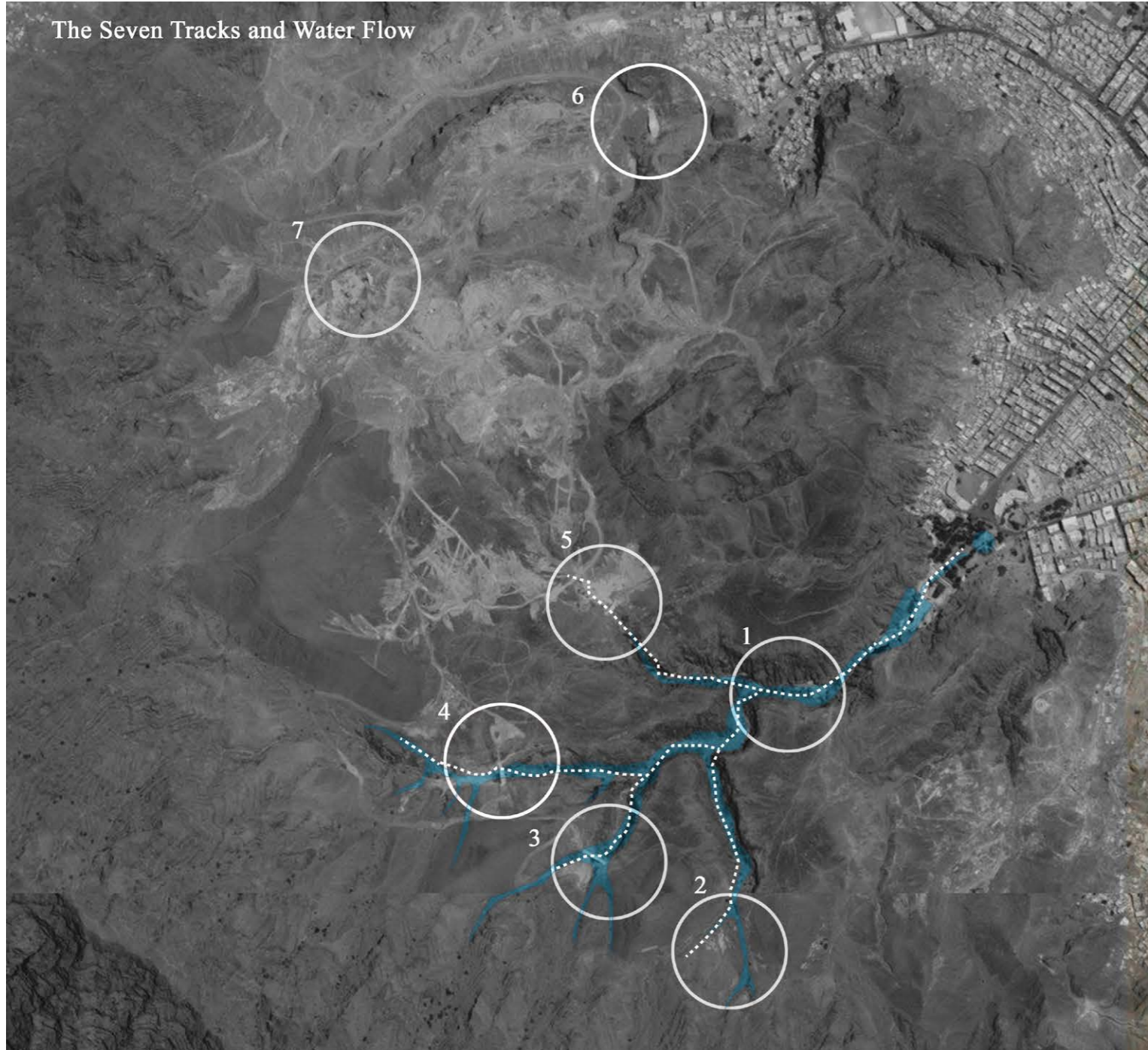
the city. Here in this summary research, we will talk about these attractions and the relation between them and the project site.

The attractions are

- Tawila Tanks (Aden Tanks)
- The Tower of Silence
- Al-Aidaros Masjid
- The Seven Tracks
- The Pomis Caves



The Seven Tracks and Water Flow



5-1- THE SEVEN TRACKS

The seven tracks are seven ancient dams which were built hundreds of years ago. They are located within the mountainous heights of the Aden tanks (Shamsan Mountain). They extend from the highest temple in Al-Khusaf to the Boumis area in the city of Crater. They are 15 to 18 meters high and about 20 meters wide, and this distance varies from one dam to another, and from one mountain to another.

These tracks were constructed of Pomis which were recently restored by ordinary cement. Pomis is a volcanic ash which contains many chemical elements, this ash can act like cement when limestone is added. These tracks look like valleys in their shape. Water flows down from the mountain heights to these valleys (tracks) and end with one of the dams. Then it fills up, the water flow continues to the next dam (track). This causes to reduce the flow of rainwater that collects in the tank course.

The tracks are related to the features of the plateau located in the flowing watercourses to the long valley of Crater. They were mentioned in the sources before the 19th century, because they are very important in the life of the city, they are still upright and perform their functions to this day.

Recent excavation and survey work on these tracks confirmed that the long tanks, except for the outside of the valley, were used as water drains. They were built on the mountain rocks as water filters, which differ in nature from the tank function as "reservoirs". It takes the function of taking the sloping water and directing it accurately from one bank to another, after the process of clearing it from (silt and stone) to reach the empty tank that is located outside the valley, which was originally built as a water reservoir.

5-2-THE TAWILA TANKS

The Tawila Tanks, are the best-known historic site in Aden, Yemen. The site consists of a series of tanks of varying shape and capacity. They are connected to one another and located in Wadi Tawila to the south-west of Aden's oldest district, Crater.

The tanks were hewn from the volcanic rocks of Wadi Tawila and then lined with a special stucco that included volcanic ash to create a strong, natural cement that rendered the tanks' walls impermeable in order to retain water for extended periods.

The tanks were designed to collect and store the rain that flows down from the Shamsan massif through Wadi Tawila, and to protect the city from periodic flooding. The largest of the tanks are the Coghlan Tank at the center of the main site and the large, circular Playfair Tank, located at the lowest point, outside the main site.

Originally there were about 53 tanks, but only 13 remain following a succession of renovations, including those done by the British in the 19th century. The existing tanks have a combined capacity of about nineteen million gallons.

By the time of the British occupation of Aden (beginning in 1839), the Tanks had been almost completely buried by debris carried down the mountains by successive floods. Sir Robert L. Playfair rediscovered the tanks and recognized their potential value. Aden had no fresh water and was often cut off from mainland water supplies by hostile tribes.





Playfair hoped that the Tanks, once repaired, could provide a reliable source of water for public consumption. The British accordingly set out to restore the tanks to their original function. However, in the process, the British modified the design and layout of the Tanks significantly from their original state. With the intention of storing the greatest quantity of water possible, British engineers replaced an intricate network of numerous, small, cascading cisterns along the valley walls with a few, larger tanks. The Tanks' ability to both control floods and store water was thus hampered, and the site that tourists visit today is very much a Victorian British creation. Further, the remodeling destroyed what archaeological evidence might have been present with regards to the original site, and this, coupled with the scarcity of documentary evidence, has made learning more about the Tanks' origins difficult.

Today, the cisterns are primarily a public park and a tourist attraction. They have not been filled for at least fifteen years and do not serve the city's water needs. They may still help with flooding, although the presence of structures in the saila, or flood course, that leads from the Tanks to the sea, impedes the flow of water. No significant restoration work has been conducted on the Tanks since the British colonial era ended in 1967

5-3-THE POMIS CAVES

The caves of Pomis are caves in the center of a mountain of different lengths and striking shapes. French traveler Henry Monfred (1879-1974) says in his book “Adventures in the Red Sea” that these caves were used as homes for some of the tribes coming from Africa called the Gabert tribes, known for eating humans’ meat. The caves became a scary place for the city residents where Gabert tribes practice their bloody rituals.

But other researches confirmed that these caves are not caves, but mines for mining and extraction of a material popularly called “Albomis”, and the age of mines coincides with the age of tanks of Aden. The purpose of this mine is the use of materials extracted in the construction of tanks as a link between the construction units of the walls of reservoirs

(Stones and bricks), as well as plastering material (coating) on the walls and floor of tanks, and filling cracks in the rock walls.





5-4-TOWER OF SILENCE

Tower of Silence is located in Crater, Aden City. The estimate terrain elevation above sea level is 109 meters. It was established during the British rule when a large number of Zoroastrian followers from British India were here with the British garrison and administration.

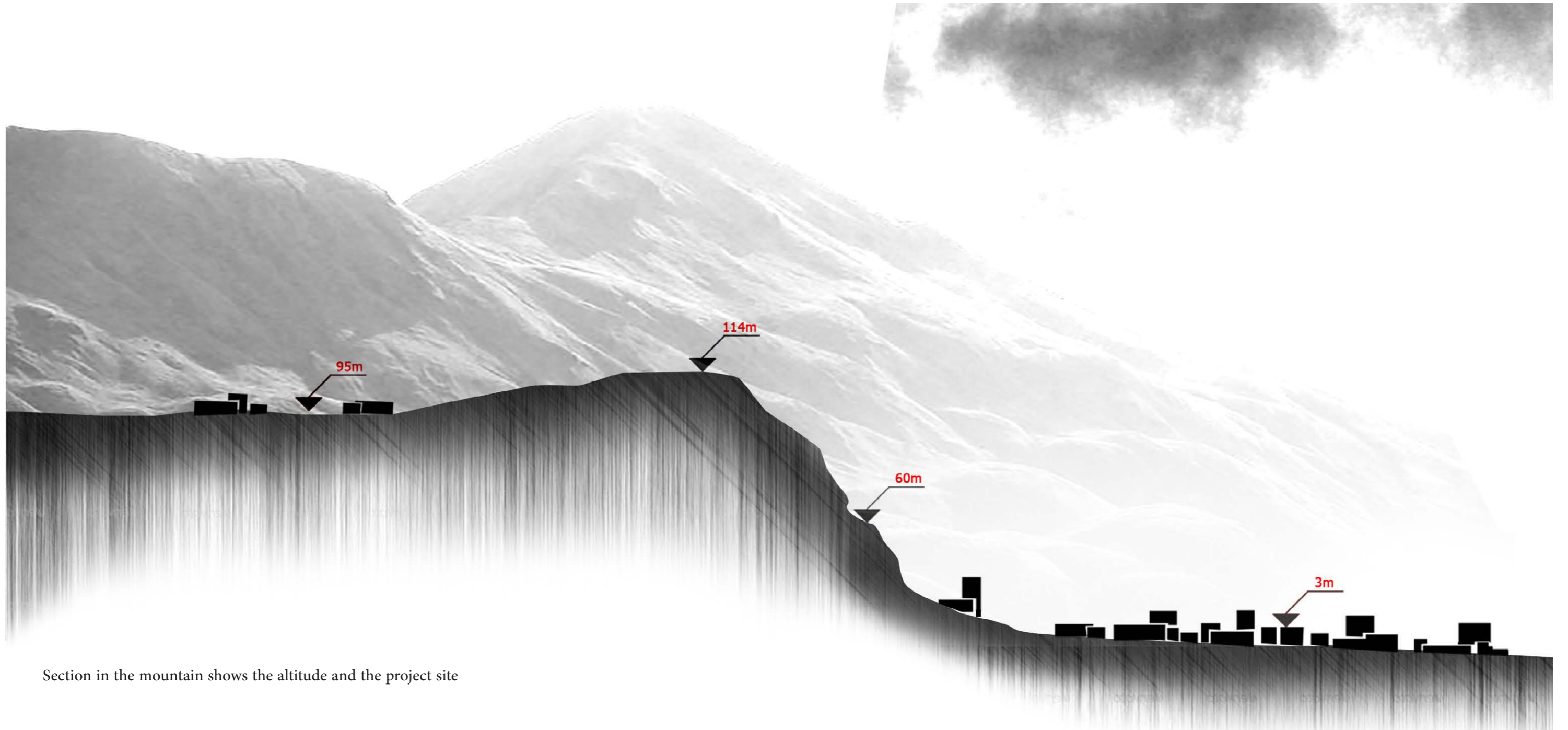
Zoroastrian theology includes a duty to protect nature. One of its strongest precepts the scripture calls for is the protection of water, earth, fire and air. They believe that burial or cremation of the dead will pollute the nature. So, the only logical alternative was to leave the rotting corpses to the elements and wildlife to consume them in specially constructed Towers of Silence.

6- THE MOST IMPORTANT HISTORICAL LANDMARKS NEXT TO THE PROJECT SITE :

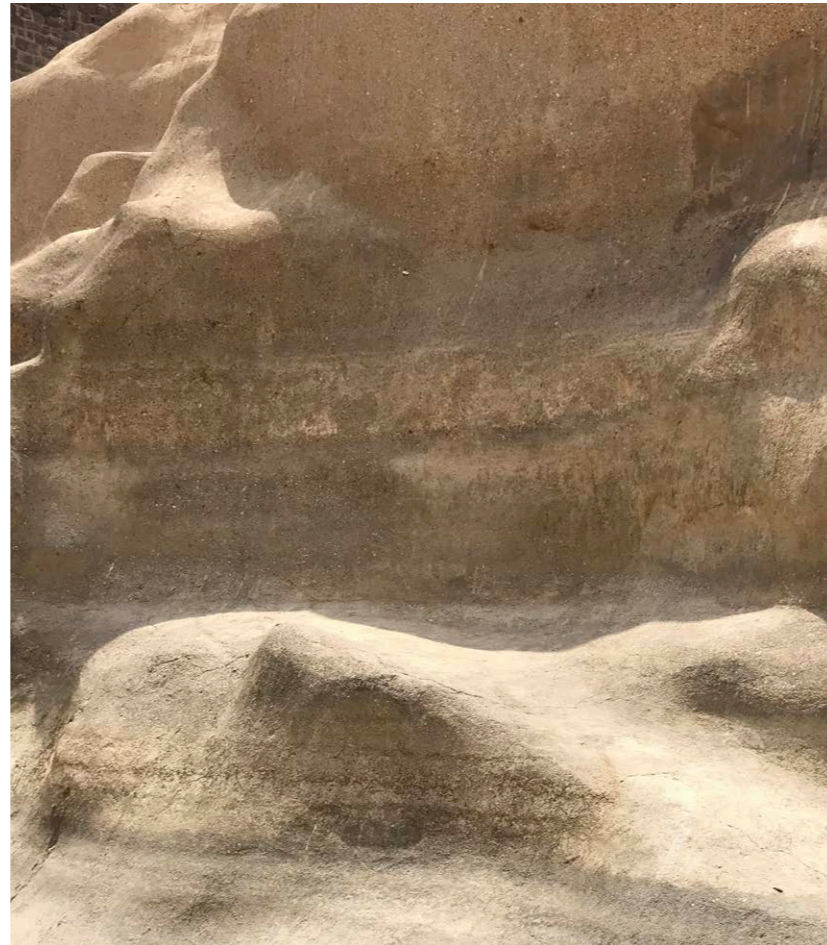
The most important historical landmarks and it's relation to the project site :

- 1- Site Location
- 2- The Tower of Silence
- 3- Al-Aidaros Masjid
- 4- The Seven Tracks (look at page
- 5- The Pomis Caves
- 6- Tawila Tanks (Aden Tanks)





Section in the mountain shows the altitude and the project site



7-STONES IN SITE

Materials on site that can be used in the project

8-VEGETATION

Some of the trees that sprout around the site.



9- WEATEHR

Cloudy, sunny, and precipitation days

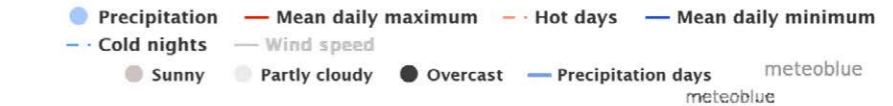
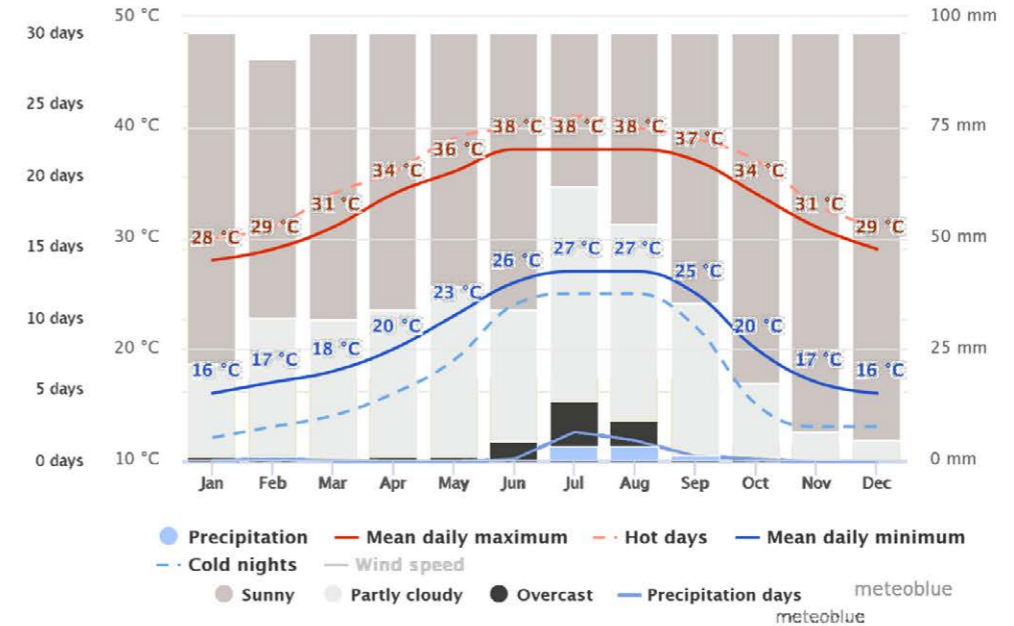
The “mean daily maximum” (solid red line) shows the maximum temperature of an average day for every month for Aden.

Likewise, “mean daily minimum” (solid blue line) shows the average minimum temperature.

Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years.

For vacation planning, you can expect the mean temperatures, and be prepared for hotter and colder days.

Wind speeds are not displayed per default, but can be enabled at the bottom of the graph. it shows also the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.



Cloudy, sunny, and precipitation days

The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

10-REFERENCES

In this paper we will list five references to buildings in climatic zones close to the city of Aden or similar terrain and how they were treated

examples on a buildings wich focus on recent developments in the adaptation and application of shading systems in hot climates.

Several newer buildings in the Middle East have transformed the oriental window technique into double-facades to reduce the cooling loads for the interior, such as the Masdar Institute in Abu Dhabi by

Foster + Partners (2010) or the Doha Tower in Qatar by Jean Nouvel (2012).



10-1- LOUVRE ABU DHABI / ATELIERS JEAN NOUVEL

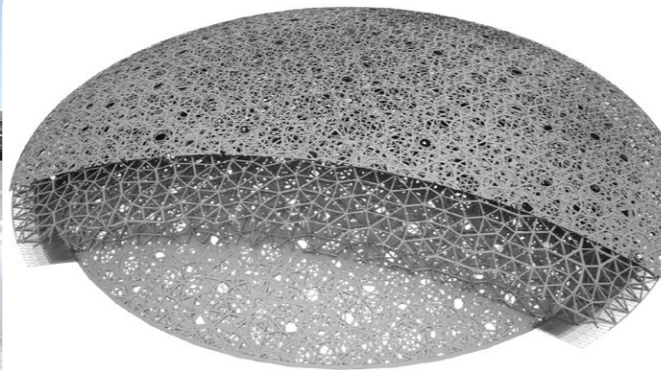
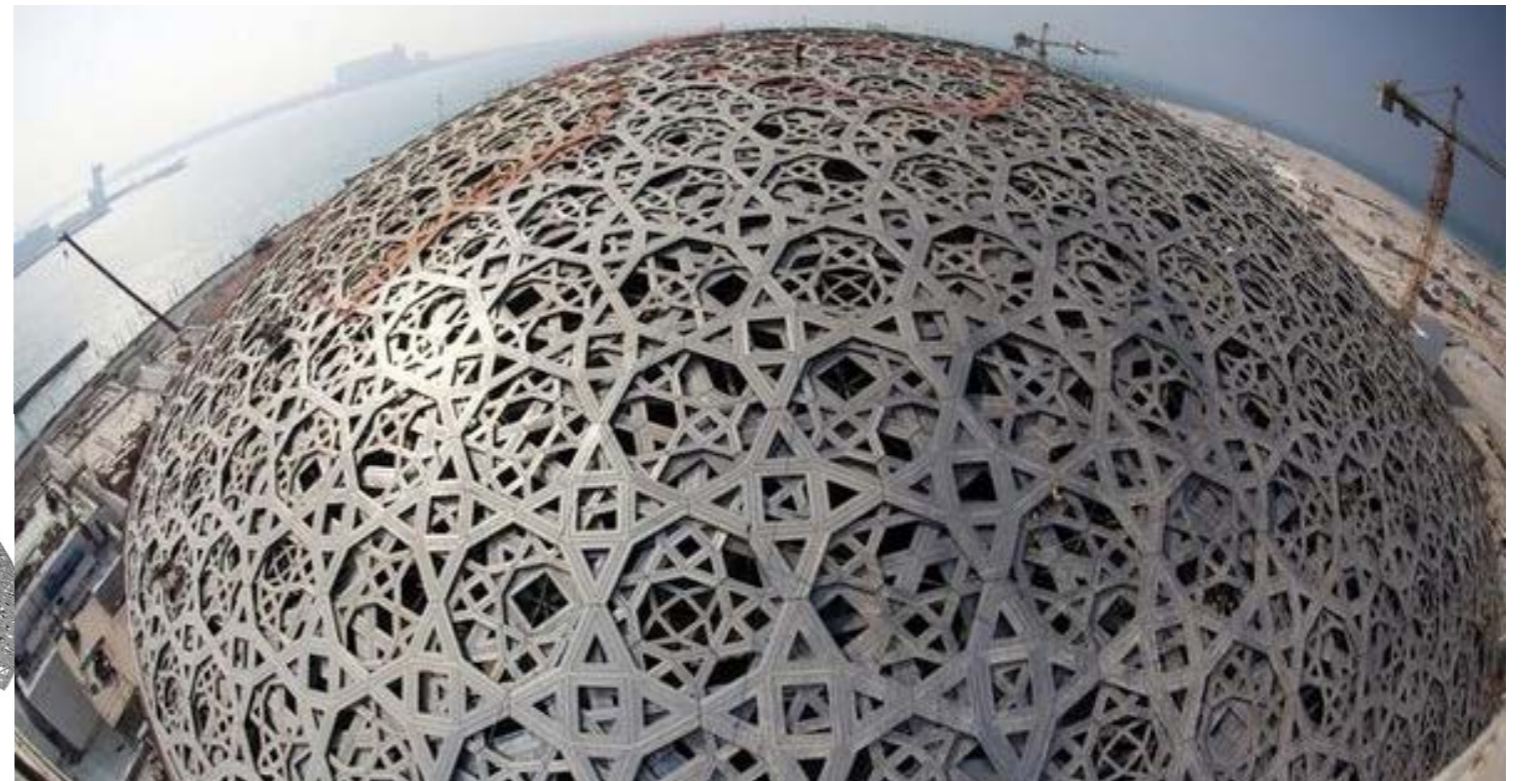
The design has a double dome 180 metres in diameter, offering horizontal, perfectly radiating geometry, a randomly perforated woven material, providing shade punctuated by bursts of sun, as Jean Nouvel described it.

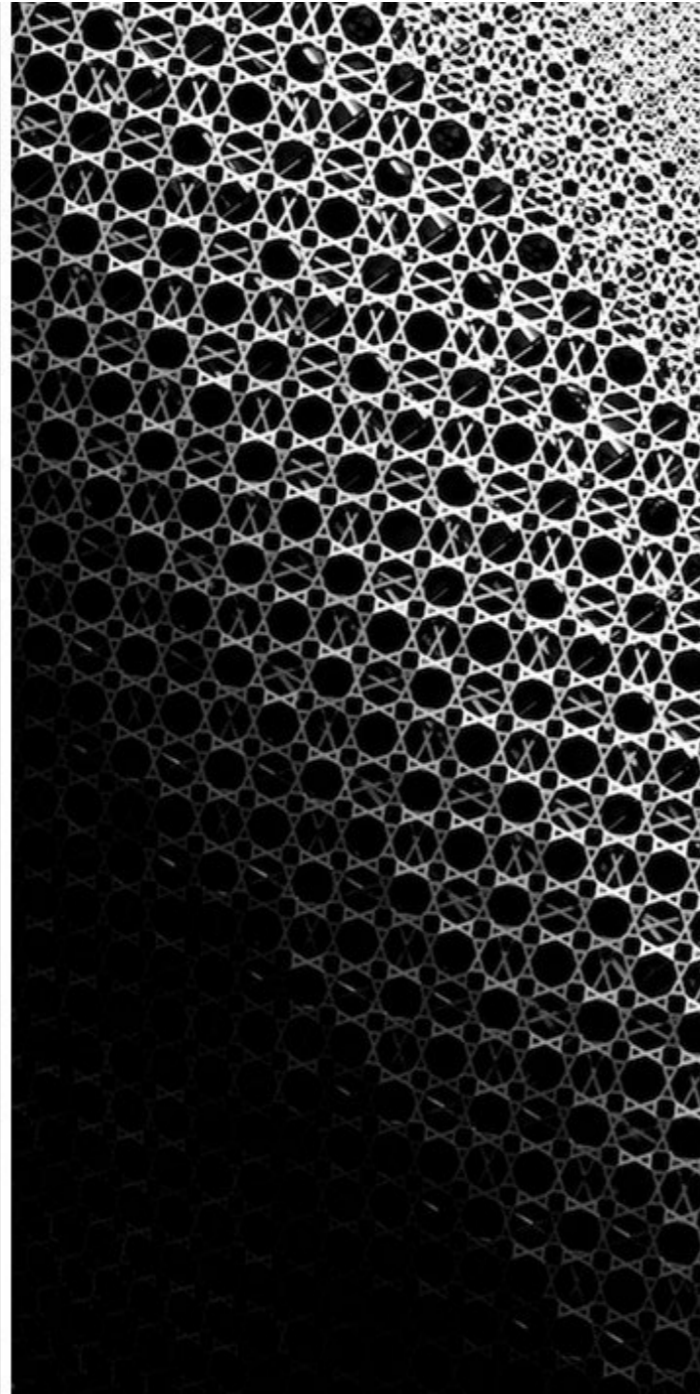
He said also “The dome gleams in the Abu Dhabi sunshine. At night, this protected landscape is an oasis of light under a starry dome.”

The semi-outdoor spaces below the dome are used to display specially commissioned installations, while the museum’s permanent collection and temporary shows are housed within white cubic blocks, to create a “museum city”.

A well as 6,400 square metres of gallery space – comprising 23 galleries for the museum’s permanent collection, a temporary exhibition space and the Children’s Museum – the Louvre Abu Dhabi also includes a 270-seat auditorium, restaurant, shop and cafe.

.dezeen.com

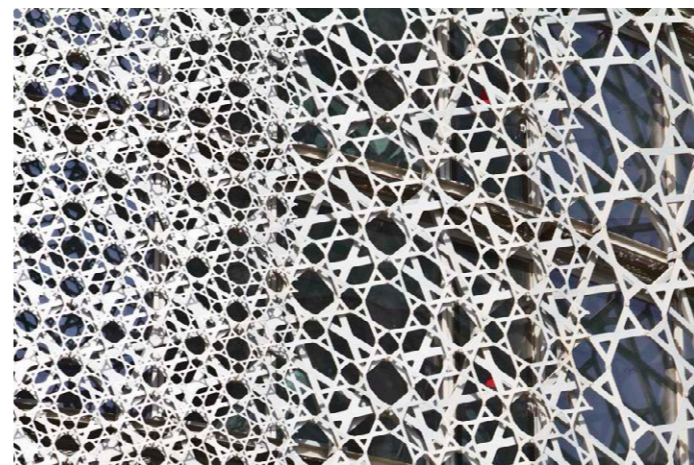
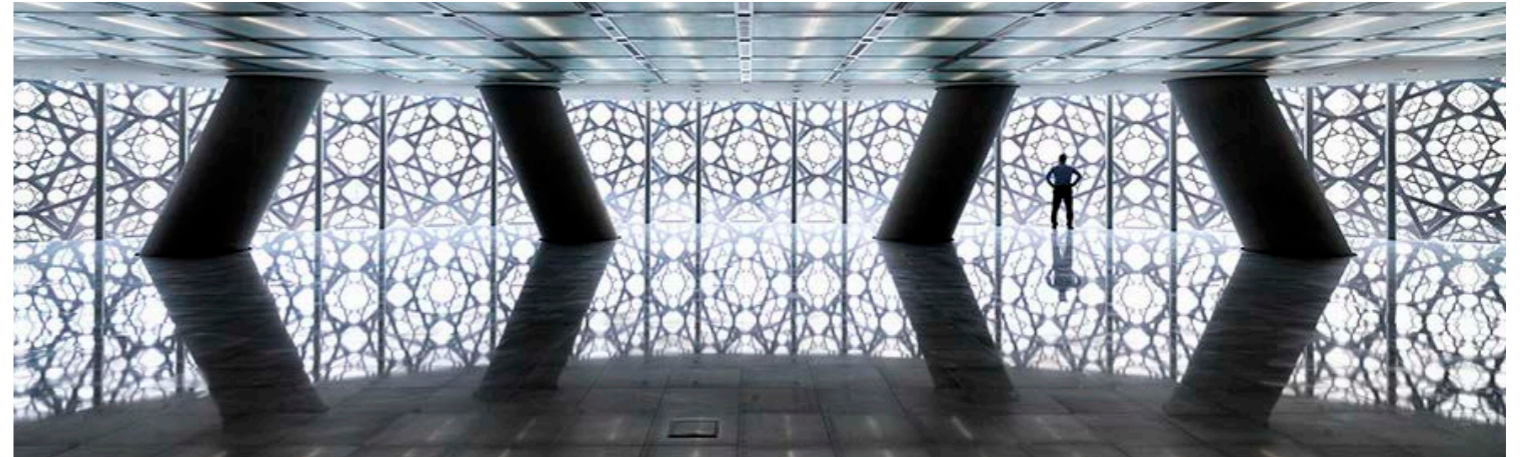




10-2- DOHA TOWER, BY JEAN NOUVEL

The 200m high Doha Tower reveals a rich multi-layered ornamentation. The building introduces a local identity and separates itself from conventional skyscrapers with its neutral structural glazing facade. Four aluminium elements have been arranged at the Doha Tower in a specific pattern that responds to the north, south, east and west with varying percentages of perforation. Here the subdivisions of very small pieces have been given up in order to achieve a comparable level of detail for the complete facade.

archdaily.com



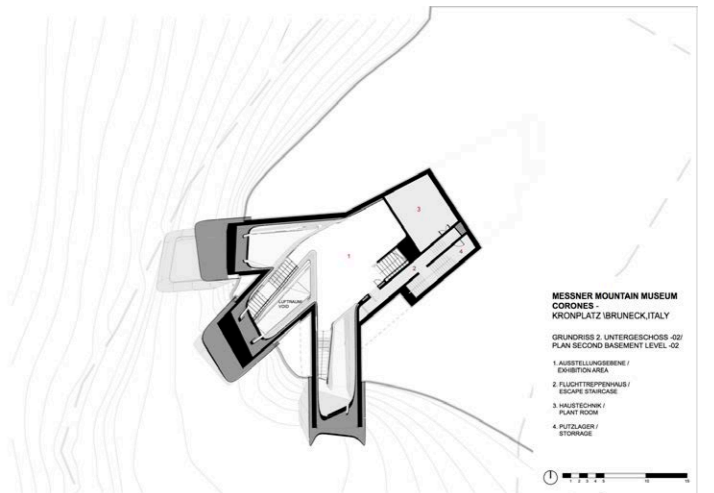
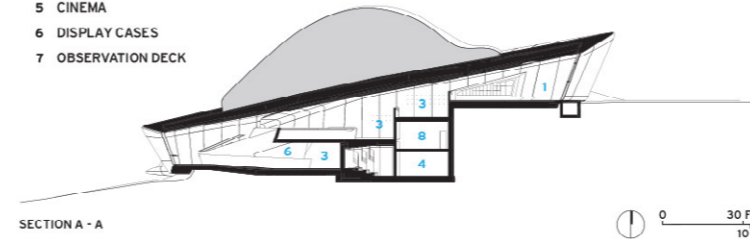
10-3- MESSNER MOUNTAIN MUSEUM CORONES / ZAHA HADID

Embedded within the summit of Mount Kronplatz, 2,275m above sea level at the centre South Tyrol's most popular ski resort, the Messner Mountain Museum Corones is surrounded by the alpine peaks of the Zillertal, Ortler and Dolomites. Established by renowned climber Reinhold Messner, the sixth and final Messner Mountain Museum explores the traditions, history and discipline of mountaineering.

Zaha Hadid explains the concept of the design: "The idea is that visitors can descend within the mountain to explore its caverns and grottos, before emerging through the mountain wall on the other side, out onto the terrace overhanging the valley far below with spectacular, panoramic views."

archdaily.com

- 1 ENTRANCE
- 2 TICKETS
- 3 EXHIBITION
- 4 STORAGE
- 5 CINEMA
- 6 DISPLAY CASES
- 7 OBSERVATION DECK





10-4- KUWAIT NATIONAL ASSEMBLY BUILDING / JØRN UTZON

Utzon's scheme most prominently features a public colonnade of soaring, thin piers that support a graceful, draped concrete roof over an open plaza. Its dramatic curves, composed of a series of semi-circular shells set onto steel cables, gesturally sweep down from atop the columns to the height of the building behind it in the natural form of a catenary. Utzon claimed that the cloth-like sensation of the roof references the iconic tent construction of the Arabian Bedouin people. Rising up toward the Kuwait Bay in front of it, the architecture is both inviting and forward-looking, casting its lofty gaze outward toward the sea and beyond.

The most astounding aspect of the plaza is its innovative and somewhat deceptive material deployment. Much has been made of Utzon's ability to make the concrete roof appear to "billow" in the wind, conveying the delicacy of fabric despite its inert rigidity. Its texture is enriched by a dual-parabolic geometry, in which individual sections curve upward perpendicularly to the curve of the whole. The experiential reward of this complex form is unmistakable: despite the staggering mass of the 600-ton beams, the roof is sensationably weightless.

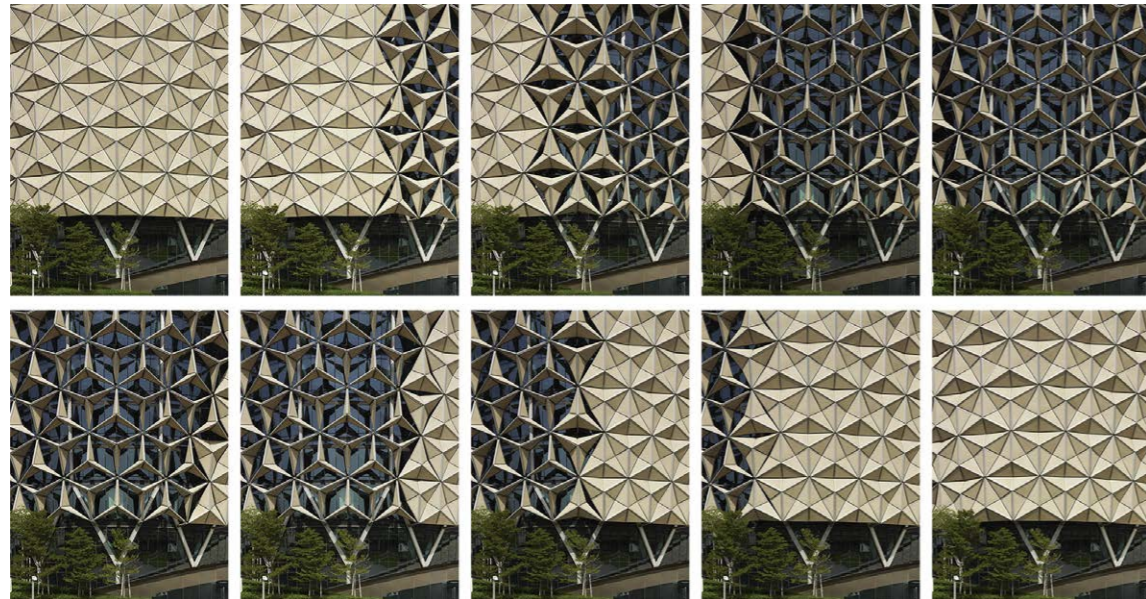


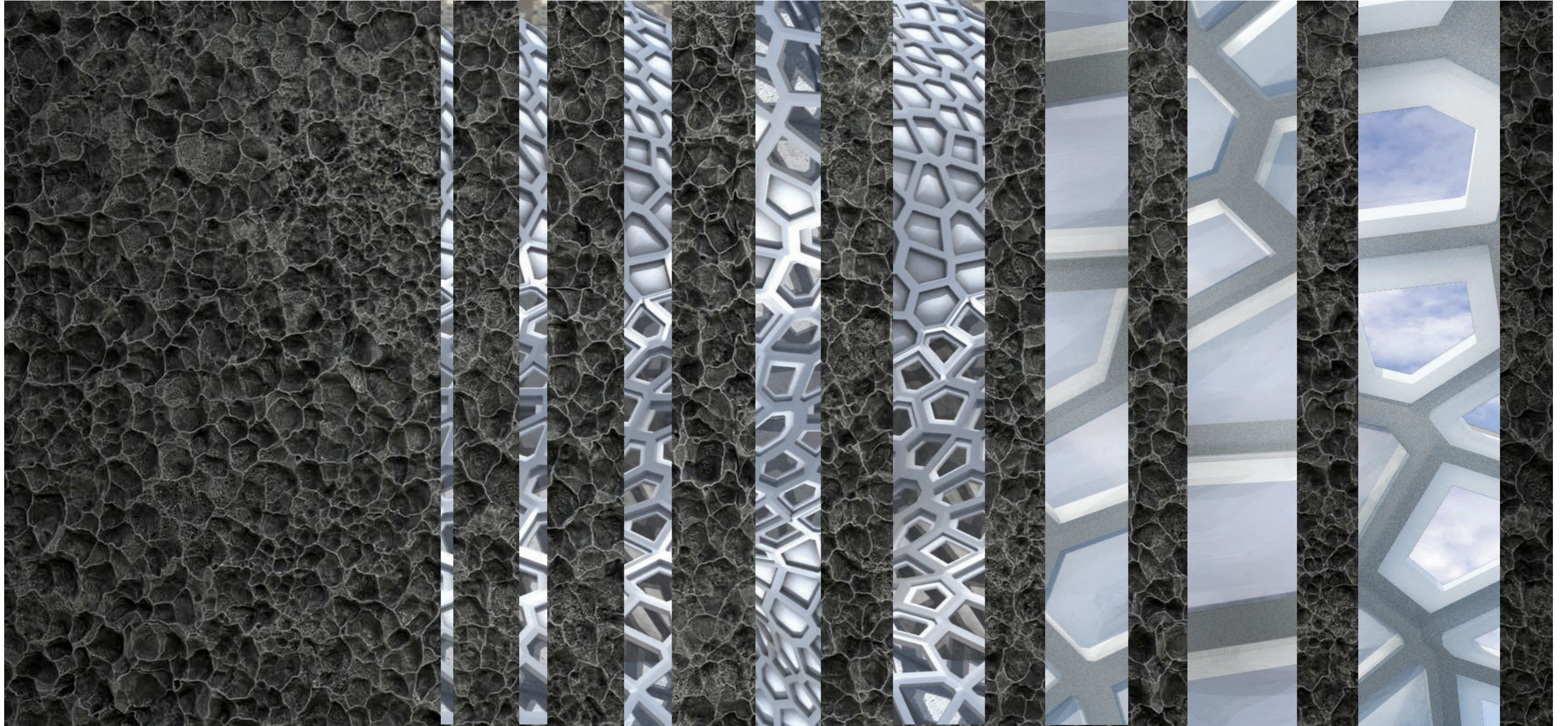
10-5-AL BAHR TOWERS BY AEDAS

The current renaissance of the mashrabiya culminates in a large-scale responsive screen system in Abu Dhabi with the Al Bahr Towers by Aedas. The solar-responsive dynamic screen decreases the towers' solar gain. According to Aedas, the lightly tinted glass reduces the incoming daylight at all times and not only for temperature-critical situations. The system even includes about 7,000 umbrella-like modules per tower driven by photovoltaic panels.

With the development from ancient to modern mashrabiya, the role of the screen has changed from a layer to protect against outside views to an element that attracts the outside viewer. The oriental

façade design, with its sophisticated play of light and shadow, spatial depth, and fine details, presents a clear statement for rooting the building in local history rather than using exchangeable glass façades. Moreover, modern sensor and data technology promise to keep mashrabiya relevant well into the future, opening a fascinating way of dynamically controlling each shadow pixel to obtain the optimum shading and atmosphere.





11- DESIGN PROJECT

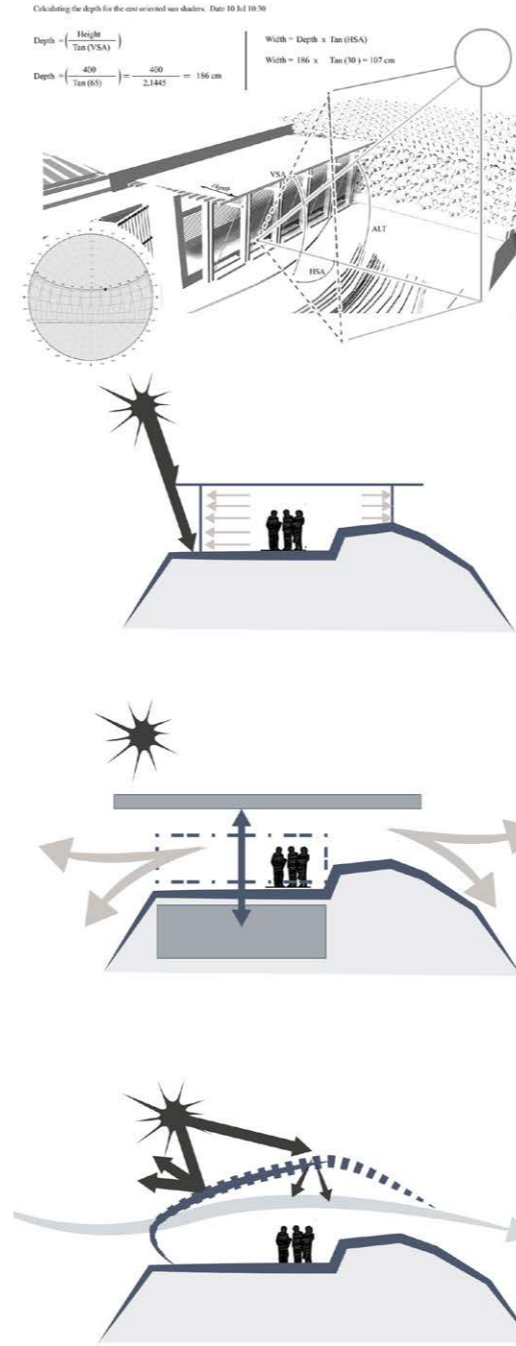
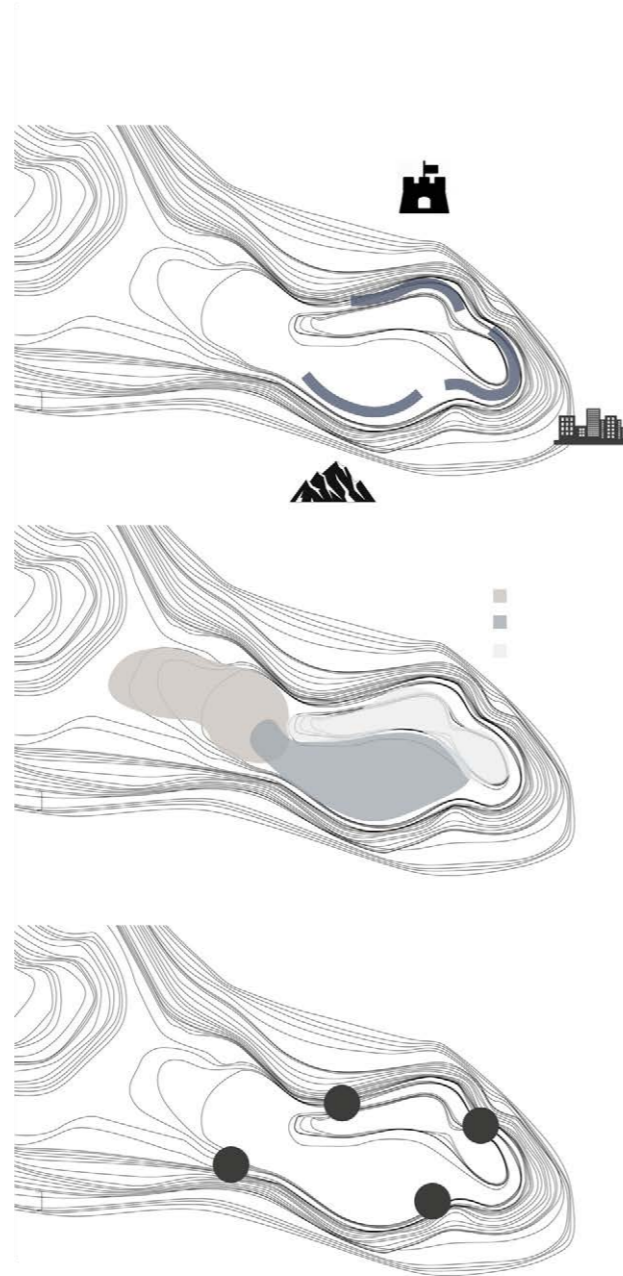
11-1- PROJECT SITE ANALYSIS

The site is located 100 meters above sea level. near the tower of silence visitors used to enjoy the view of Aden and the ancient “Aden Tanks” from above, the site has a unique characteristics, and it needs a design that improve them by enhancing the value of the landscape and the view.

the site has three main views first one is the northern view, which overlooks the city, the second is the eastern view which overlooks the series of Shamsan Mountain and the western view overlooking Aden’s historic tanks.

The site is semi-flat. as the surface level is between one meter and two meters. in the diagram shows the three zones with three potential different functions that people can use in a this small area.

The points in the last diagram show possible places that can be used to have solid blocking elements.



11-2- DESIGN CONCEPT

In the first stages of the design, I started to draft the museum at the top of the site area with a normal Mashrabiya system through using calculations related to the sun path in the city.

The positive part is that it was easy to deal with the sunray as well as creating spaces using basic materials and techniques. The negative part is that the site has unique views which will be blocked by the previous designs. At the same time the plateau is used by the people as an open scenery area.

As a result, I decided to first retain the plateau and enhance it, then divide the building into two parts , one is the roof which will be the main shading system, and the other will be underground (the museum).

A conclusion to the previous analysis is that the upper part (the roof) should be a new landmark that attracts people and can be seen from the city.

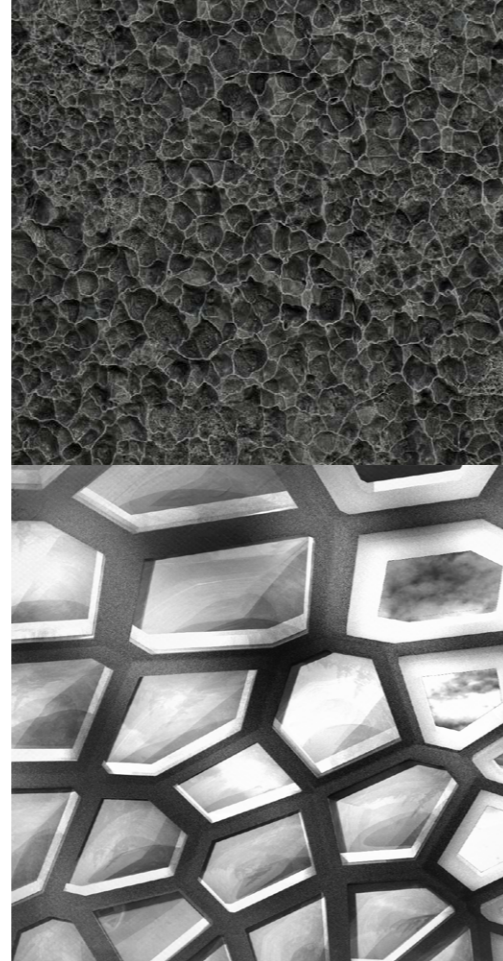
11-3- THE ROOF DESIGN

With the development of shading systems, the role of these new systems has changed not only from a layer to protect against the sun rays also it become an element that attracts the outside viewer.

In this case, the roof is designed in a parametric way that resembles the lava stones which can be found in some parts of the volcanic mountains. The roof has almost five hundred fifty units that react to the sun path. The material used in these units and the way they act is inspired by the Barda which is a rudimentary shading system that is still used until now.

The solar-responsive dynamic shading roof will decrease the solar gain, the lightly tinted structure reduces the incoming daylight at all times and not only for temperature-critical situations.

To design the mechanism of these units, there are two possible alternatives. The first one is a mechanical method where each unit has a rubber in the middle tensed the fabric towards the center, connected by rubbers to the edges of the unit shapes, these rubbers will pull that opening of the fabric when the sun is not in a perpendicular position or thirty degrees less or more. This calculation that decides which unit is open and which one is closed can be known by Grasshopper by linking the sun path and the program will calculate the output data.

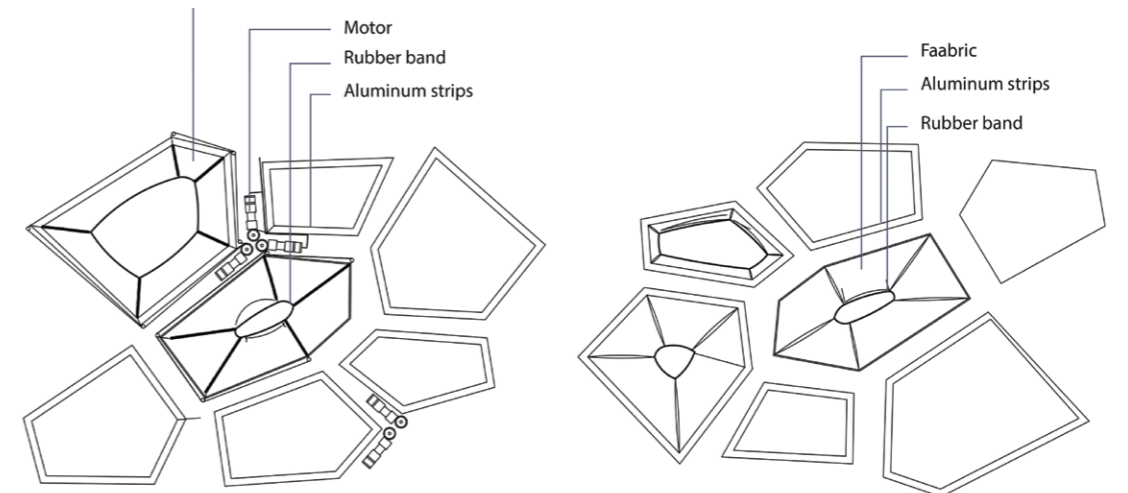


So, the machine knows exactly when and where the units are open and closed.

The other method is that by using a fabric that tenses to the edges of the unit and in the middle a rubber band will be naturally responsible for the size of the opening for each unit. The rubber has its unique characteristics unlike other elements. It expands when it gets colder and shrinks when heated.

When the sun heats the rubber band, it will shrink, making the fabric tense towards the center of the unit. When the sun is not reaching the rubber band, it will become colder and will expand, letting the fabric relax and making the opening wider.

This method needs research to know how long the rubber extends in different temperatures.

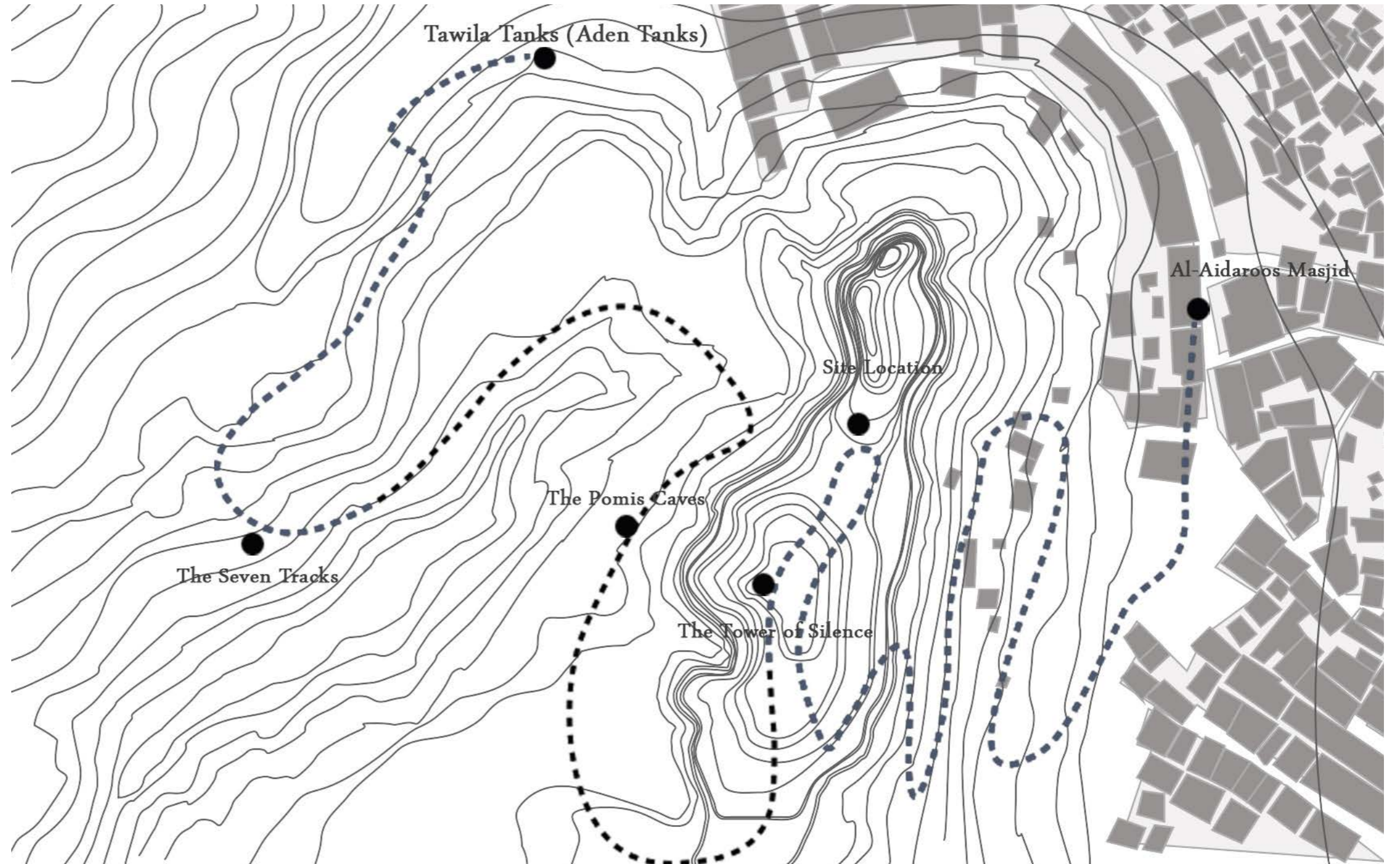


11-4- CREATING NEW TRACK

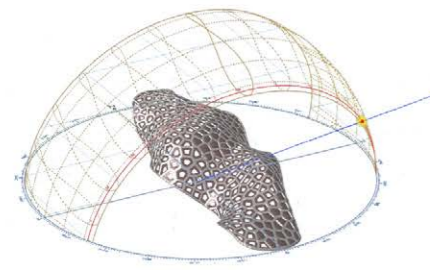
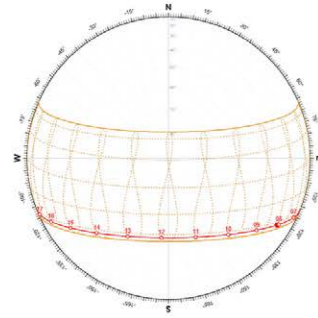
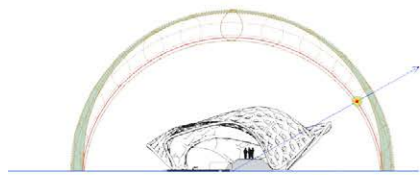
Tourists used to visit the so-called Seven Tracks which are located on the flat part of Shmsan mountain. The Seven Tracks are a water paths that lead to the seven dams used by the ancients to conserve water for reuse., the project will locate near the tower of silence one of design visions is to link that ancient place to the tracks and make the place more accessible and lead the tourists through one journey in the history of Aden.

besides linking the three historical sites, it offers a place that serves as a gallery/seasonal museum which the city lacks.

Unlike the seven tracks, the new designed one will be for humans. There is already an old track in a poor condition, unlinked, and needs to be improved. The track will start from Al-Aidaros mosque and will continue towards the tower of silence which is near the site. After visiting the site, the visitor will continue towards the Pomis caves, then will continue downwards to one of the seven tracks and will end up in Al-Tawila tanks.



11-5- SOLAR-RESPONSIVE DYNAMIC SHADING SYSTEM



GEOGRAPHIC LOCATION

Latitude: 12.861884894°
 Longitude: 45.007803181°
 Timezone: GMT+03:00

DATE AND TIME

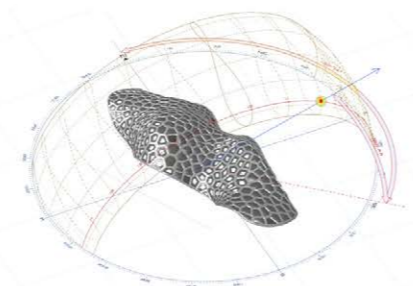
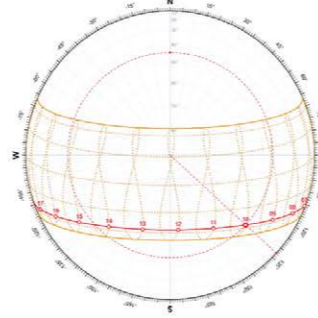
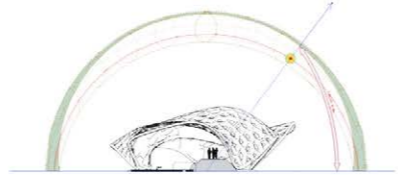
Date: 03 Dec 2018
 Time: 07:58

SOLAR INFORMATION

Azi / Alt: 121.32° / 23.43°
 Rise / Set: 06:07 / 17:32
 Daylight: 11:25 Hrs

TWILIGHT TIMES

Civil: 05:44 / 17:55
 Nautical: 05:18 / 18:21
 Astronom.: 04:52 / 18:47



GEOGRAPHIC LOCATION

Latitude: 12.809327245°
 Longitude: 44.957668457°
 Timezone: GMT+03:00

DATE AND TIME

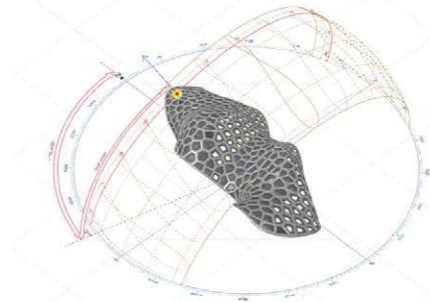
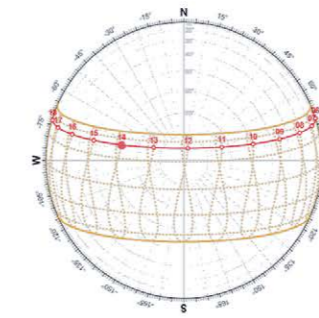
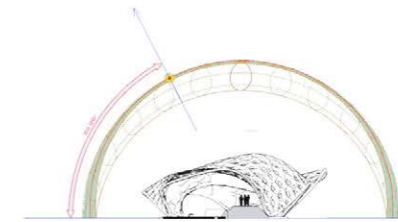
Date: 27 Jan 2018
 Time: 10:00

SOLAR INFORMATION

Azi / Alt: 132.74° / 44.88°
 Rise / Set: 06:27 / 18:00
 Daylight: 11:33 Hrs

TWILIGHT TIMES

Civil: 06:05 / 18:22
 Nautical: 05:39 / 18:48
 Astronom.: 05:14 / 19:13



GEOGRAPHIC LOCATION

Latitude: 12.809327245°
 Longitude: 44.957668457°
 Timezone: GMT+03:00

DATE AND TIME

Date: 25 Aug 2018
 Time: 14:00

SOLAR INFORMATION

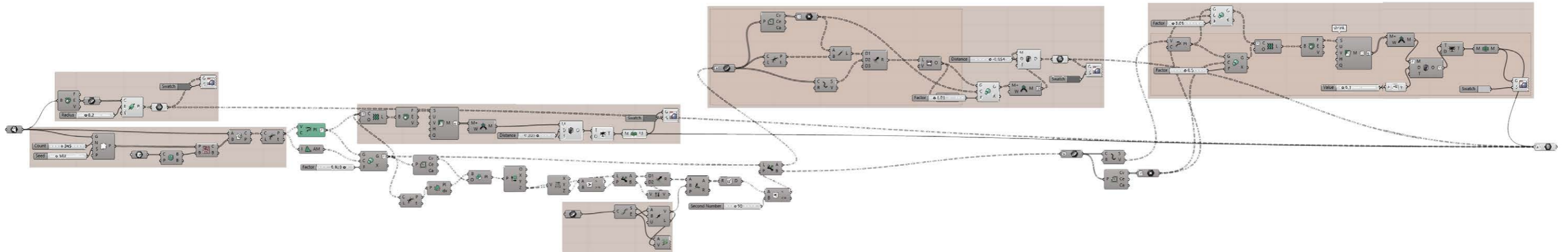
Azi / Alt: -91.32° / 61.12°
 Rise / Set: 05:49 / 18:16
 Daylight: 12:26 Hrs

TWILIGHT TIMES

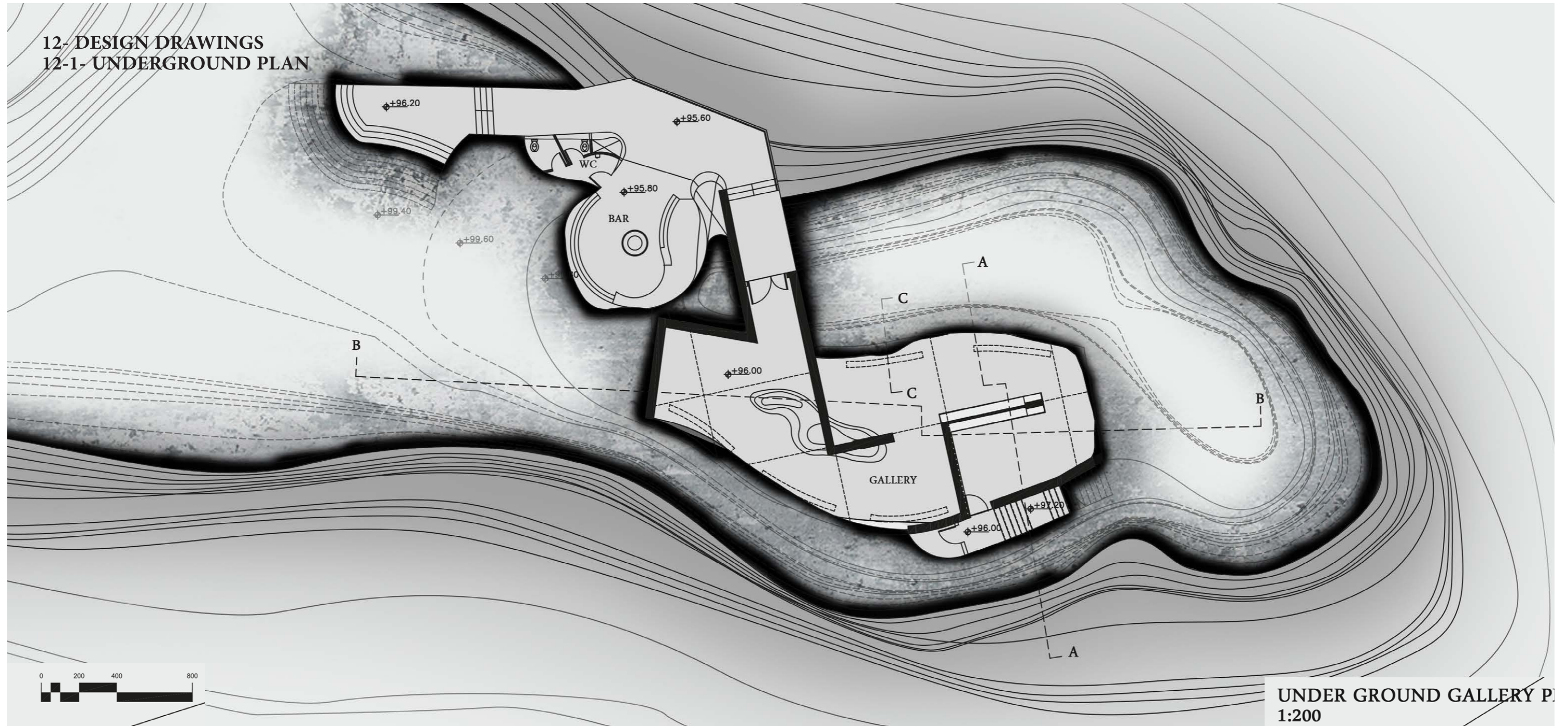
Civil: 05:27 / 18:37
 Nautical: 05:02 / 19:02
 Astronom.: 04:37 / 19:28

11-6- GRASSHOPPER CODE

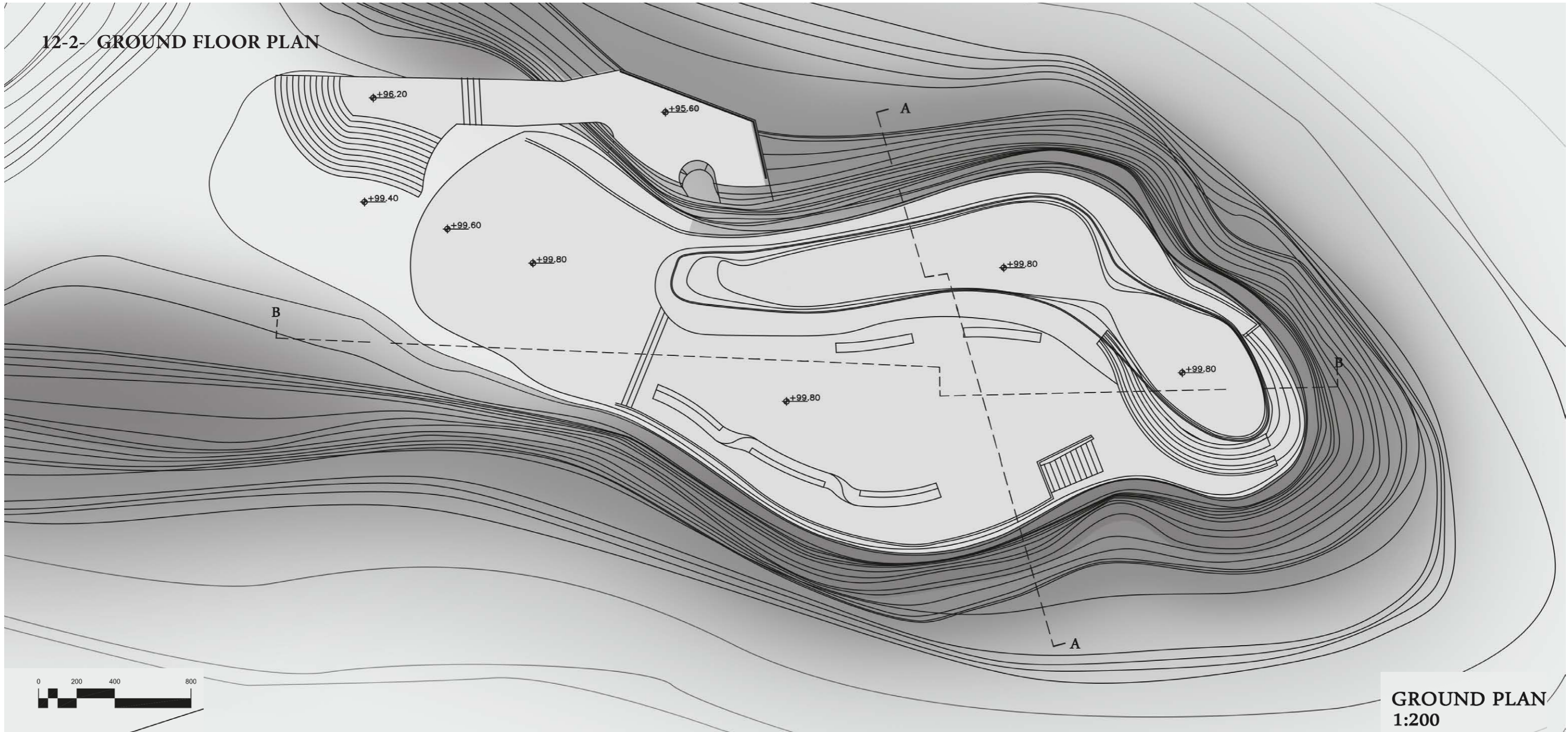
Grasshopper code
Changing the shading system pattern in relation to the sun path



12- DESIGN DRAWINGS
12-1- UNDERGROUND PLAN



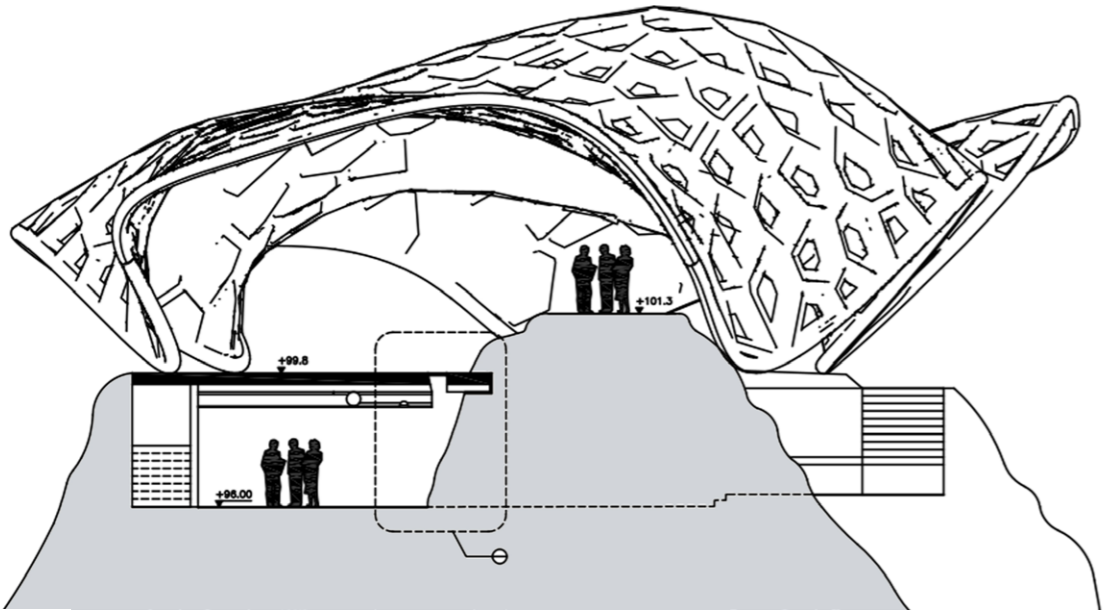
12-2- GROUND FLOOR PLAN



GROUND PLAN
1:200

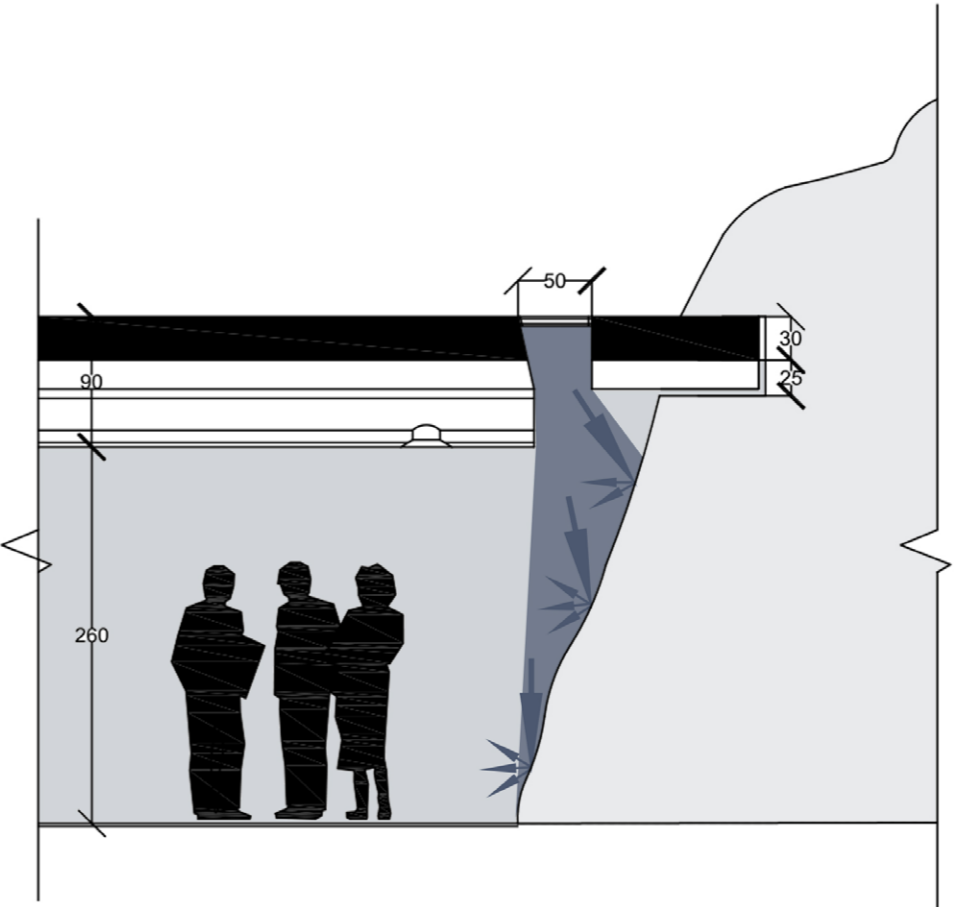
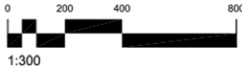
12-3- SECTIONS

This section shows how the gallery underground will illuminate with indirect sunlight coming from the top. The wall will cover by the Pomis material which will easily spread the light in the room.

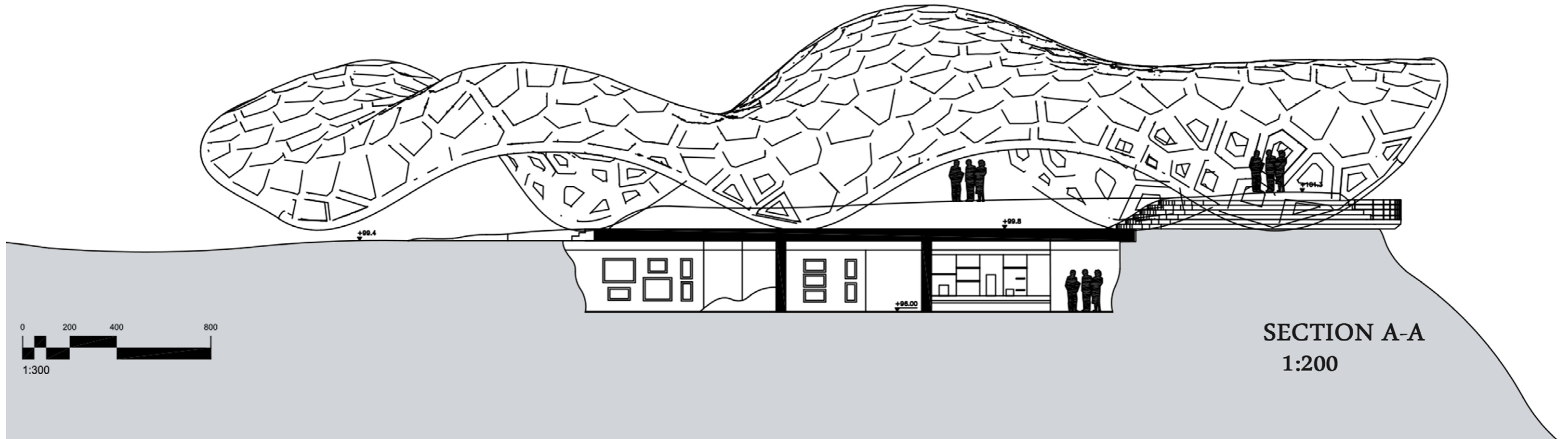


S

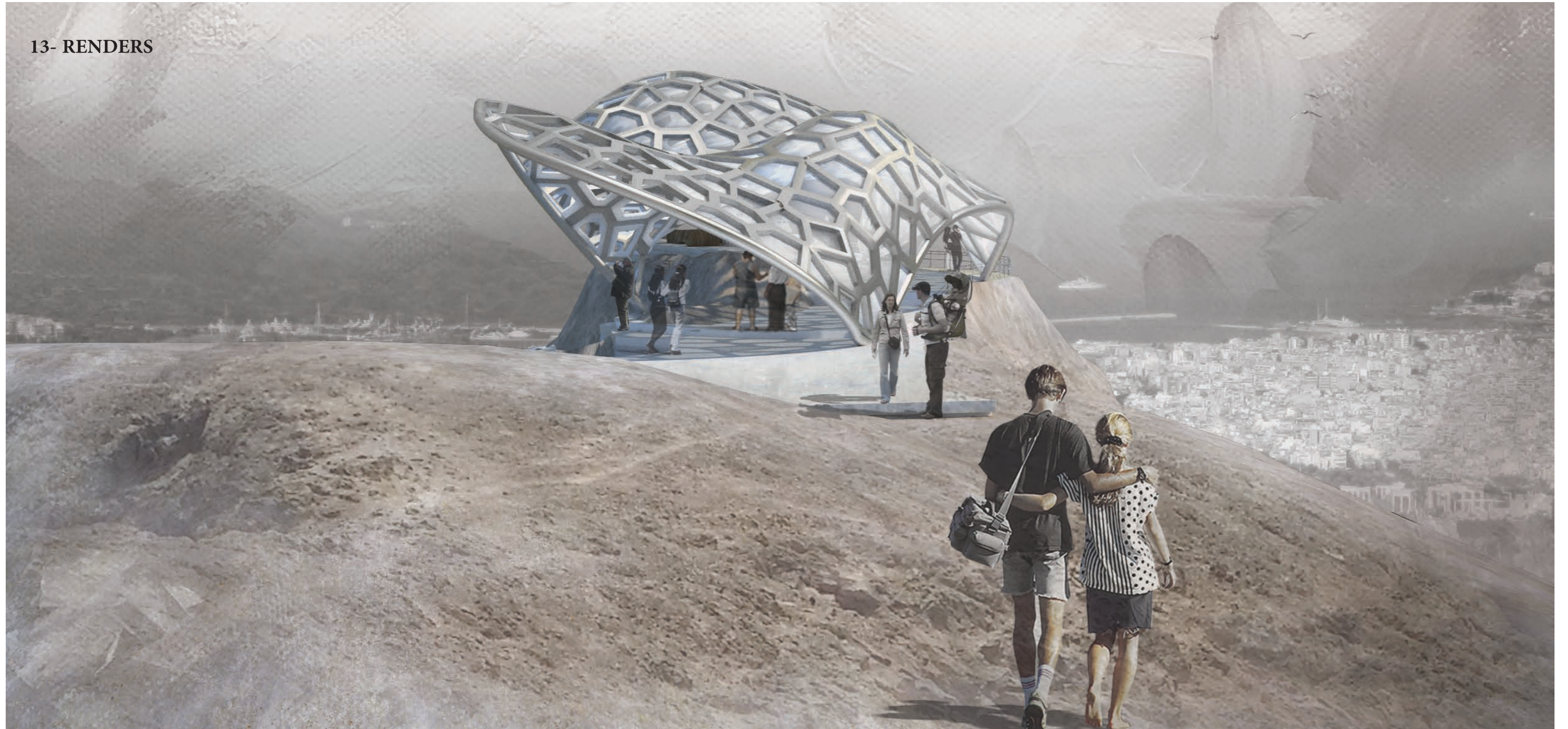
SECTION B-B
1:200

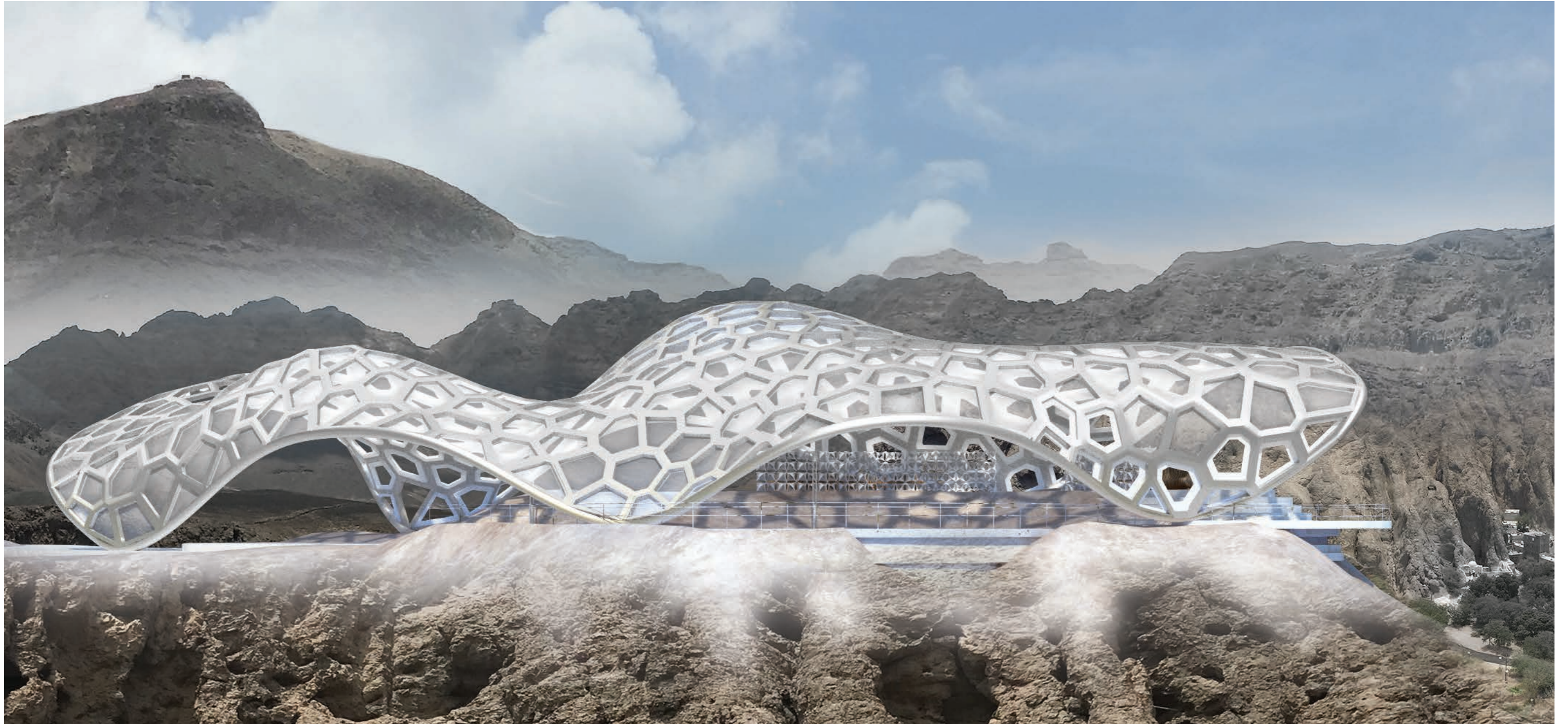


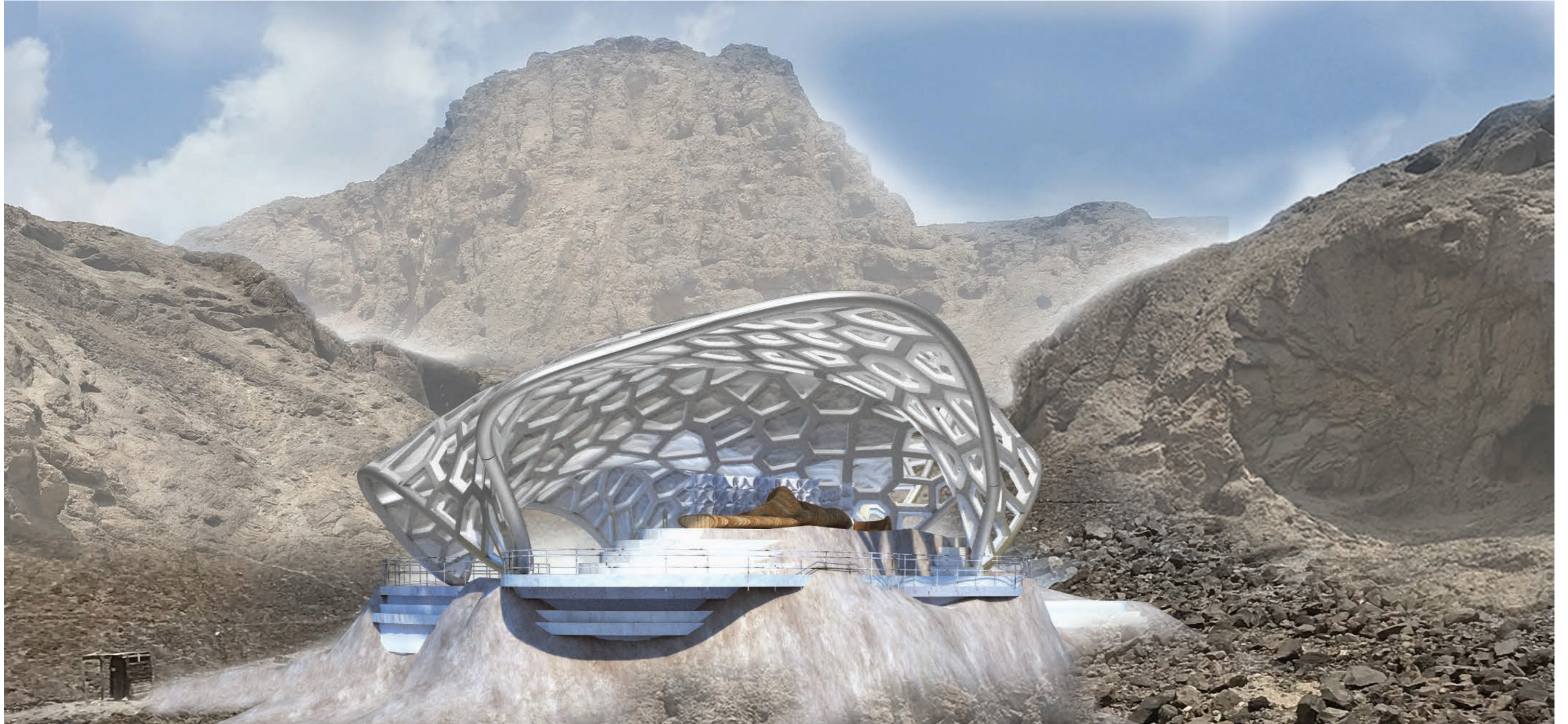
12-4- SECTIONS

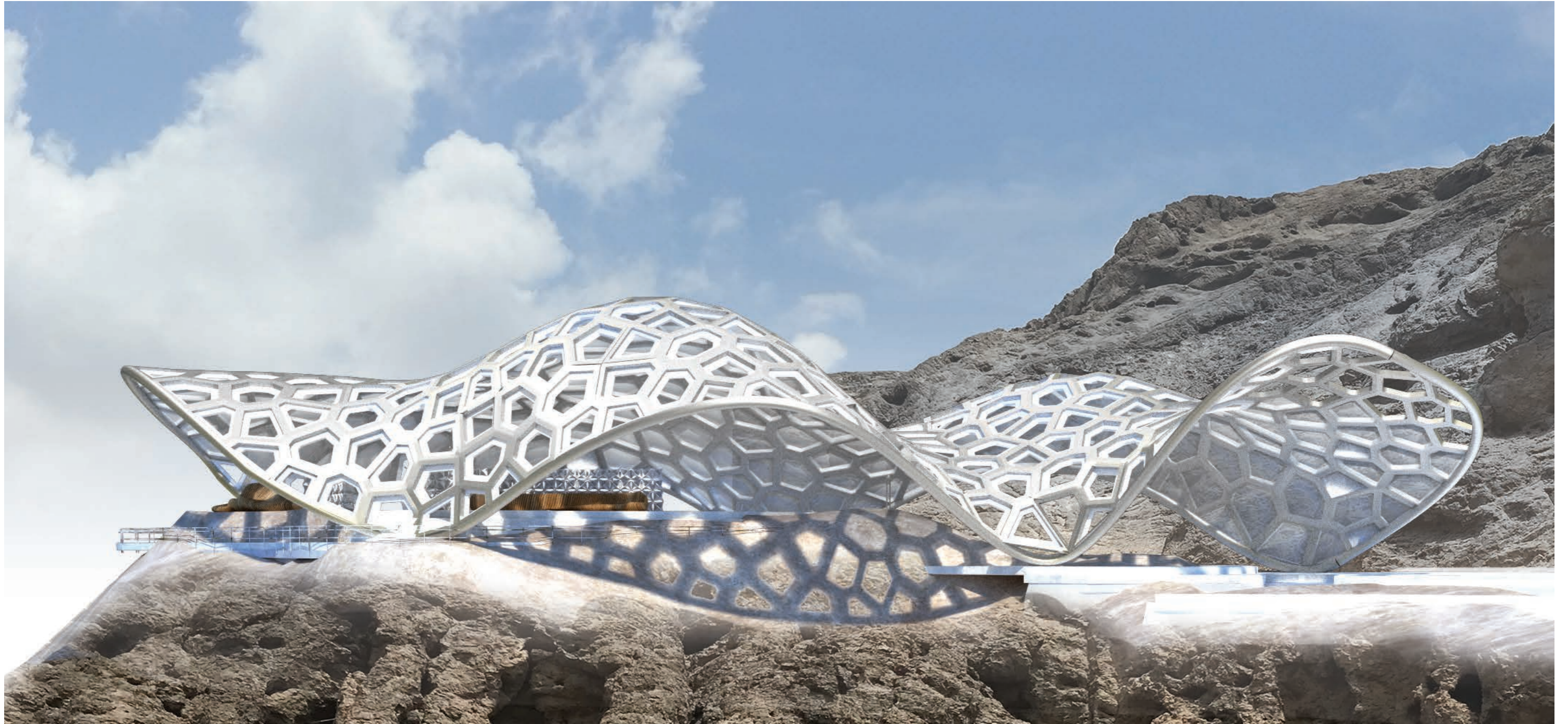


13- RENDERS















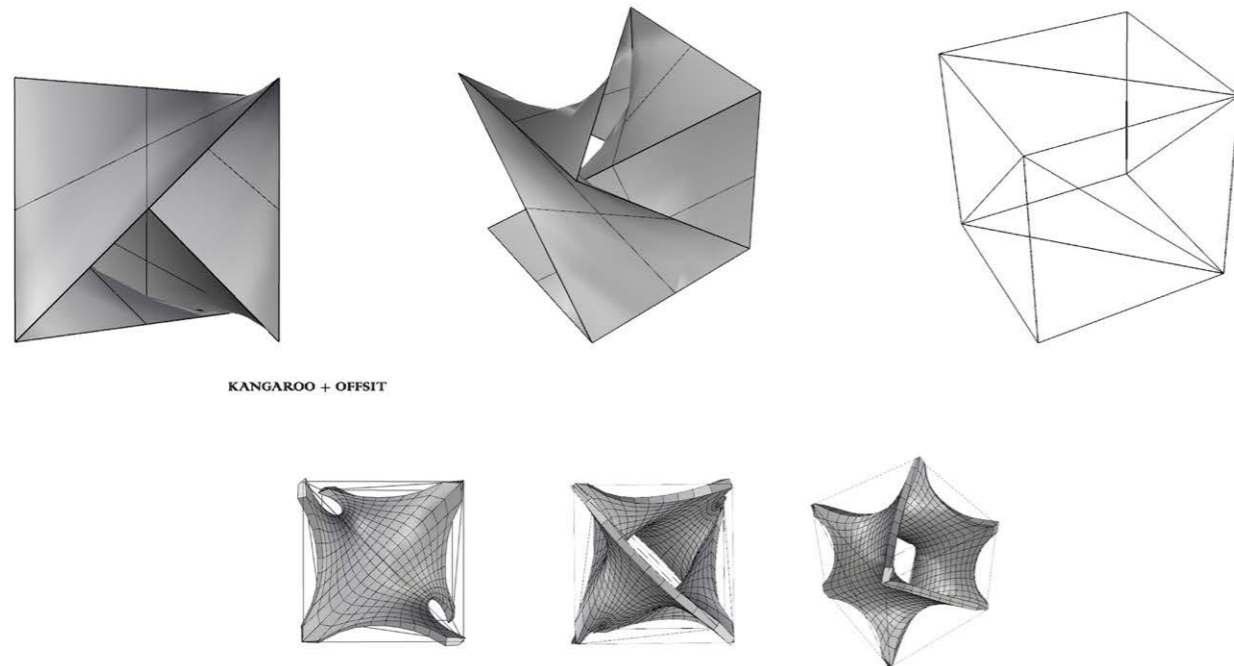
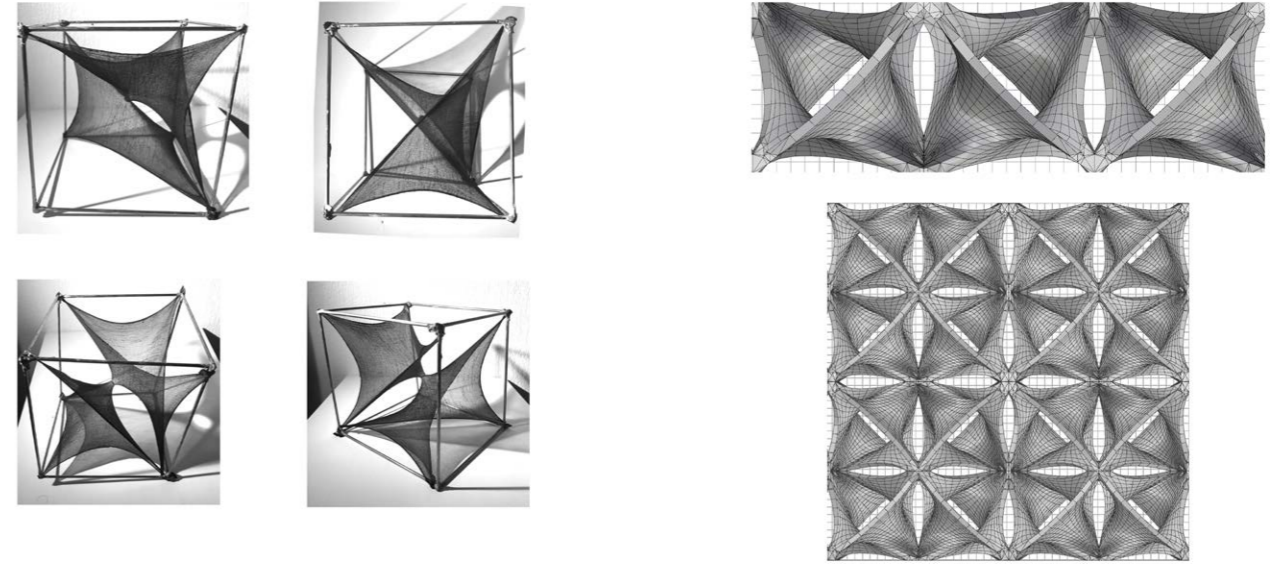




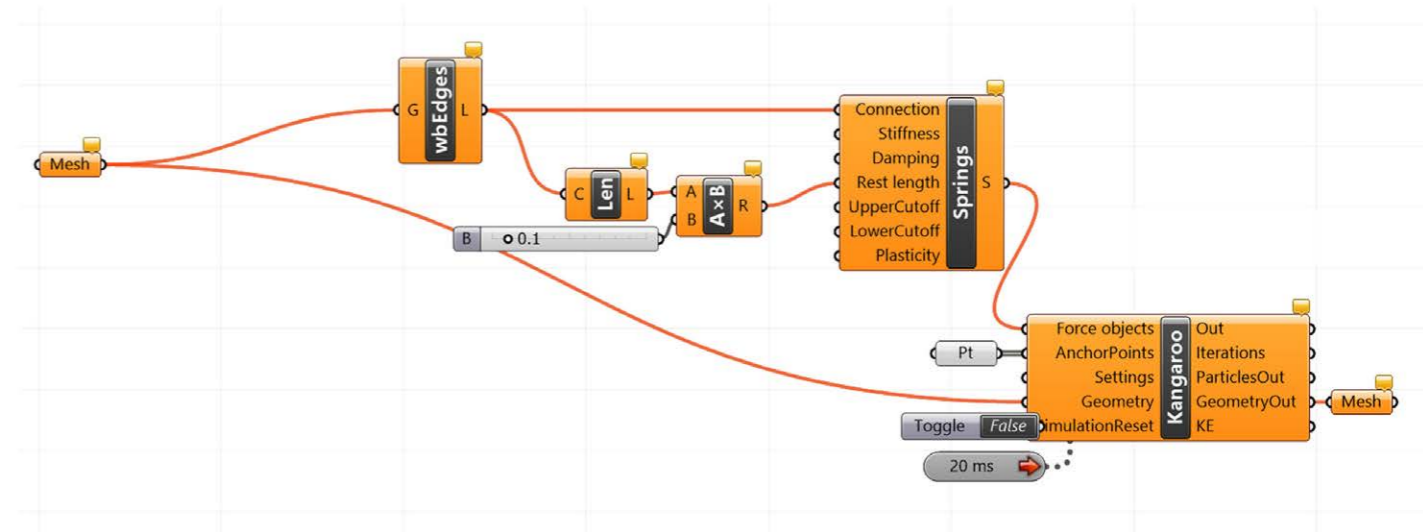
14- SITE FURNITURE

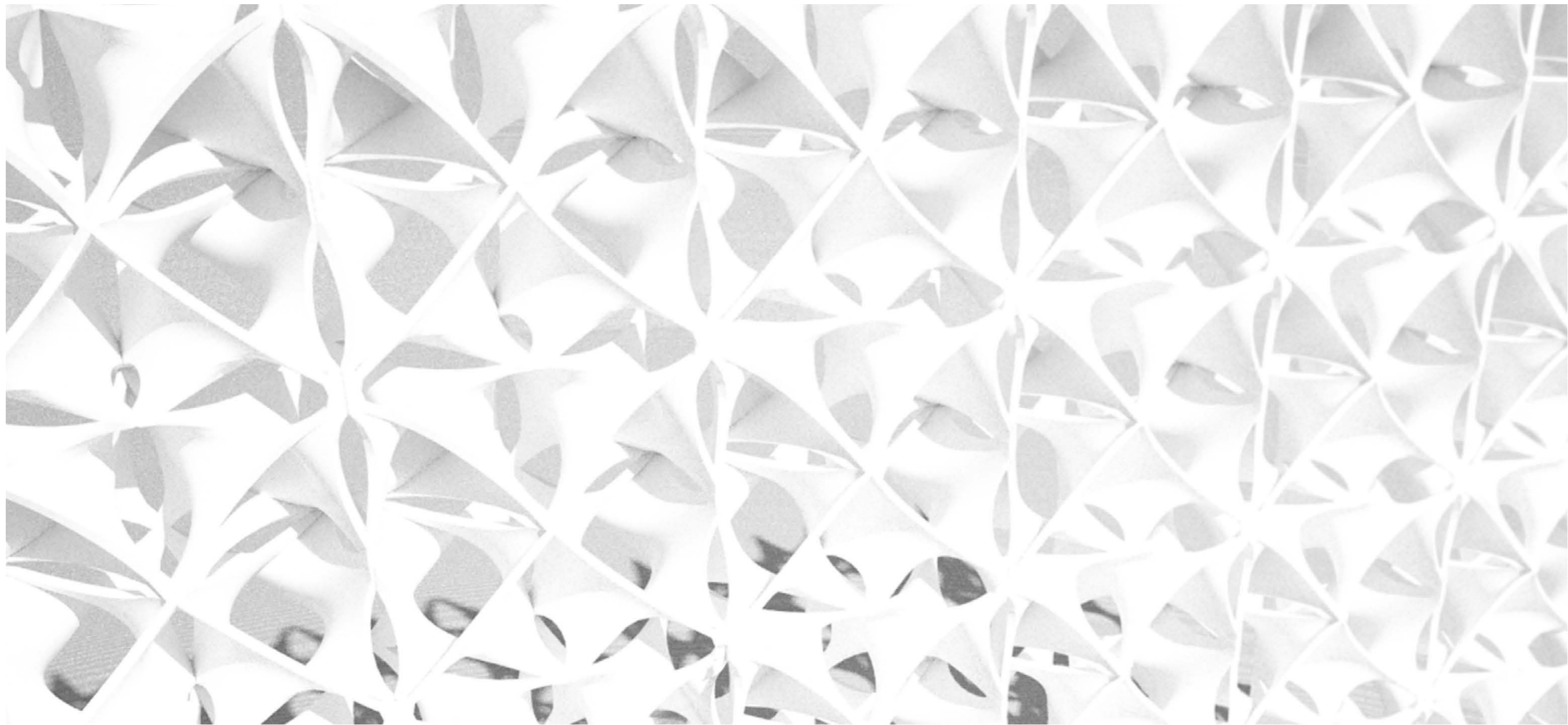
14-1- MASHRABIA WALL

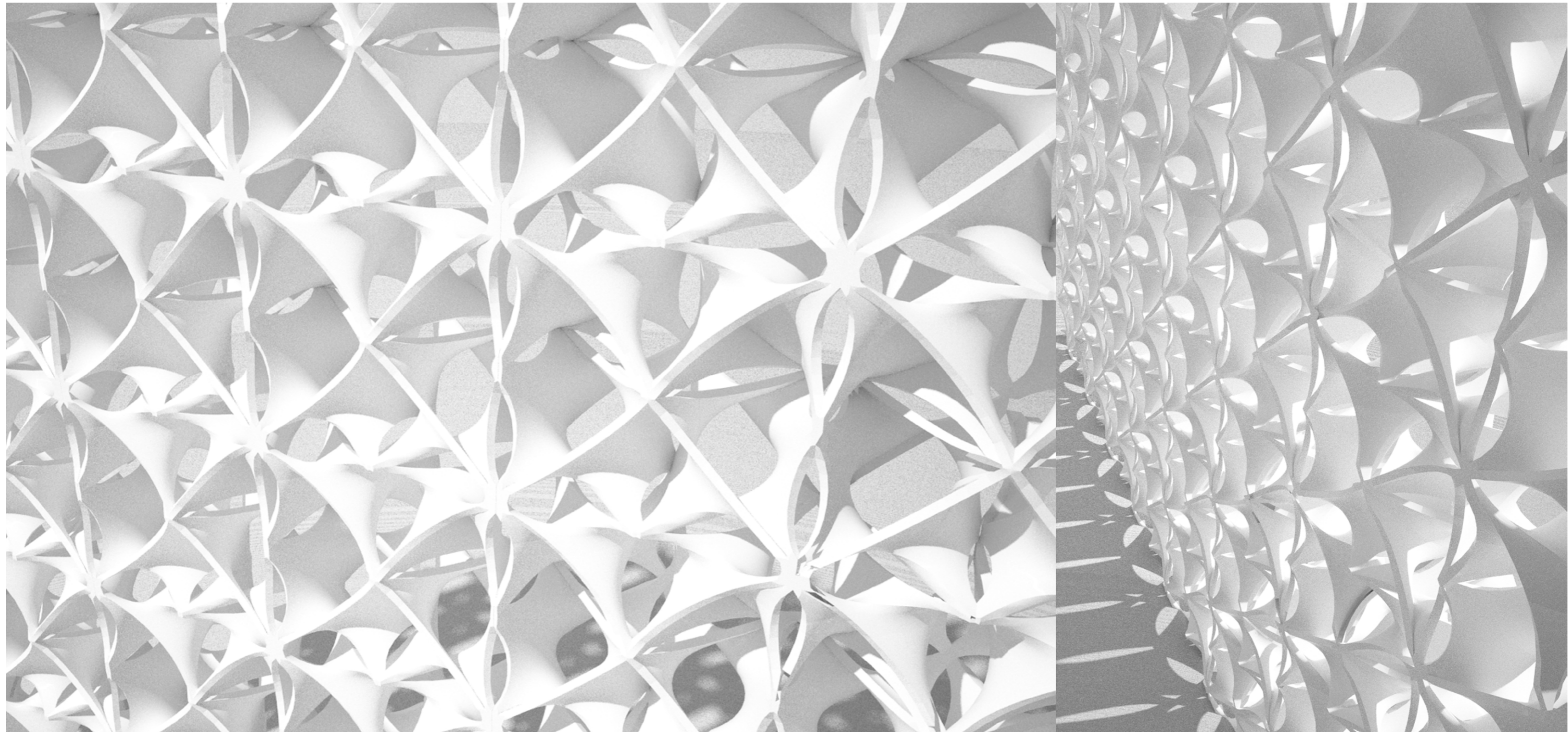
To create a comfortable area for people, new site furniture was designed to make the place better. The first one is the Mashrabia walls. By creating a new Mashrabia system, the sun light as well as the wind flow will be reduced which is important in a project with a high altitude. This element will locate next to the sitting benches to block the wind for the people who are using these benches.



KANGAROO + OFFSIT



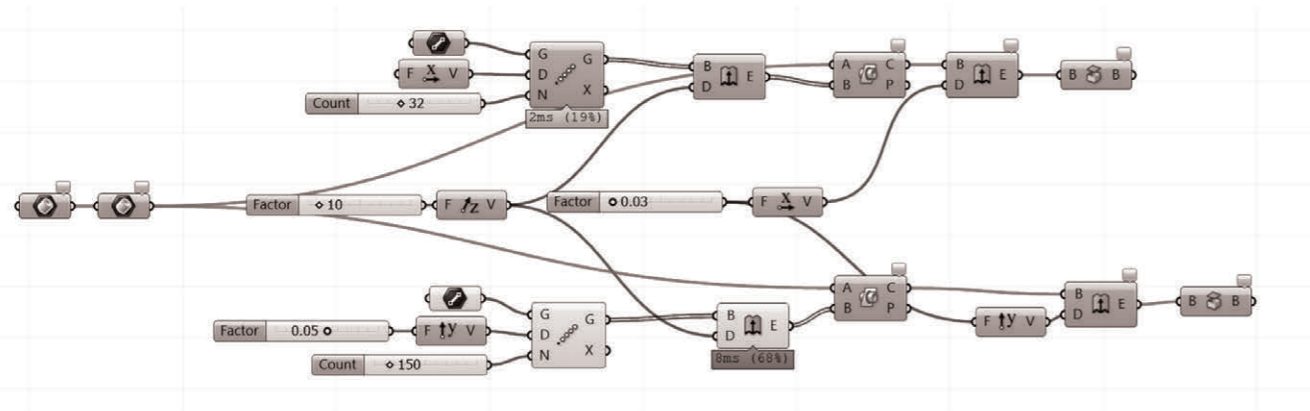
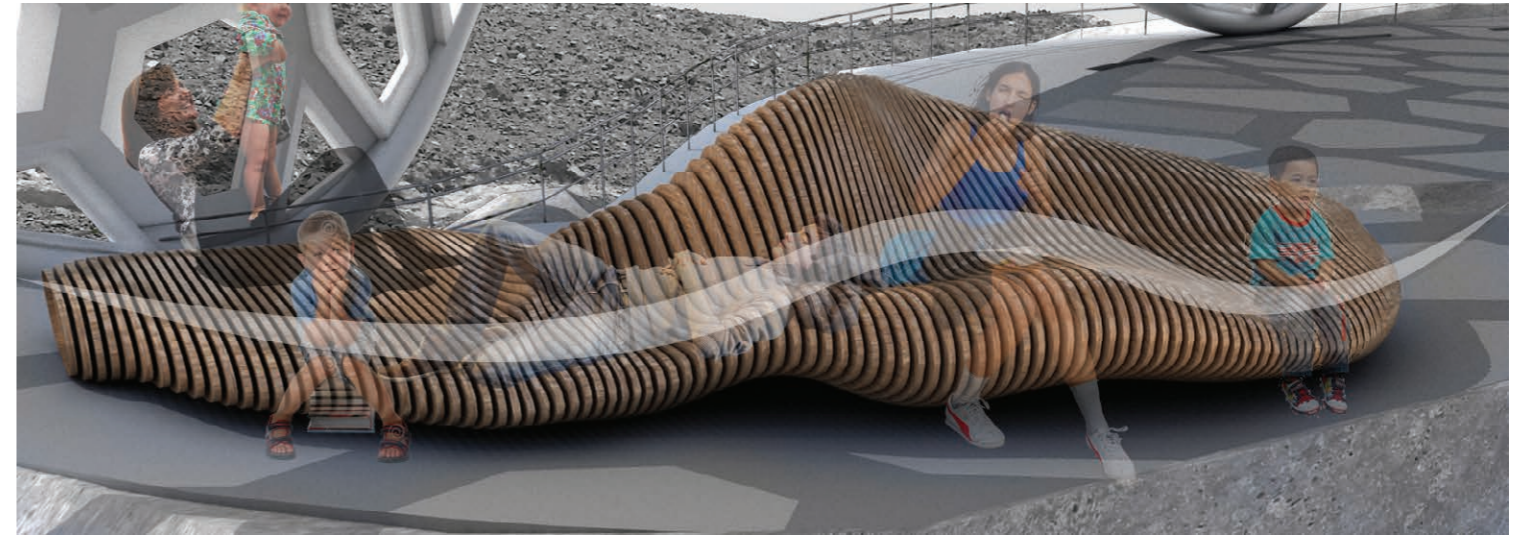




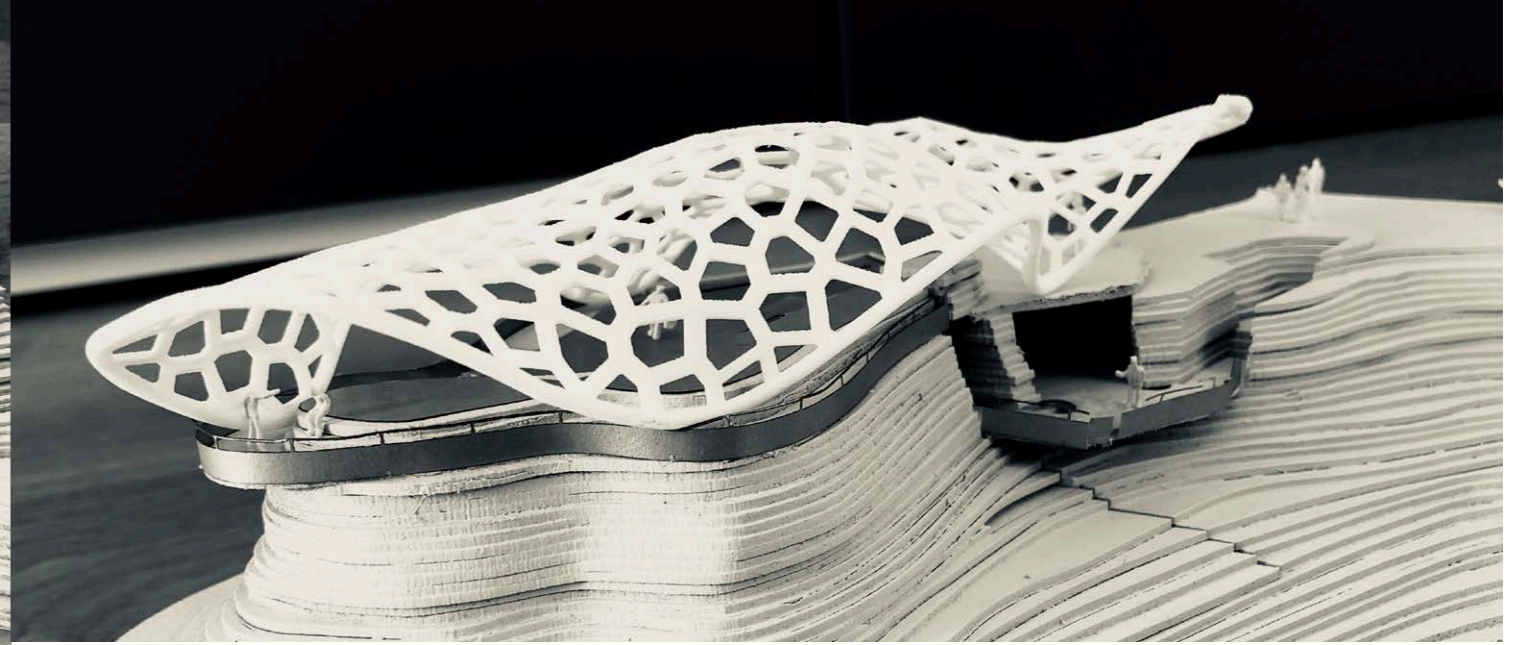
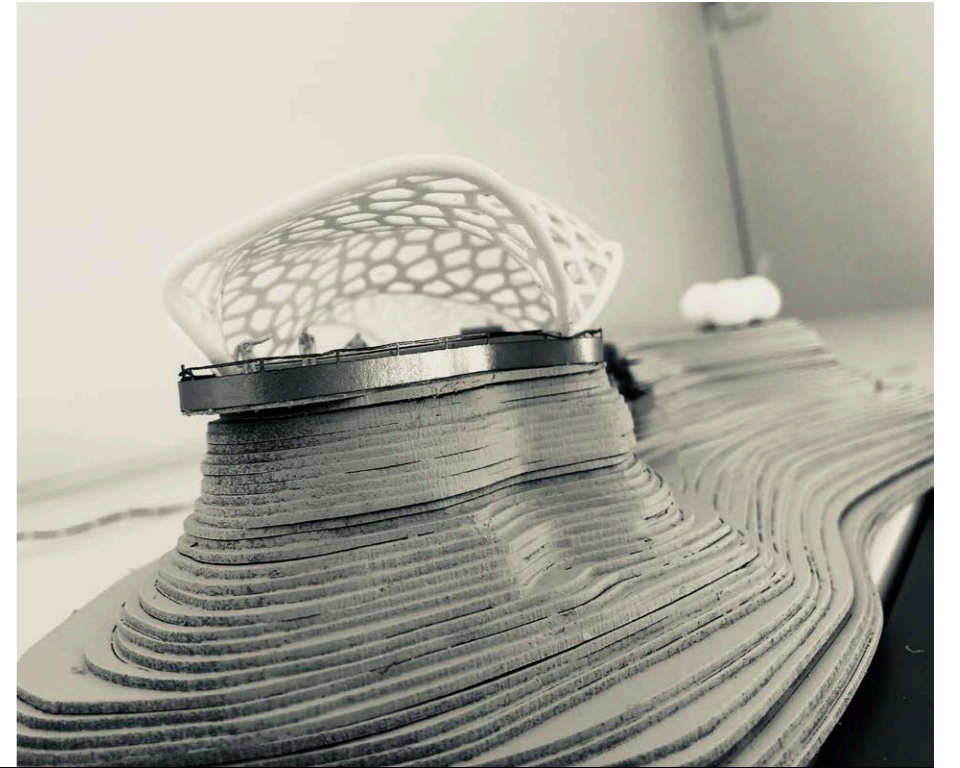
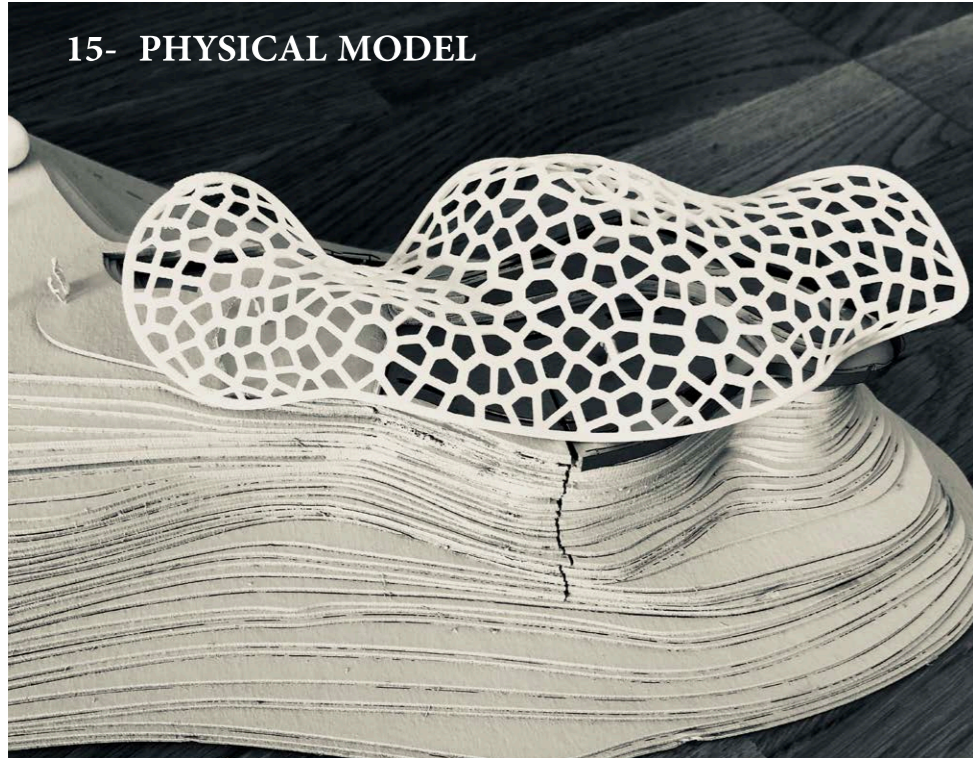
14-2- PARAMETRIC BENCHES

New parametric benches were applied

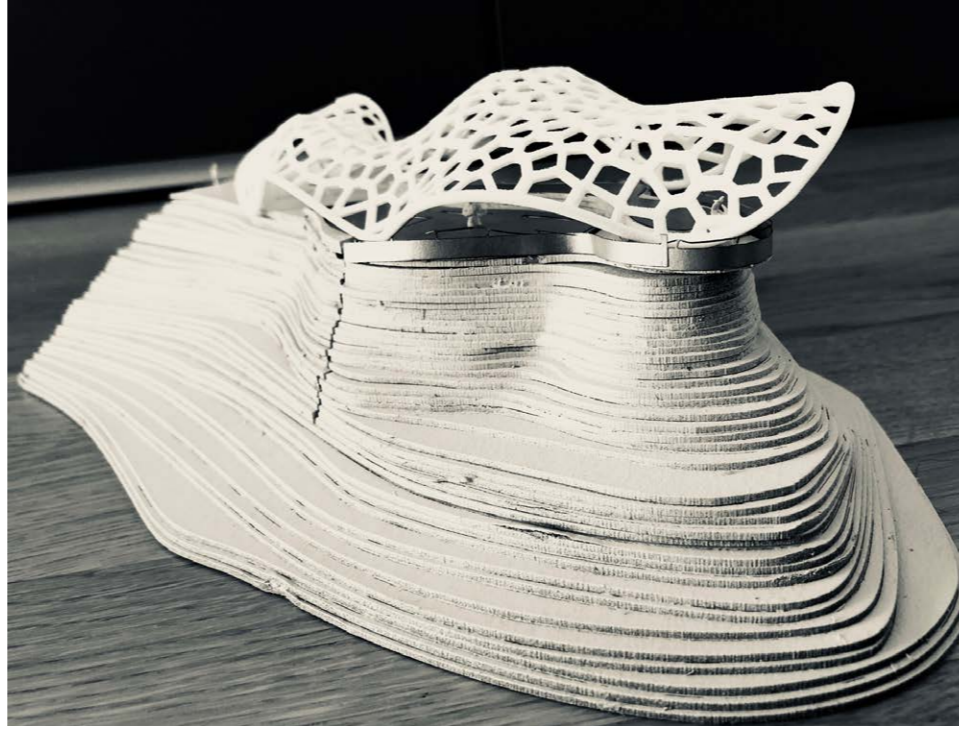
These benches design goes with the idea of the topography of the mountain shaping different ways of sitting and uses.



15- PHYSICAL MODEL



15- PHYSICAL MODEL



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- Stretchy Science: A Rubber Band Heat Engine - By Education.com, Mack Levine on August 15, 2013
- Light Matters: Mashrabiya - Translating Tradition into Dynamic Facades, by Thomas Schielke
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- IaaC Students Develop Material System with Responsive Structural Joints, by Evan Rawn.
- Pomies caves in Smsan Mountain , by Ziad Ahmed
- Butterfly pavilion by German studio 3deluxe clad with 4,000 golden aluminium flowers, by Kim Megson

-Dynamic window daylighting systems: electropolymeric technology for solar responsive building envelopes, Elizabeth A. Krietemeyer; Shane I. Smith; Anna H. Dyson;

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- <https://www.archdaily.com/883157/louvre-abu-dhabi-atelier-jean-nouvel/5a01c327b22e38b1dc0004fb-louvre-abu-dhabi-atelier-jean-nouvel-c-ateliers-jean-nouvel-dome>.
- <https://earthobservatory.nasa.gov/IOTD/view.php?id=88574>.
- http://alamree.net/aden_p3/h7/aden_1006.jpg

PHOTOS BY

- Rami Ahmed Alwan (my brother)
- Aymen
- Mazen Alsharif.
- Abdulghafor Mohammed

Programs used

- AutoCAD Architecture 2016
- Rhino 6.
- Grasshopper.
- Photoshop cc 2017
- 3D Studio Mxx 2018-Vray2018
- Adobe Illustrator CC 2017
- Indesign cc.

