

# ALEXANDRIA UNDERWATER MUSEUM FOR SUNKEN MONUMENTS

(A Journey to the Sunken City)

Master of Architecture in Architecture



**ALEXANDRIA UNDERWATER MUSEUM FOR SUNKEN  
MONUMENTS ((A Journey to the Sunken City)**

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Thesis submitted to the faculty of Virginia  
Polytechnic Institute and State University in  
partial fulfillment of the requirements for the  
degree of Master of Architecture in Architecture

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## ALEXANDRIA UNDERWATER MUSEUM FOR SUNKEN MONUMENTS

(A Journey to the Sunken City)

Dalia Hafiz

This thesis is a study of a journey in the deep mystery of the eastern harbor on the Mediterranean sea in the city of Alexandria. For Herodotus, the four major elements for civilization's development overtime are water, air, land, and fire. In this project, the effort is made to connect three of the four elements within an architectural context: "Underwater museum".

The building orientation, shape and location allow a discovery of the building elements and shape consequently while participating in the building visit. From street level, the building can be seen as a simple curved wall on the harbor facing the sea. While pursuing the passage in the journey, the building shape and components start to build the experience. Different lighting conditions, vertical and horizontal circulation methods, building form and structure are used to direct the journey starting from sky and land, through water, to underwater, then finally discovering the ruins at the seabed.



# ACKNOWLEDGMENT

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First, I would like to extend my deepest thanks and gratitude to my committee members: Hans, Jim, Bill and Steve for their academic guidance and professional advices.

Special thanks go to my husband, Ismail for his understanding, his encouragement and his support all the time during my studies at Virginia Tech. He is always surrounding me with love and kindness. I would like also to thank my mother and father for making me believe in myself and encourage me to pursue my Master's degree. Their blessings, guidance and love have brought me a long way in my life.

I would like to share my deep feeling of love and happiness with my expected baby girl soon, and waiting for the day when she reads this thesis.

Last, but not the least, I would like to express my heartfelt gratitude to all my friends at Virginia Tech. Throughout my life as a graduate student, their regular support, advice and friendship has been a very vital factor in seeing this day.

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# **ALEXANDRIA HISTORICAL BACKGROUND**

# ALEXANDRIA HISTORICAL BACKGROUND

الإسكندرية Alexandria, is the second-largest city in Egypt, extends about 32 km (20 mi) along the coast of the Mediterranean Sea. Alexandria is one of the most famous cities in the world. It was founded around a small pharaonic town in 331 BC by Alexander the Great. It remained Egypt's capital for nearly a thousand years. The city was known because of its Lighthouse of Alexandria (Pharos), one of the Seven Wonders of the Ancient World; its library (the largest library in the ancient world); and the Catacombs of Kom el Shoqafa, one of the Seven Wonders of the Middle Ages.

The city was formally under Roman jurisdiction before falling to the Sassanid Persians and then the Byzantine Emperor Heraclius. Napoleon's French troops stormed the city in 1798, and it remained in their hands until the arrival of a British expedition in 1801. Mohammed Ali, the Ottoman Governor of Egypt rebuilt it around 1810. All those influences created a city with a unique city character *Ref [1]*.



# ALEXANDRIA HISTORICAL BACKGROUND

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Alexandria, known as "The Pearl of the Mediterranean", has an atmosphere that is more Mediterranean than Middle Eastern; its ambience and cultural heritage distance it from the rest of the country although it is actually only 225 km from Cairo the capital.

The central district of Alexandria is known more from books than from what we may actually see in the area. The site where the Pharos Lighthouse once stood is now occupied by the Fort of Quit Bay out on the area that circles around the top of Eastern Harbor forming the eastern section of the top of the T. Heading south from the Fort of Quit Bay, we come to the stunning Abu El-Abbas Mosque. West of this is the Anfushi Tombs; some of the oldest in Alexandria *Ref [2]*.





# ALEXANDRIA HISTORICAL BACKGROUND

In addition to the places previously listed on Alexandria's coast, there are other historical places in the rescue list of the UNESCO. These include Pharos Island, taken in consideration with the Eastern Harbor area, old Alexandria, and Western and Northern Harbors.

Researchers describe the destruction of the Harbors as probably caused by an earthquake, indicated by the position of collapsed columns and walls. They all fell systematically in one direction.

The sea encroached on the land following the quake, and ruins are now a couple of miles from land in the Bay.

The destruction most likely happened in the 7th or 8th centuries. Divers found Islamic and Byzantine coins and jewelry from that period, but none more recent *Ref [3]*.





# PROJECT LOCATION

# PROJECT LOCATION

The proposed project will be the first underwater museum. It will be located off the coast of Alexandria by the eastern coast, near the new Library of Alexandria.

The ruins were discovered years ago, but they remained in the seabed because of the absence of knowledge and technology to remove them. For the last two years a team has been working to map the site of Egypt's eastern coast in waters 20 to 30 feet deep, using modern technology including the use of magnetic waves.

The discoverers were amazed with what they found: Greek, Roman and Byzantine monuments as well as many old Pharaonic sphinxes, statues, columns and even missing pieces from Upper Egypt temples. The discoverers did not figure out how the missing parts of the temples that were originally located at Upper Egypt, ended up laying on the Alexandria seabed (the distance between Alexandria and Upper Egypt is more than 1000 Kilometers). They also found pieces believed to be from the Pharos of Alexandria lighthouse (one of the seven ancient wonders of the world) and pieces from Cleopatra's palace that was located on the harbor.



# PROJECT LOCATION



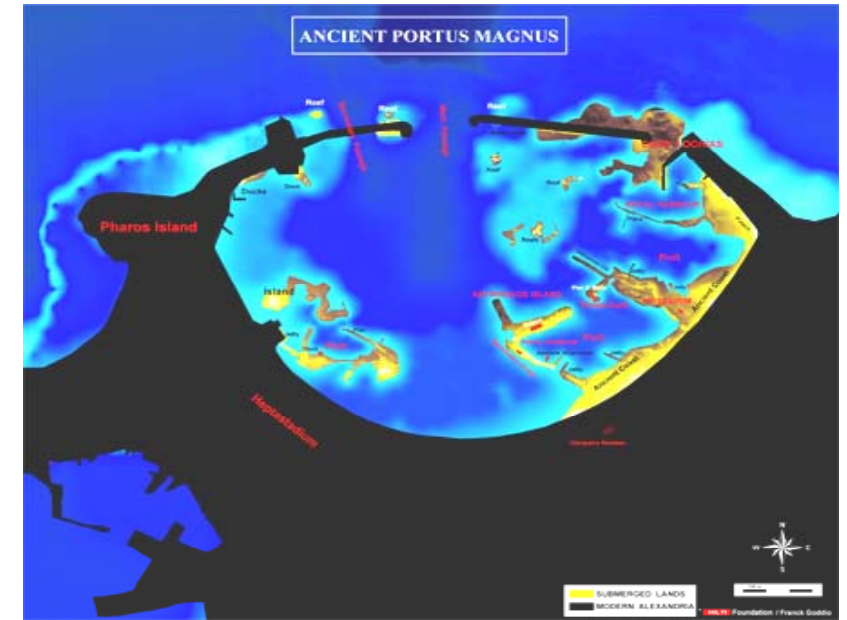
*Ref [4]*

# PROJECT LOCATION

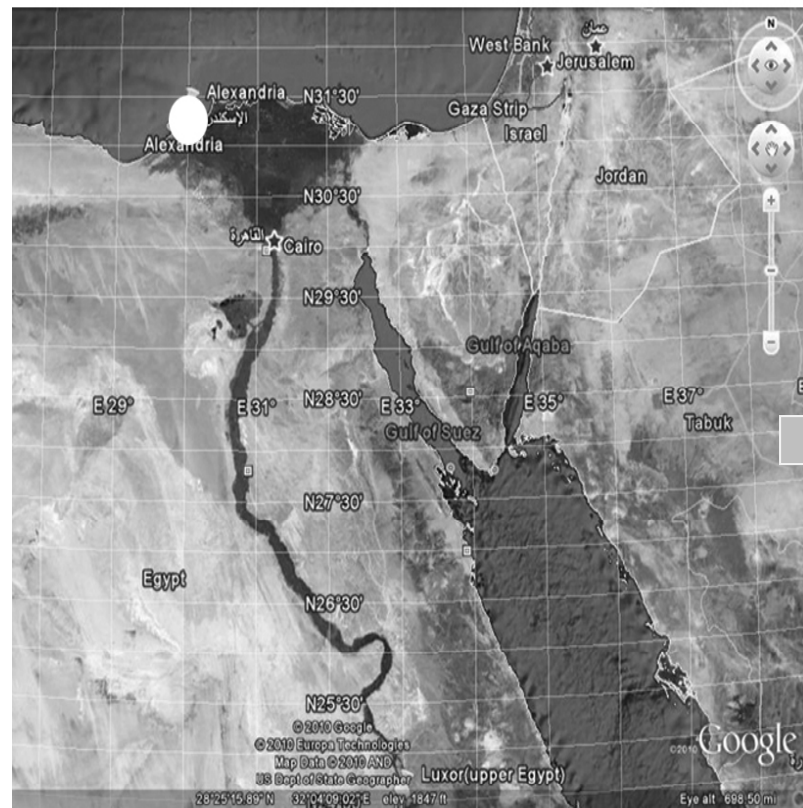
A team of archaeologists, historians, geophysicists and divers, have studied and charted the complete harbor with the remains, a complete imaginary picture of the harbor area were formed based on this work, the ruins and old maps *Ref [5]*.



Imaginary perspective of the Eastern harbor

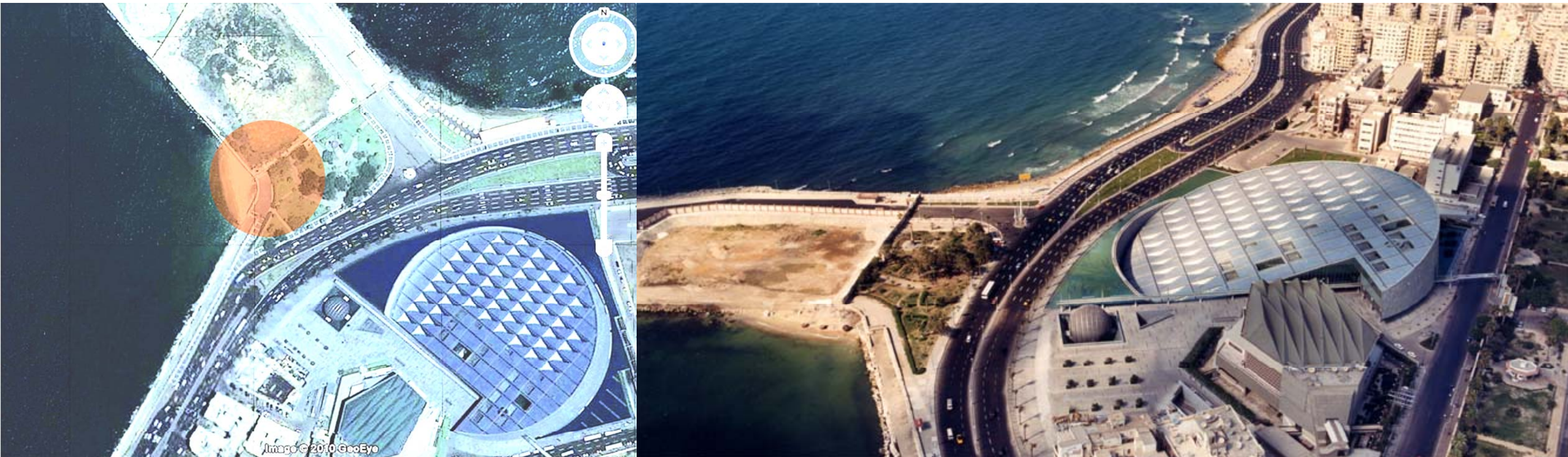


Imaginary plan of the Eastern harbor with ruins locations



# PROJECT LOCATION

The site selection was based not only on the presence of the ruins, but also the history and context, since it is the approach from the old eastern harbor, the place of Cleopatra's palace, and faces the proposed location of the old lighthouse. This location was the first point of defense for the city, it has seen many invasions, celebrations and defeats over the years. The imagination of researchers helped to create an image of the area and determine the layout of the sunken Alexandria *Ref* [5].



# PROJECT LOCATION

The Bibliotheca Alexandrina (the major project neighbor to the proposed museum) was inaugurated in 2003 near the site of the old Library. The design of the new library is both timeless and bold. Its vast circular form alongside the curved Alexandrian harbor recalls the cyclical nature of knowledge, fluid throughout time.

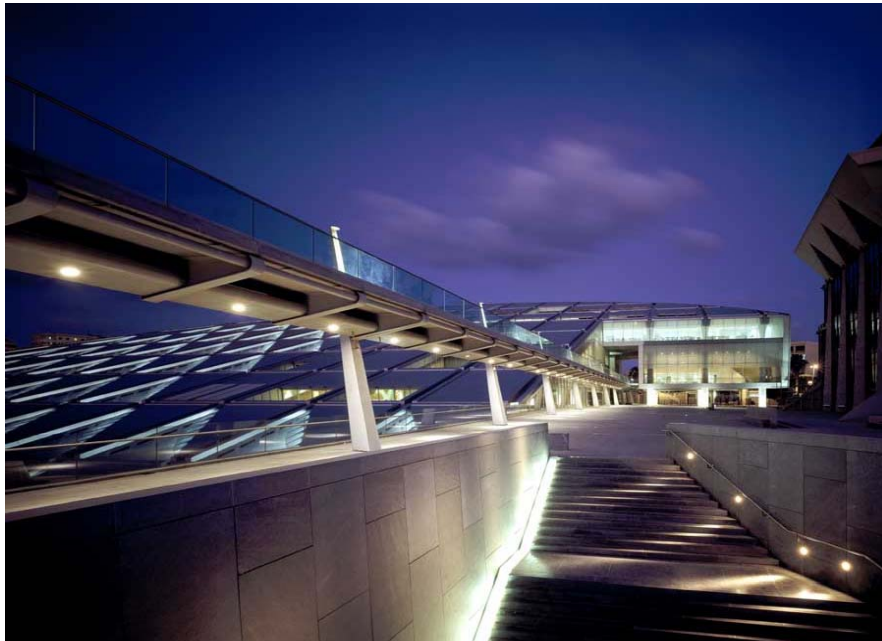
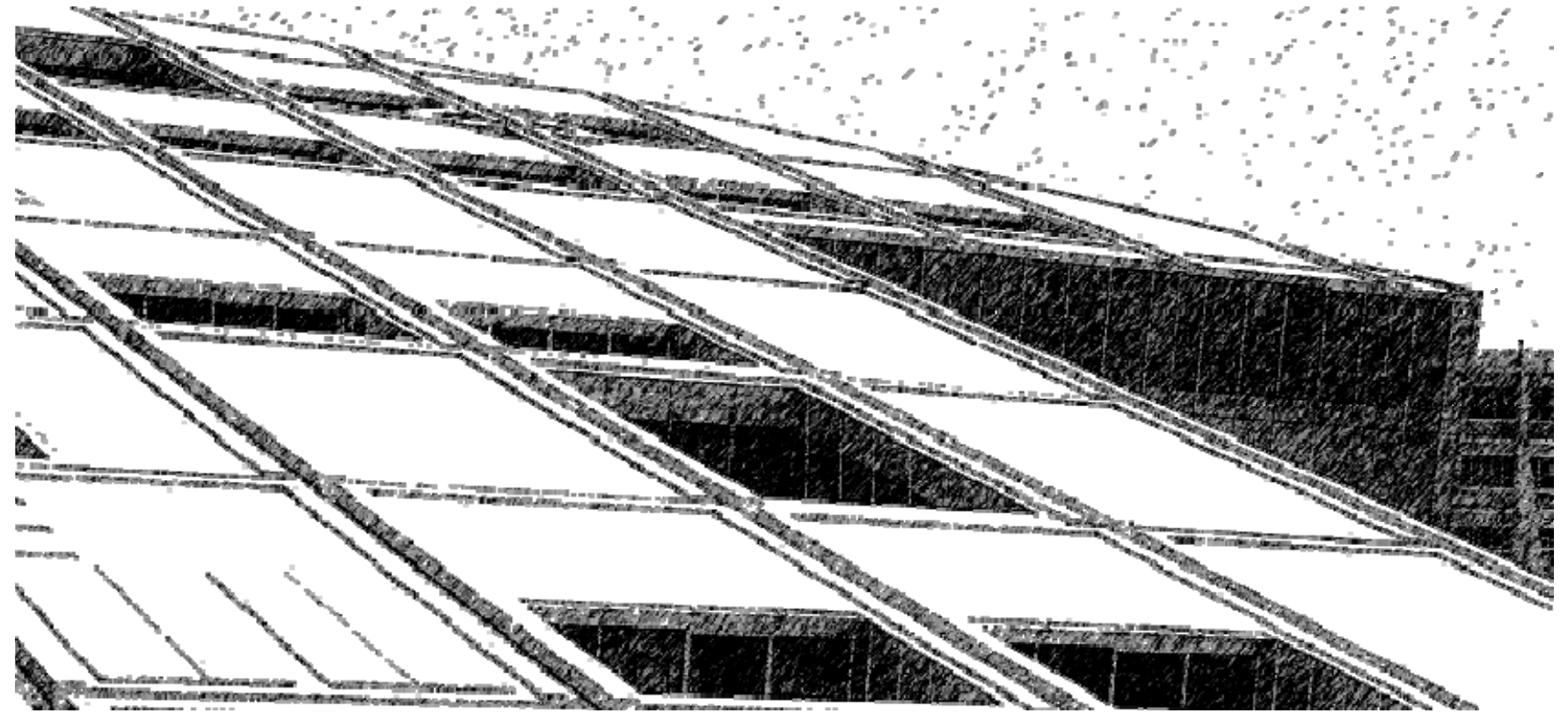
The glistening tilting roof of the library recalls the ancient Alexandrian lighthouse and provides the city with a symbol for learning and culture. As it descends into the earth and reaches upward to the sky the library manifests within its apparent movement a frozen moment in time. Synchronous with this movement stands a grand stone edifice of historic proportions *Ref [6]*.



Alexandria library

# PROJECT LOCATION

The new Library of Alexandria is located on a outstanding site, the complex comprises three main elements: the conference center, the planetarium and the new building. They are all connected underground below the plaza into one large functional complex *Ref [7]*.







# DESIGN CONCEPT

# DESIGN CONCEPT



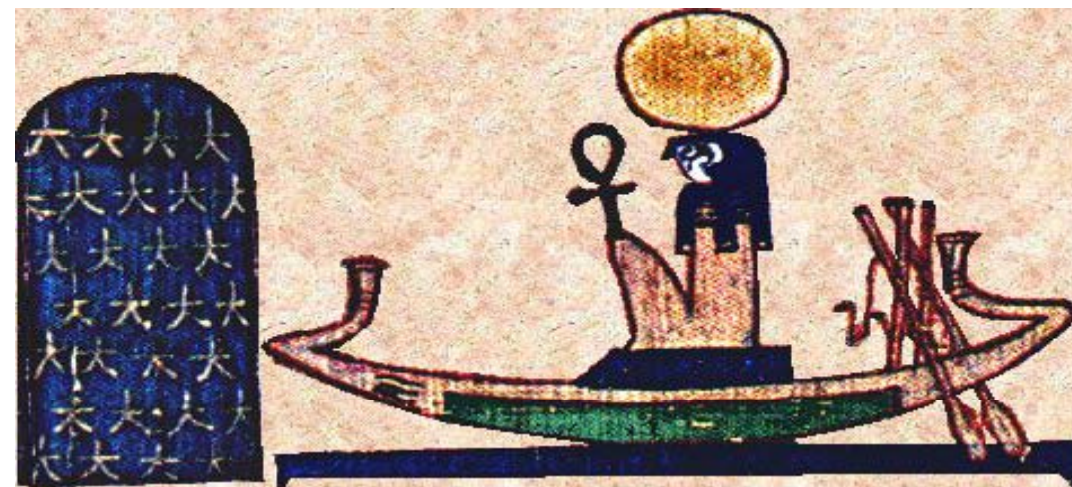
The main design concept for the proposed building consists of the geometry relationships between the sun, earth and moon.

To the Egyptians, the sun represented light, warmth, and growth. This made the sun deity Ra very important and was seen as the ruler of all creatures. The sun disk was either seen as the body or eye of Ra. From very early times Ra was a sun god. He took on many of the attributes and even the names of other gods *Ref [8]*. Ra was thought to travel on two solar boats called the Mandjet, or morning boat and the Mesektet, or evening boat. These boats took him on his journey through the sky and the underworld.

Such was Amon Ra's reputation among the Classical Greeks that Alexander the Great journeyed there after the battle of Issus and during his occupation of Egypt, where he was declared the son of Amon by the oracle. Alexander thereafter considered himself divine.



Raa 8 hours night journey

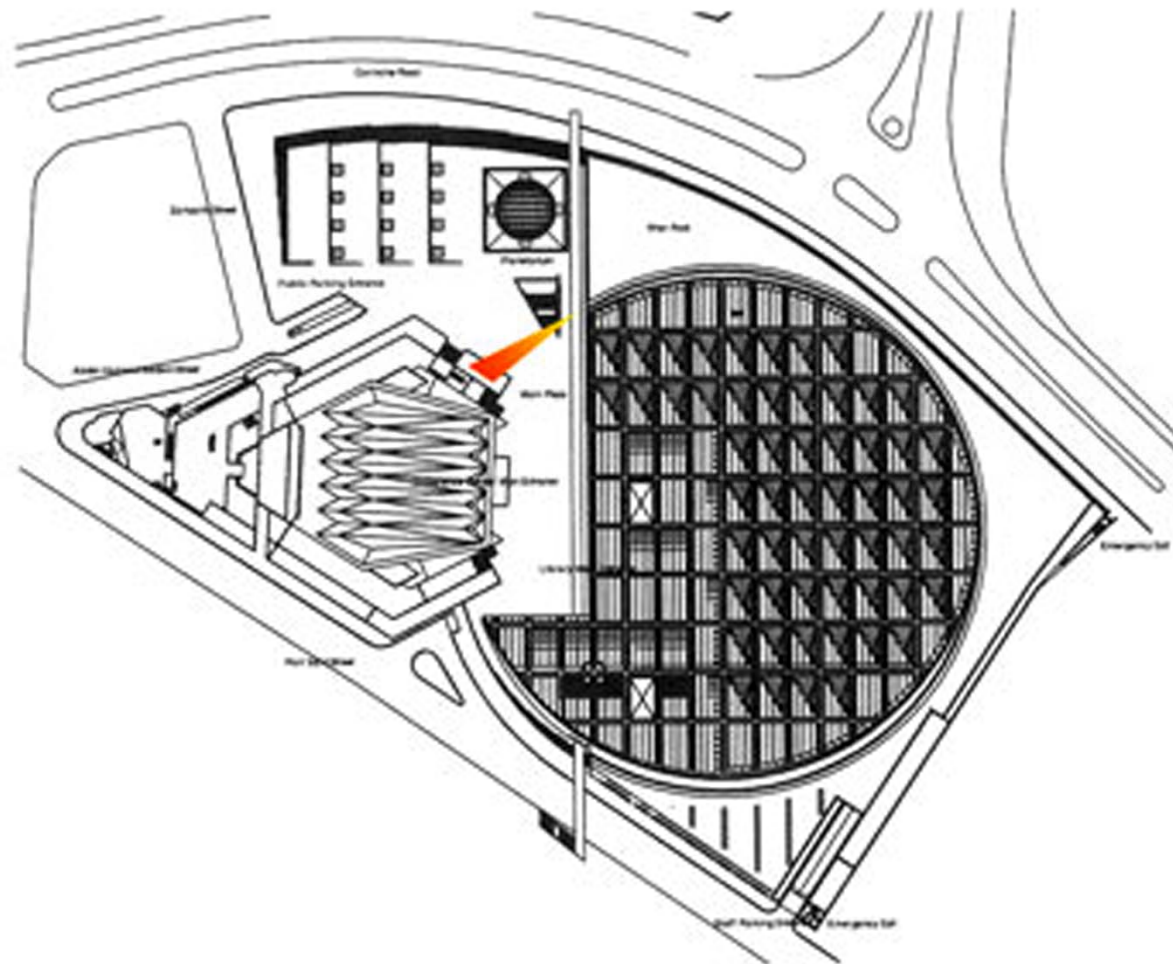


Amon Ra Boat

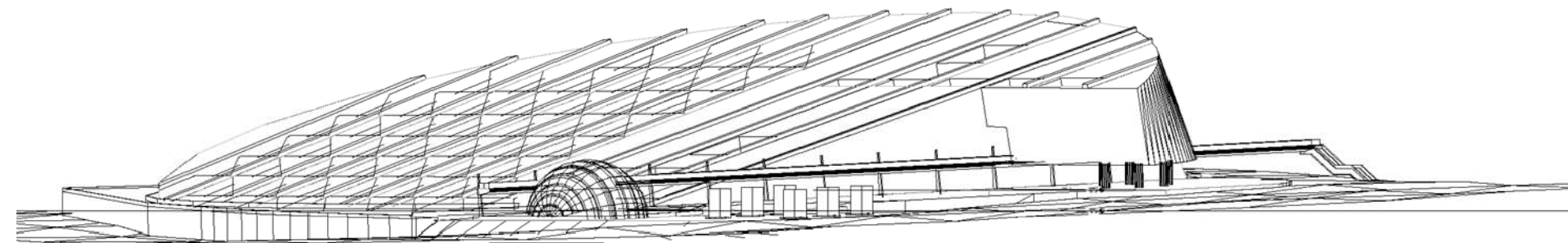
# DESIGN CONCEPT



The existence of a symbolic, enormous and important nearby building such as the library was a challenge. The proposed building could either accept the library and work in harmony with it, or reject it and present its own design and geometry. With that in mind, it was decided that the design would do both; respond to the library geometry in one part of the building (the cylinder shape), and reject it (a submerged structure). The museum will have a large collection of monuments from different *époques* and civilizations and the design should celebrate and respect all the civilizations displayed inside and outside the museum.



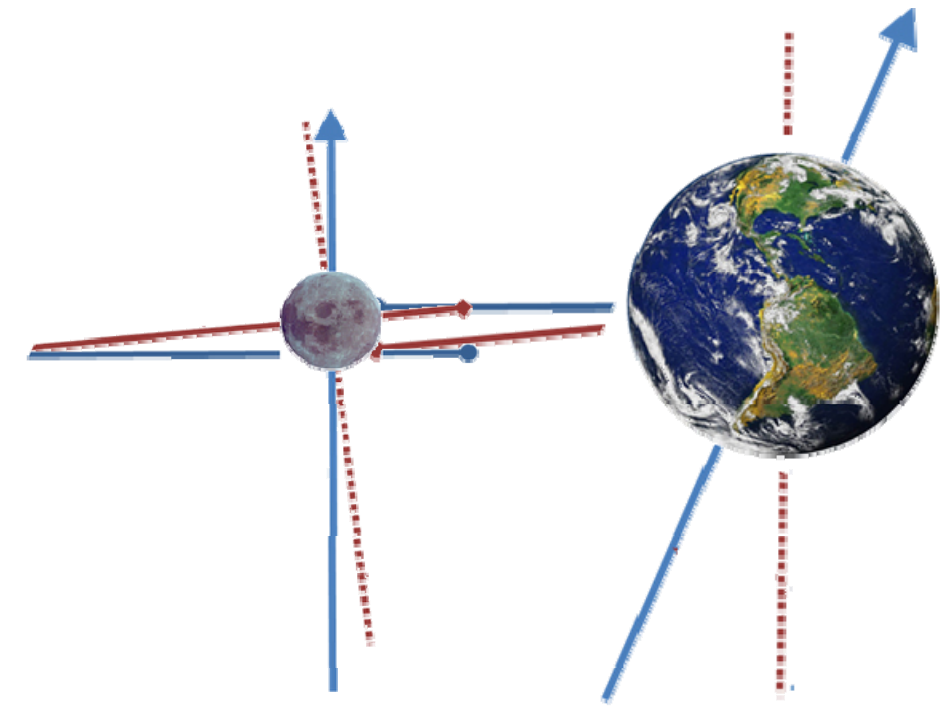
Alexandria library Site Plan



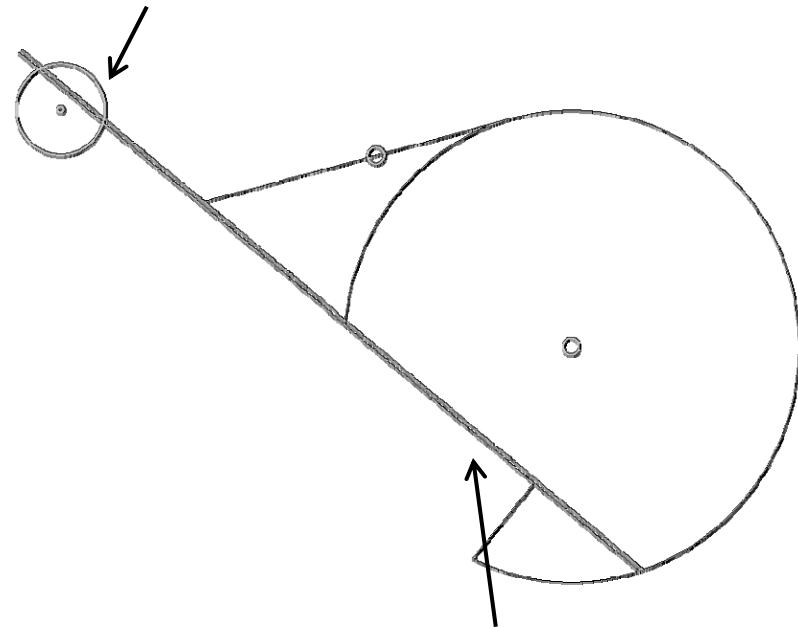
Alexandria library West Elevation

# DESIGN CONCEPT

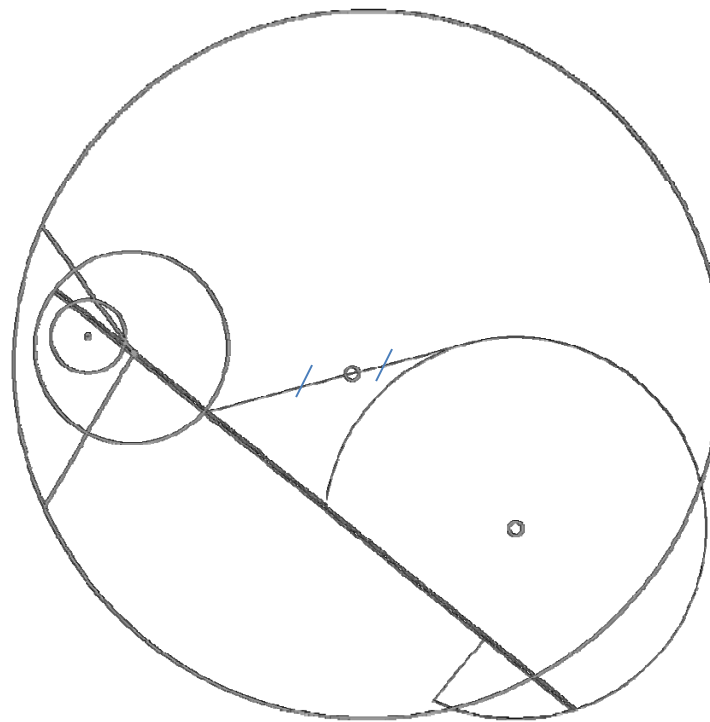
The inclined cylinder terrestrial building geometry creates in plan with the library the same proportions between the earth (represented in the library) and the moon (the terrestrial museum volume). From the terrestrial building, underwater Plexiglas tunnels (as the rays of the sun) take visitors to a structure where they can view antiquities lying on the seabed. The proportions and geometry of the submerged volume are extracted from the ship of the sun by Amon Raa, the ancient Egyptian God of the sun. He used the ship in his journey around the earth and the moon to the other world, and this journey starts from the south and ends in the North, and this is how the museum journey starts and ends.



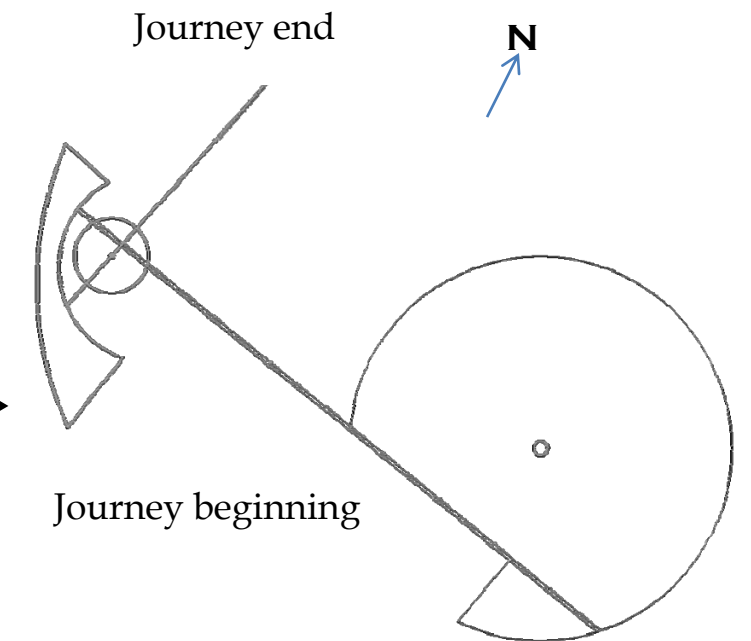
Proposed Underwater Museum



Alexandria Library



Building geometry study

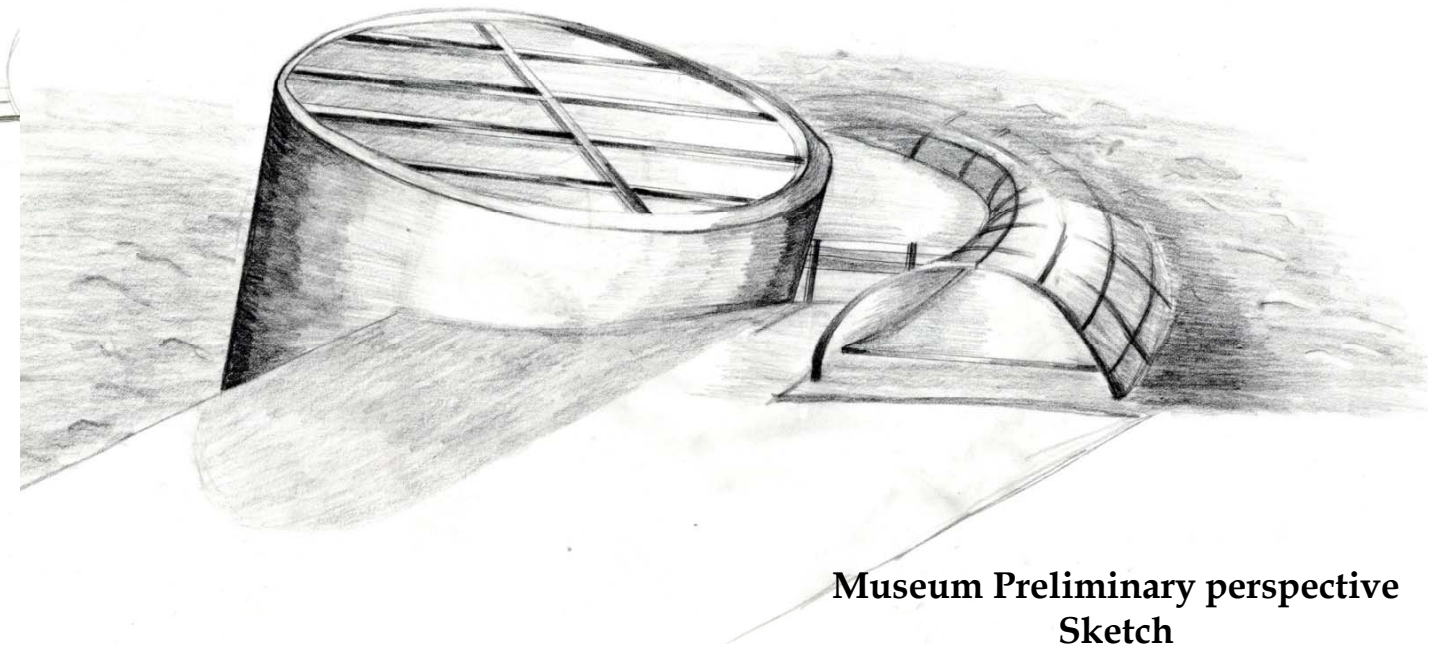


Earth- moon geometry relationship

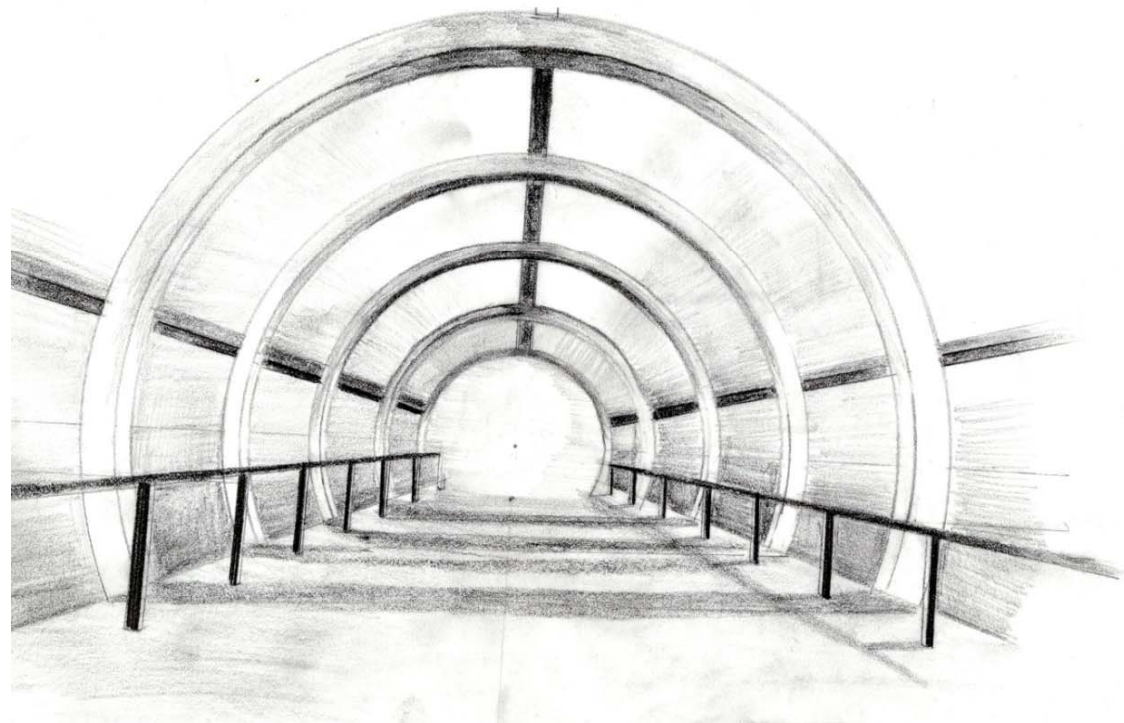
# DESIGN CONCEPT



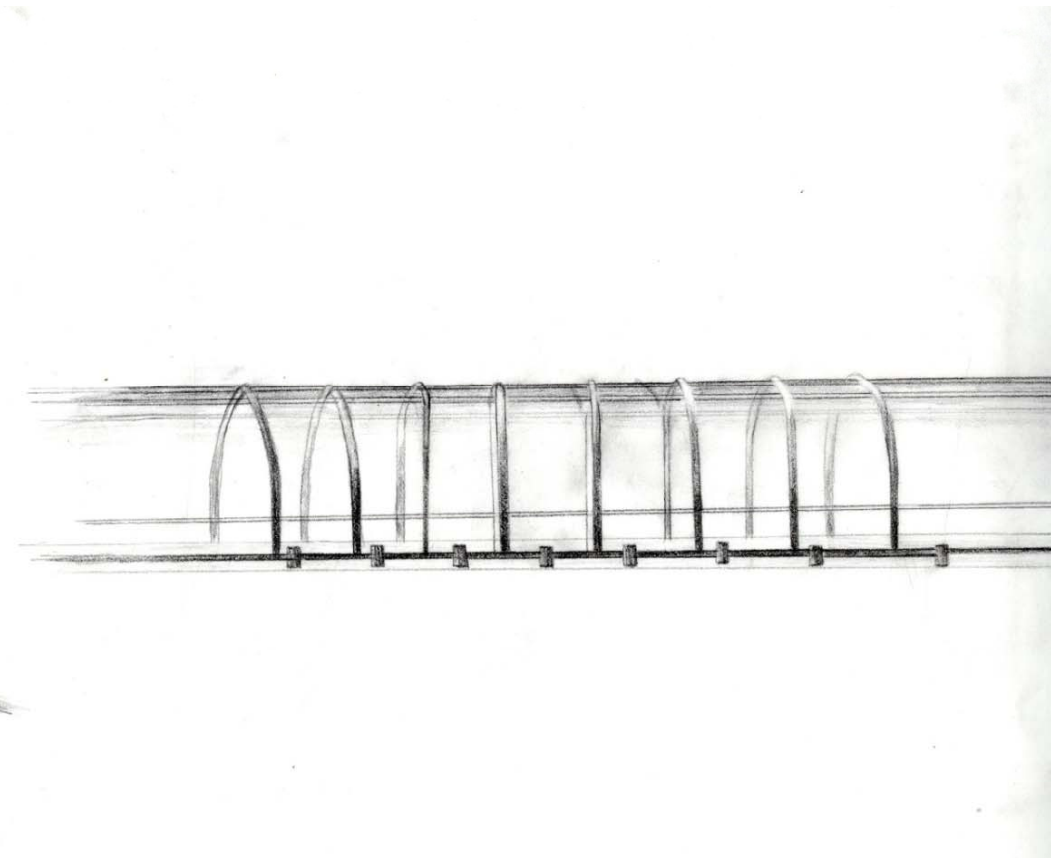
Museum Preliminary perspective Sketch



Museum Preliminary perspective Sketch

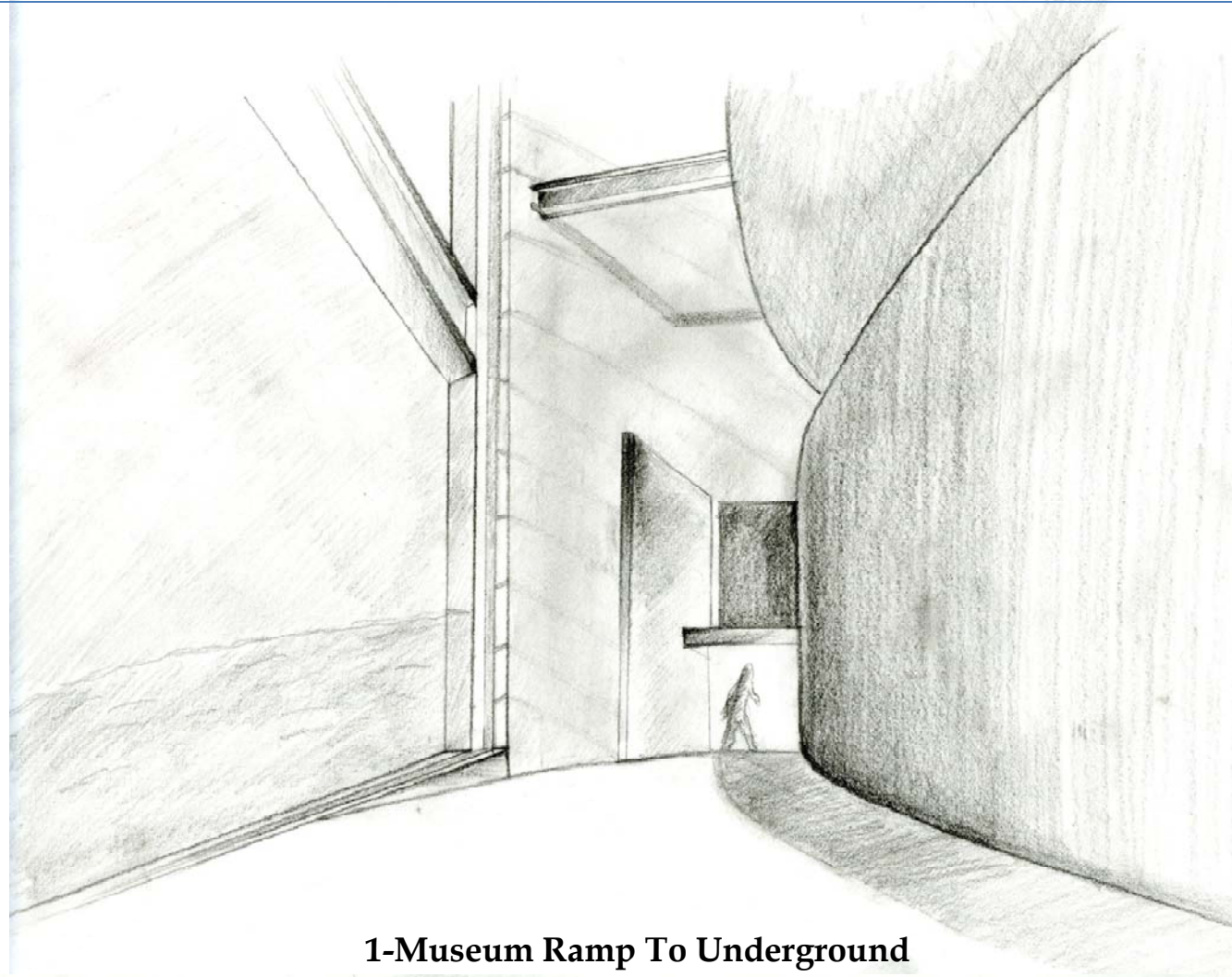


Museum Submerged Tunnel Interior Sketch

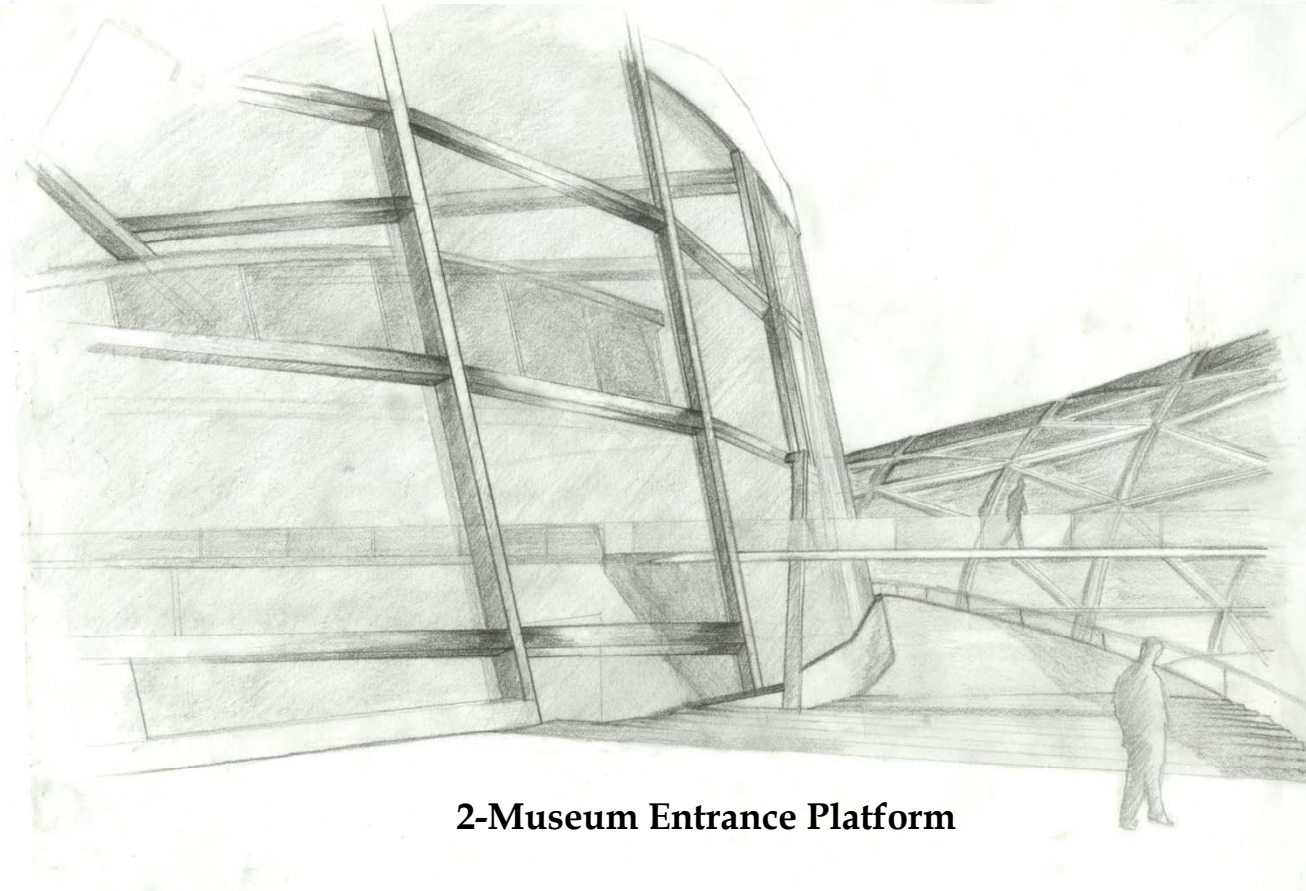


Museum Submerged Tunnel Elevation Sketch

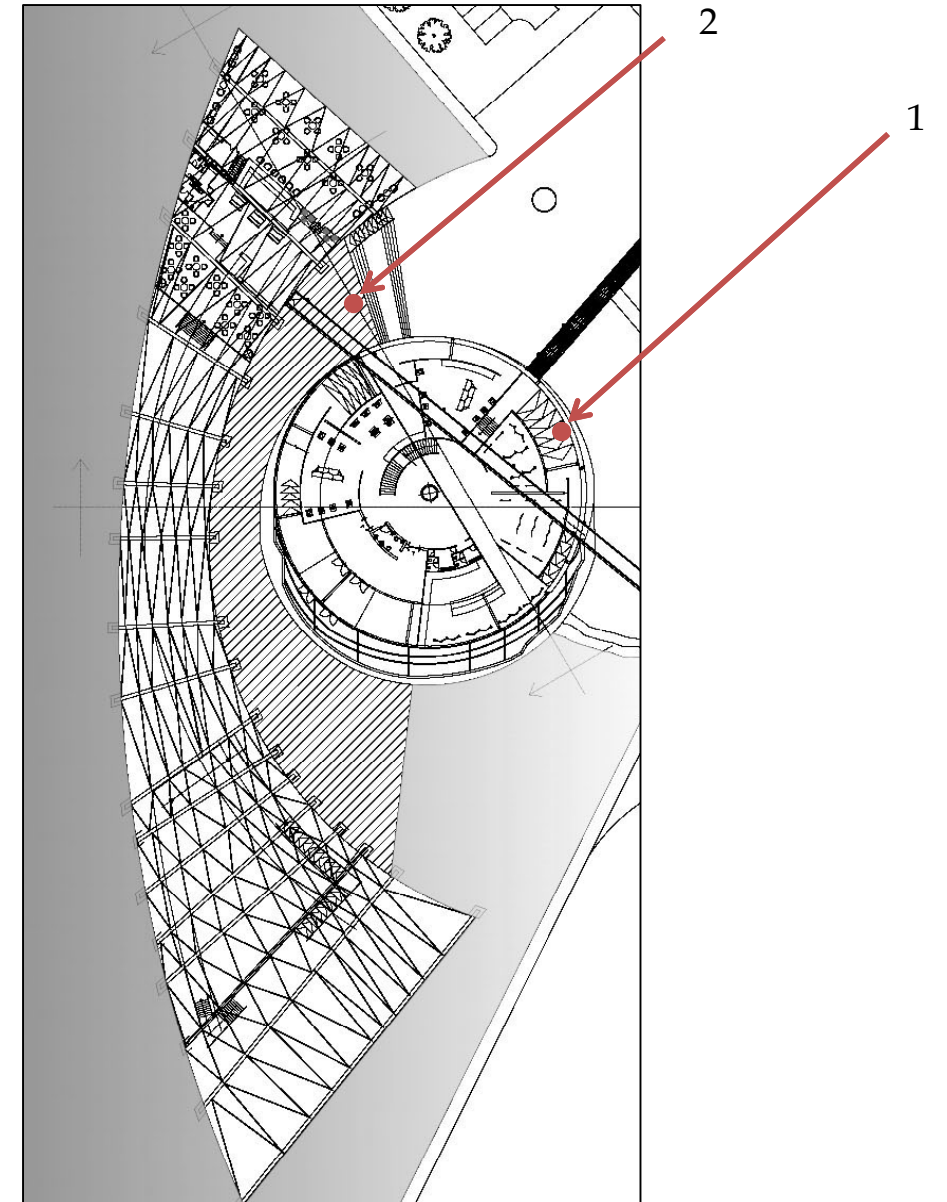
# DESIGN CONCEPT



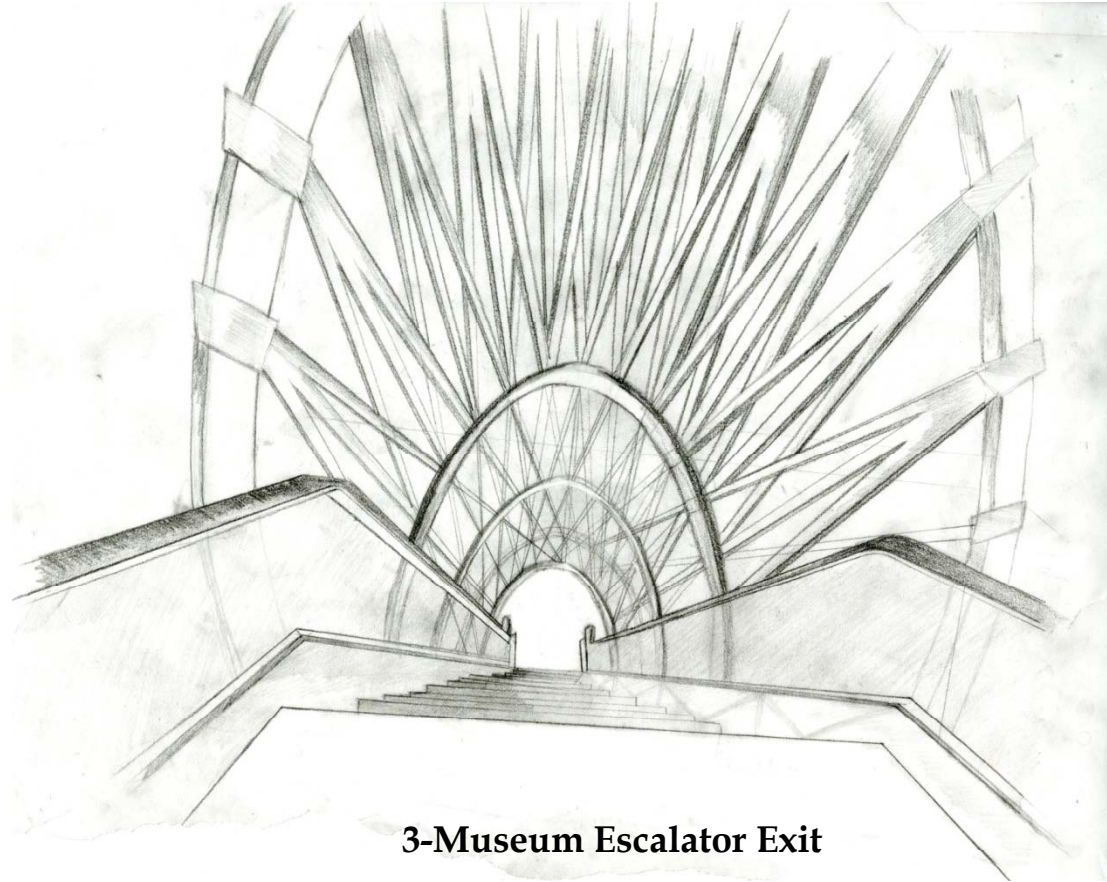
1-Museum Ramp To Underground



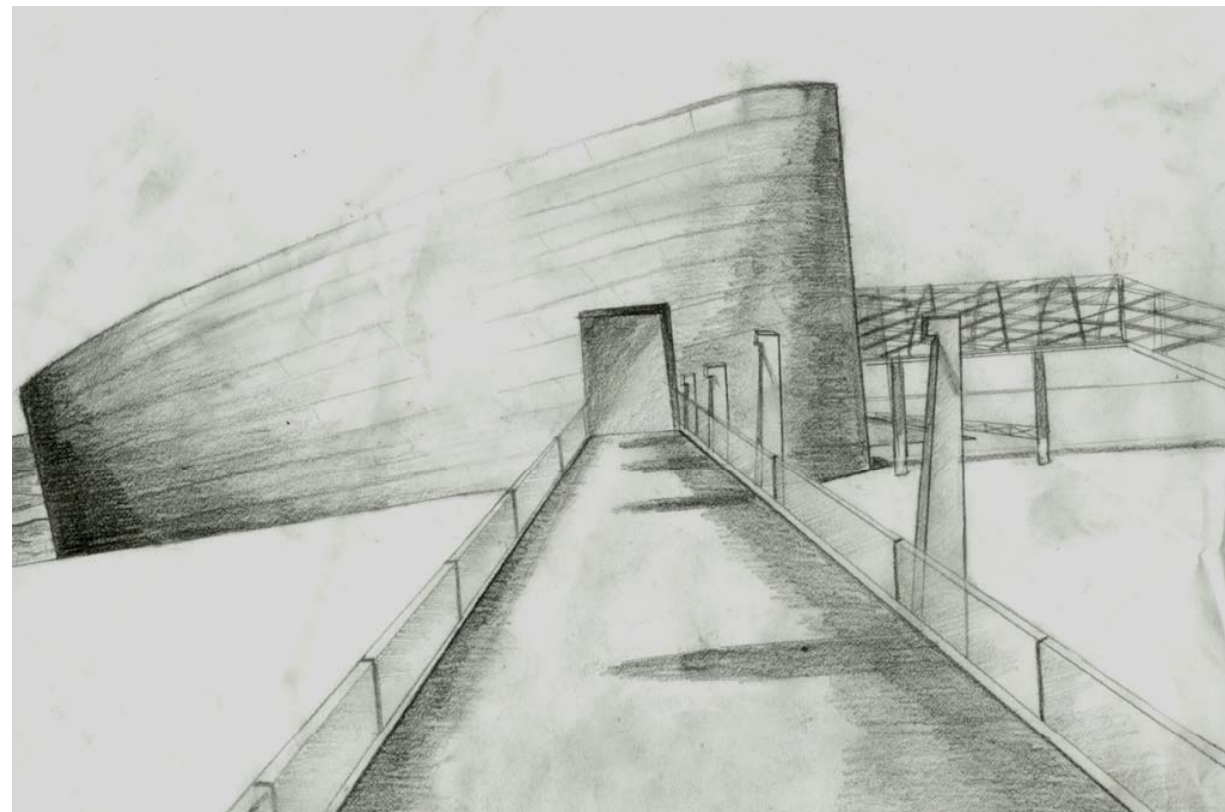
2-Museum Entrance Platform



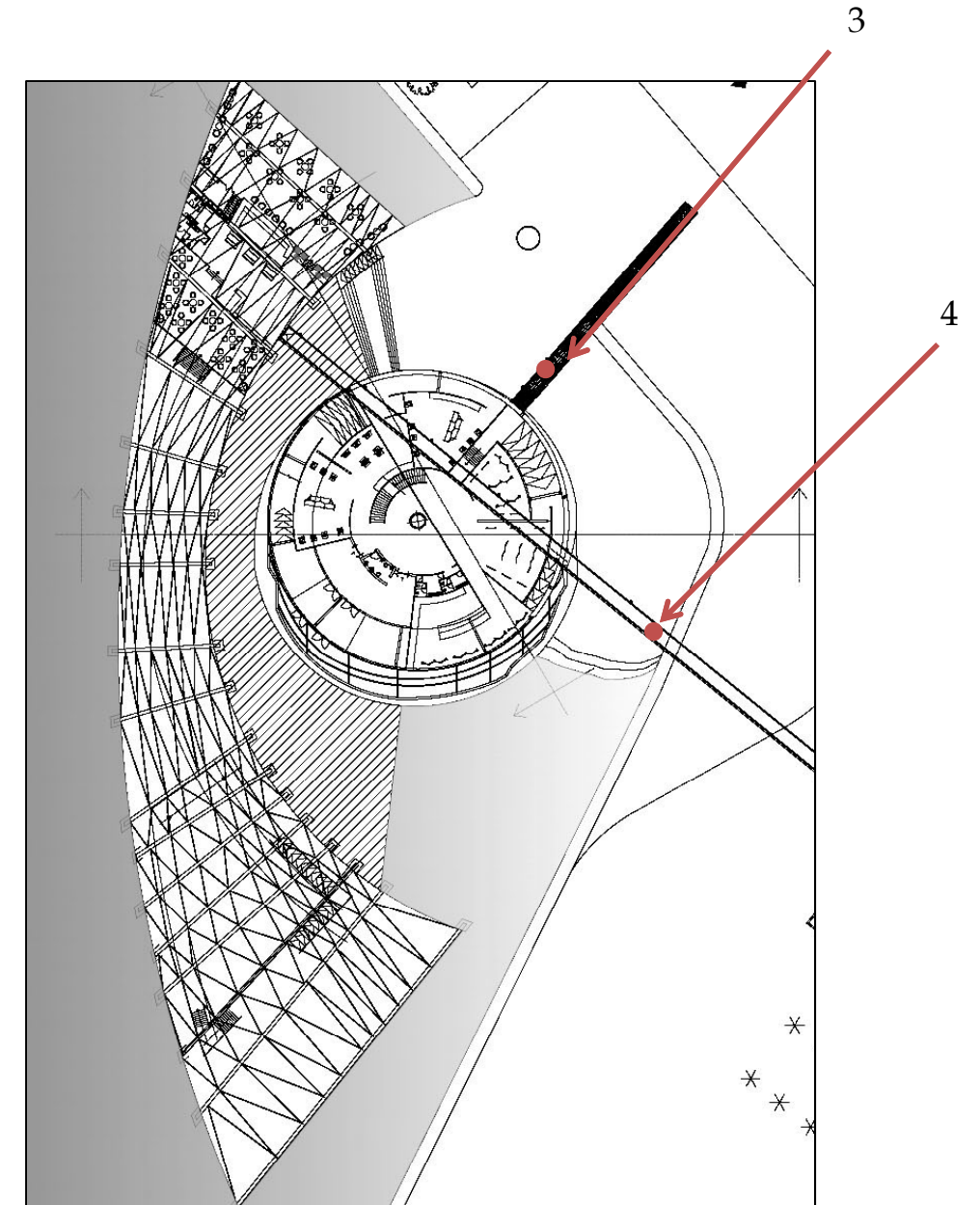
# DESIGN CONCEPT



3-Museum Escalator Exit



4-Museum Entrance Bridge from the Library



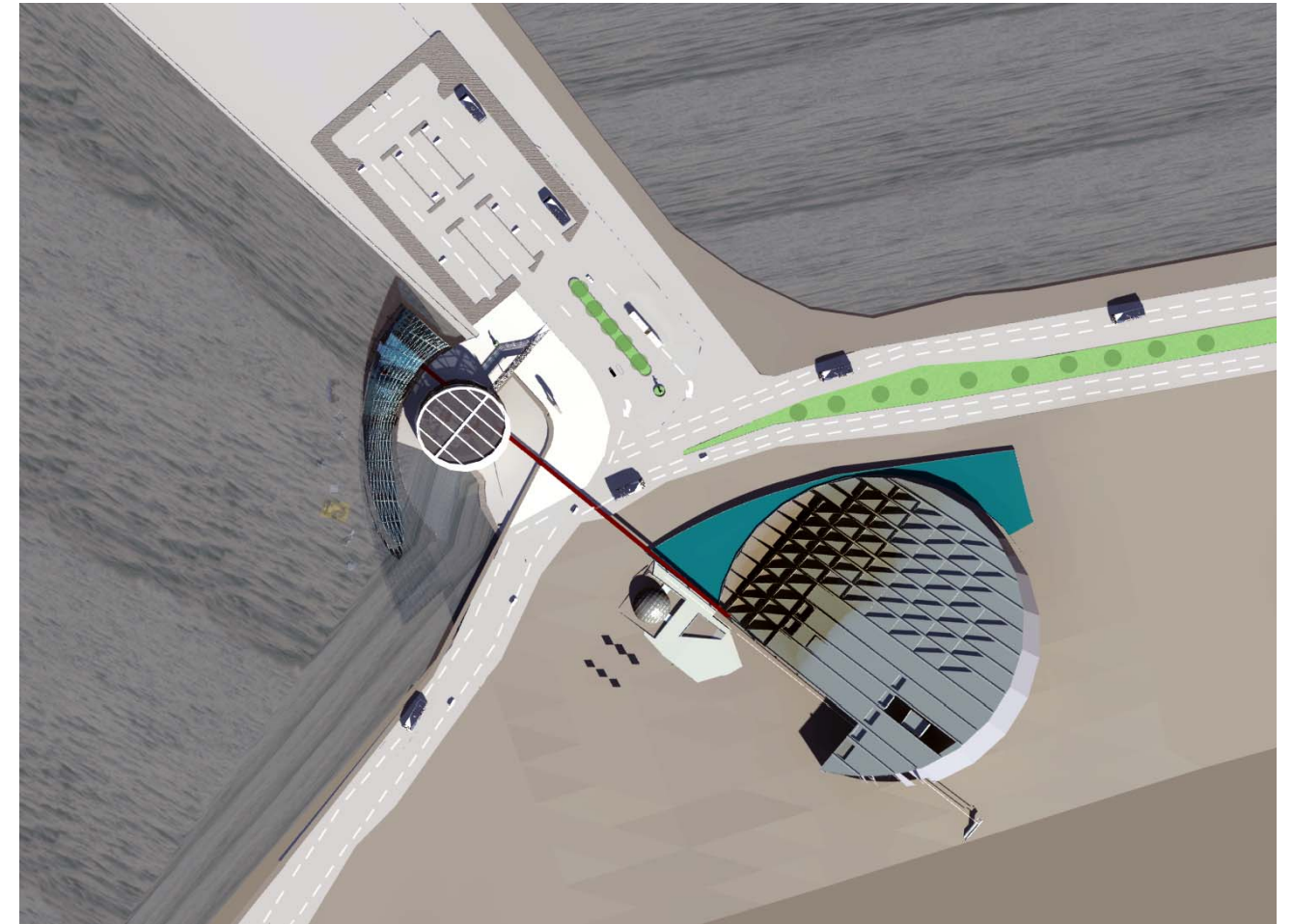


# ARCHITECTURAL DRAWINGS

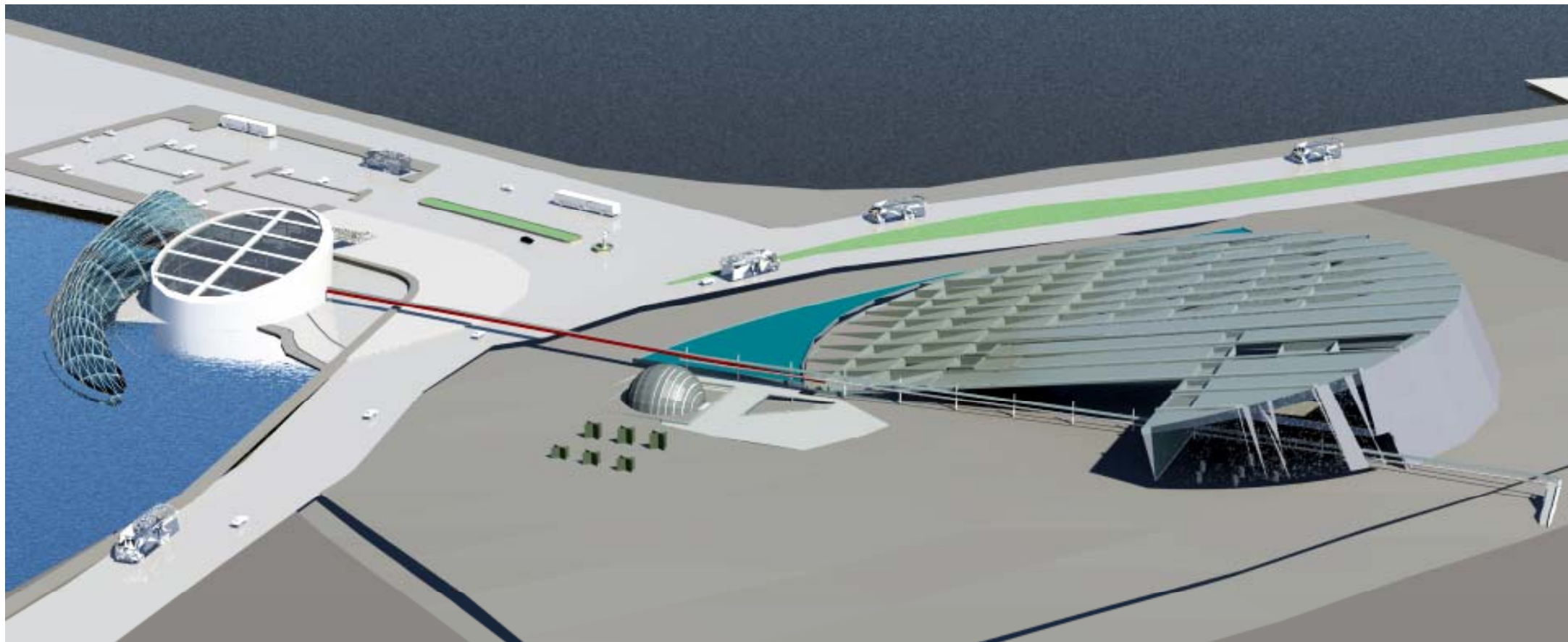


# ARCHITECTURAL DRAWINGS

The project site is located on the harbor; levels of the building are open to the sky, on the sea level, other submerged under the water, another level is floating and one more is located on the water surface level. The inspiration of giving the opportunity to discover the 3 elements: sky, land and water while being inside the same building was quite inspiring in the design process; Each moment gives a different sense. This is where the mystery of the building emerges, each monumental piece position, and location under the water tell us something about its story.



Bird's eye view showing Library and proposed museum



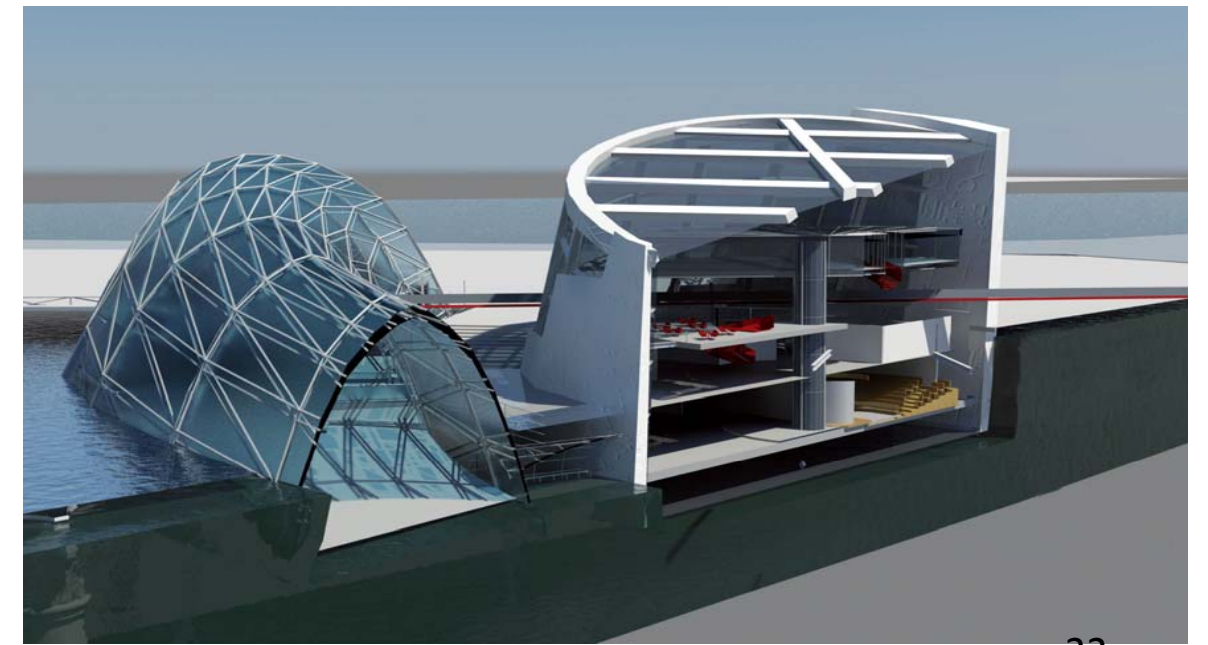
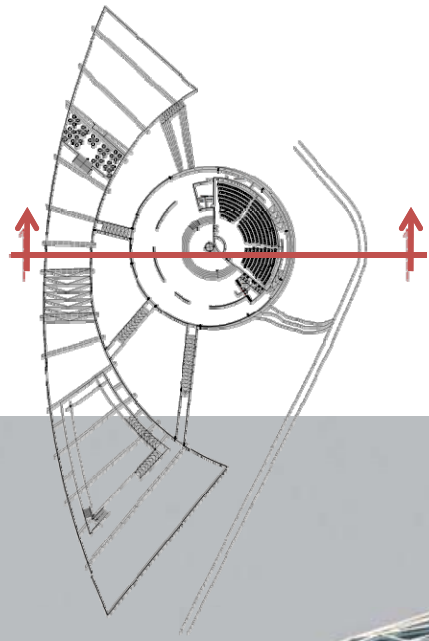
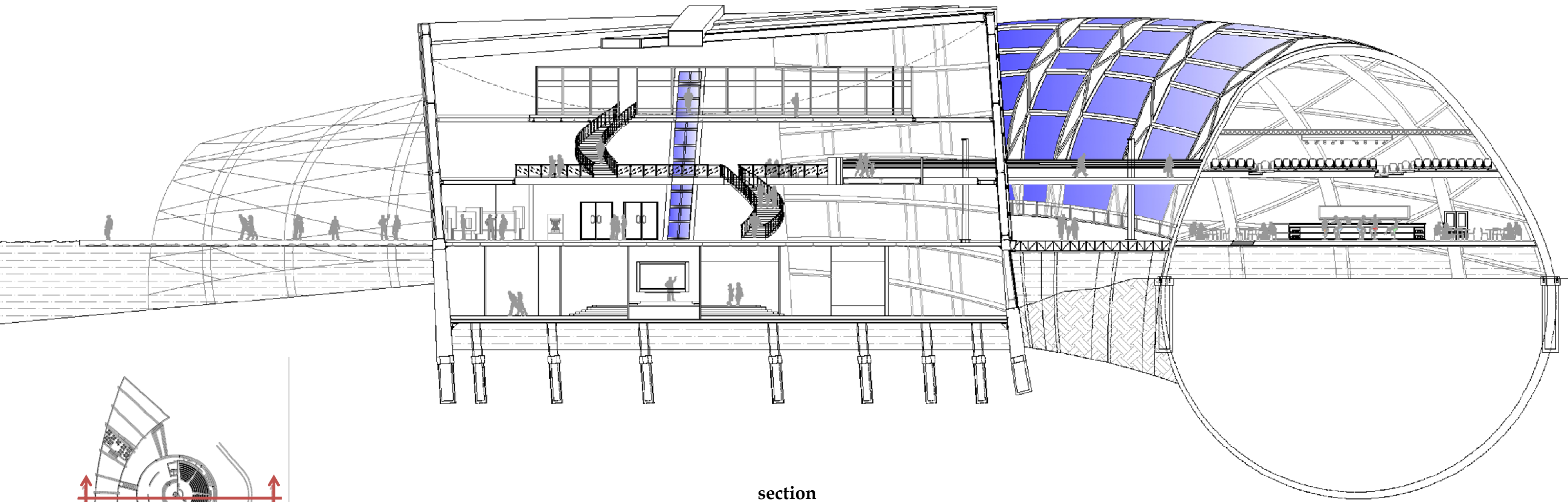
Site plan

# ARCHITECTURAL DRAWINGS

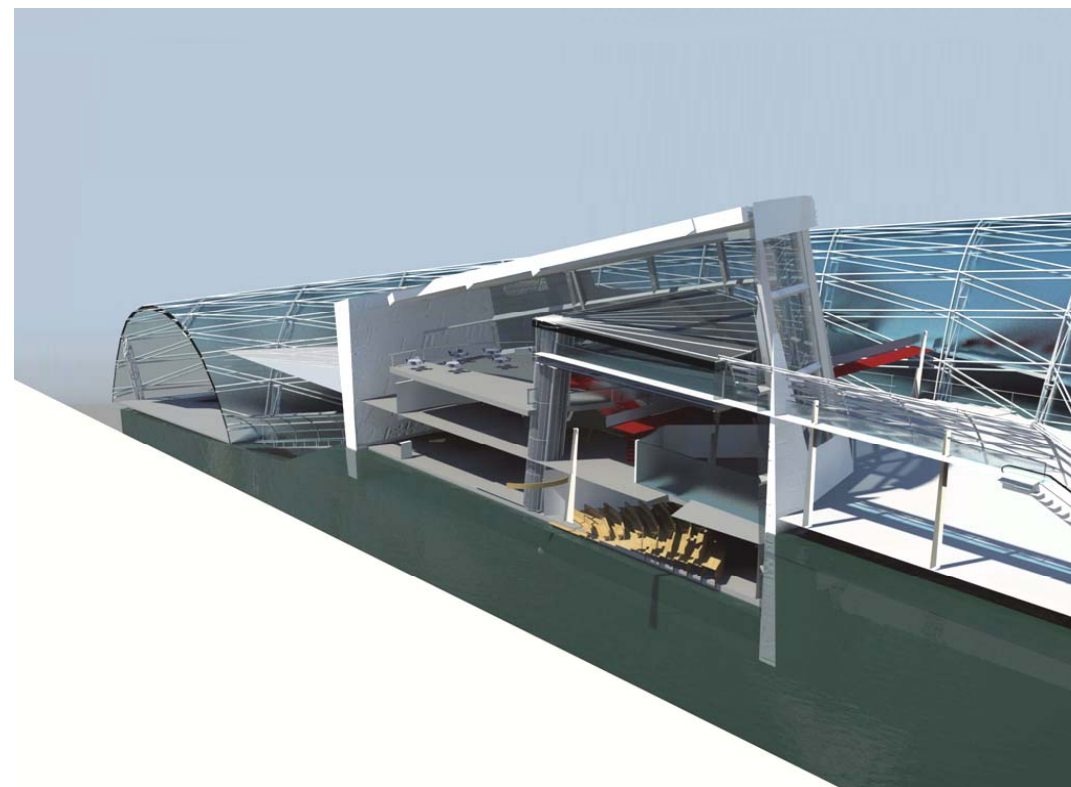
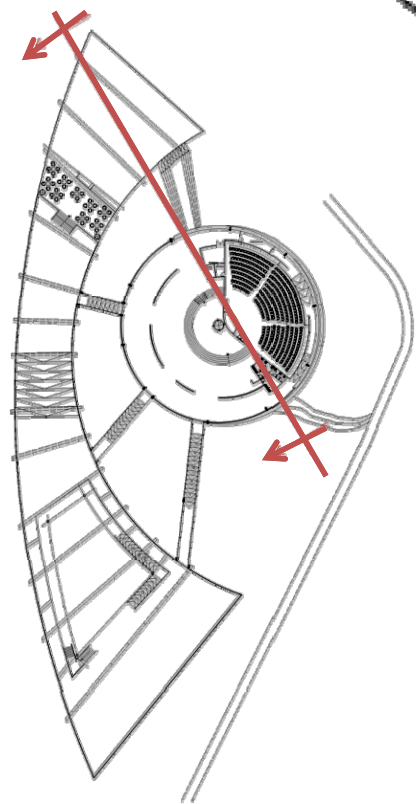
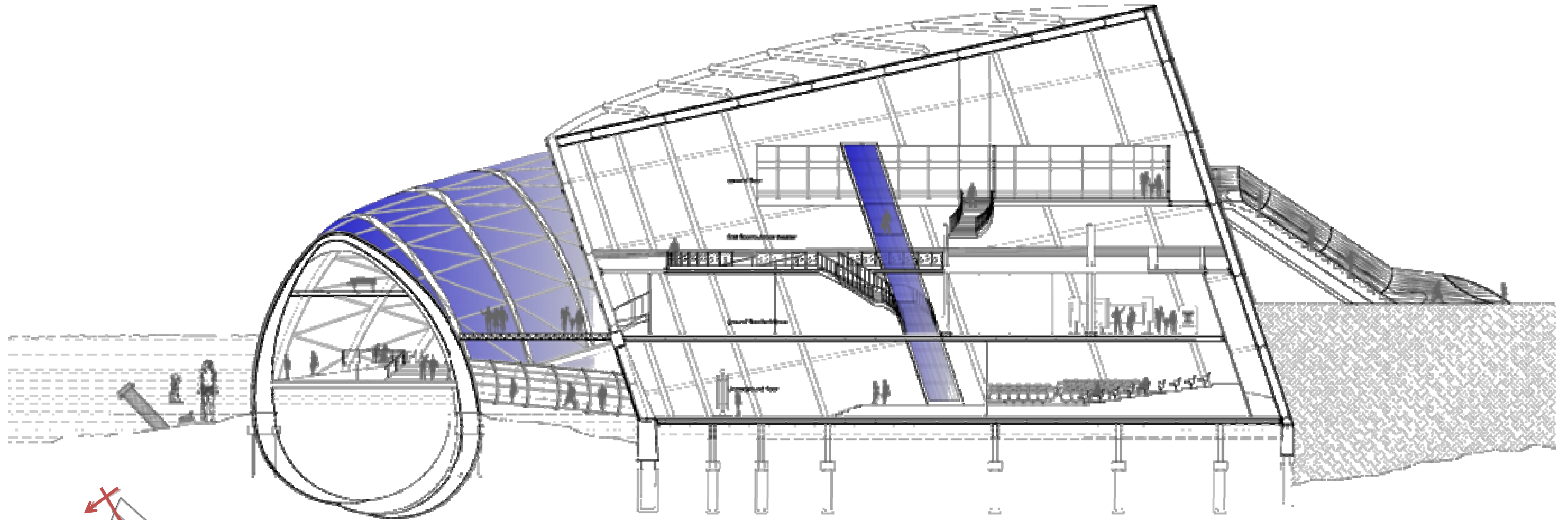


Perspective

# ARCHITECTURAL DRAWINGS

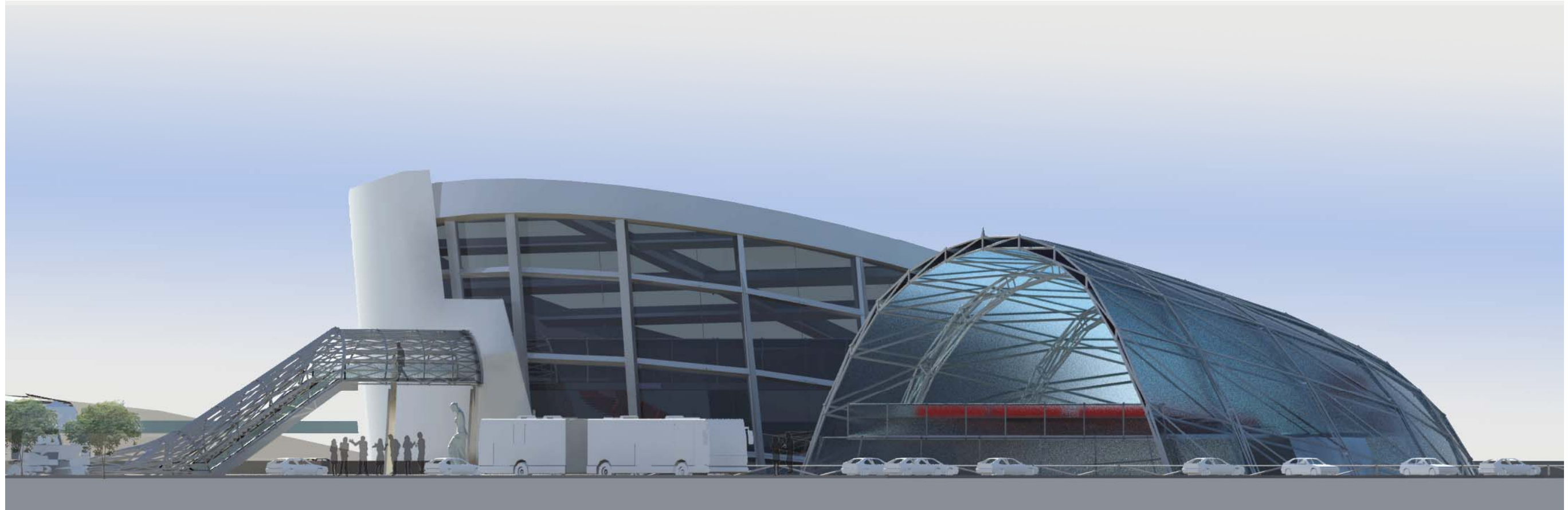


# ARCHITECTURAL DRAWINGS

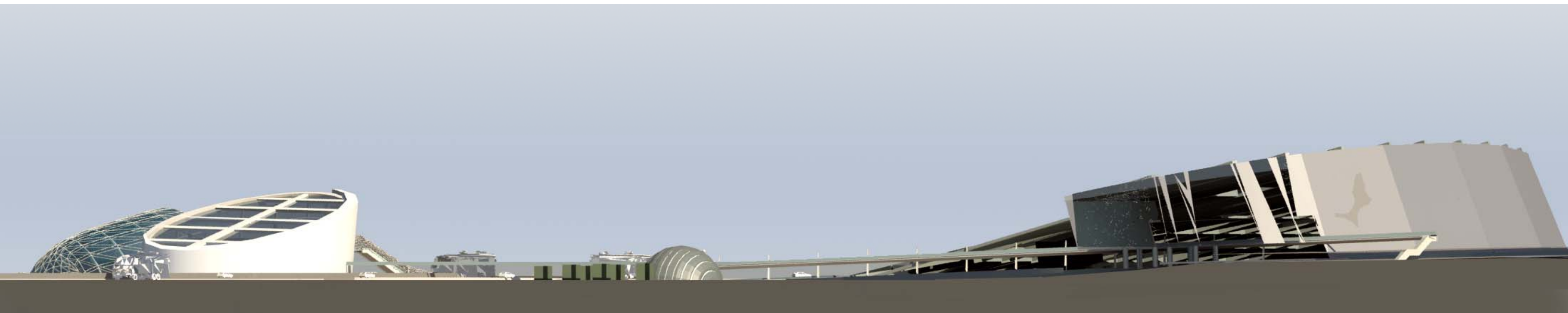


Section

# ARCHITECTURAL DRAWINGS

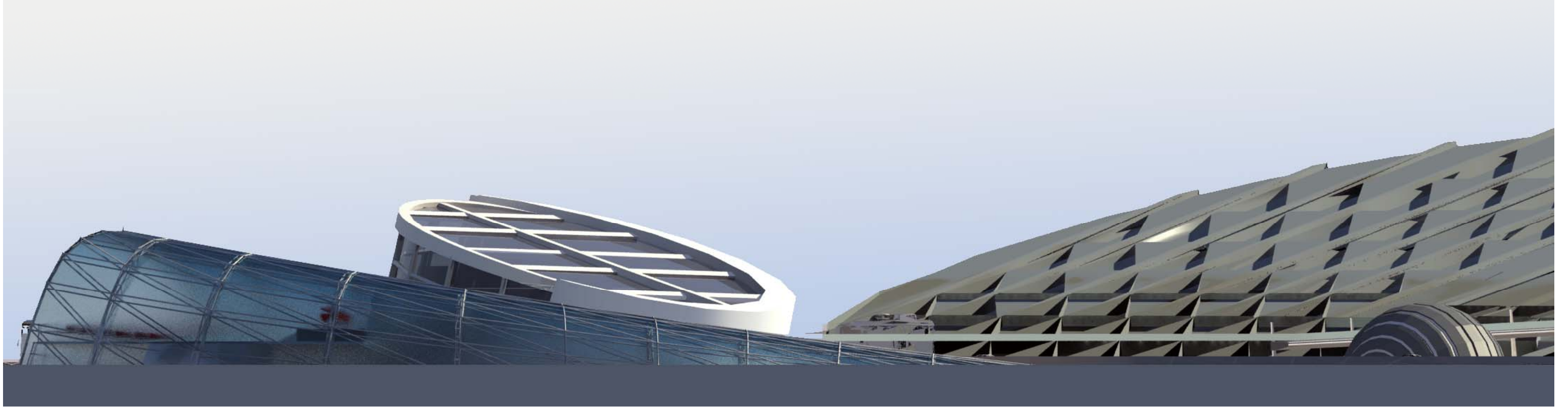


Elevations

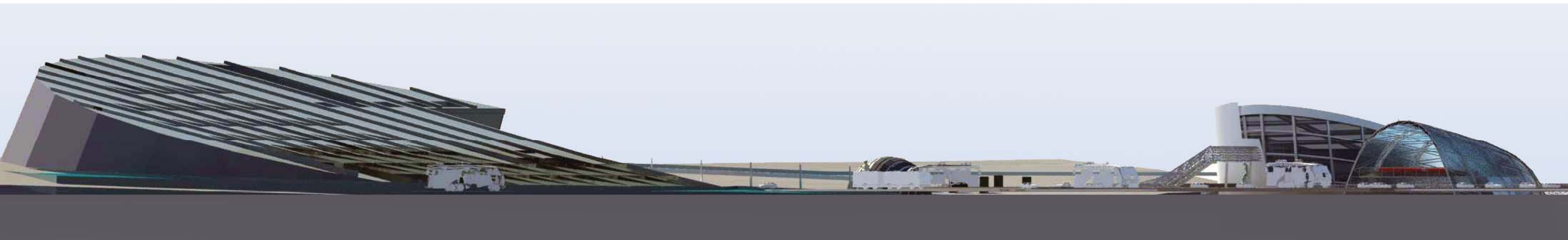


# ARCHITECTURAL DRAWINGS

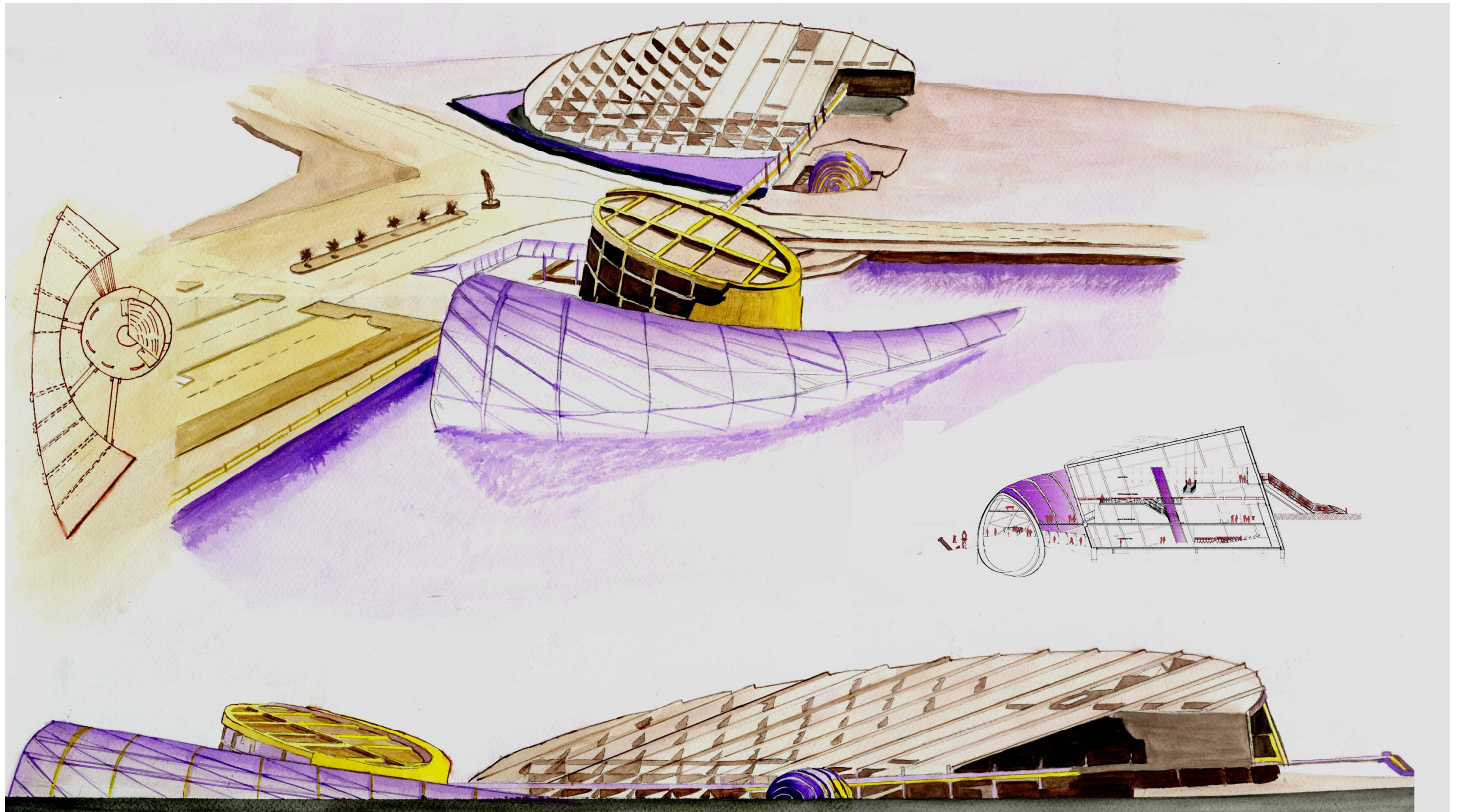
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Elevations



# ARCHITECTURAL DRAWINGS



Project presented in Water coloring

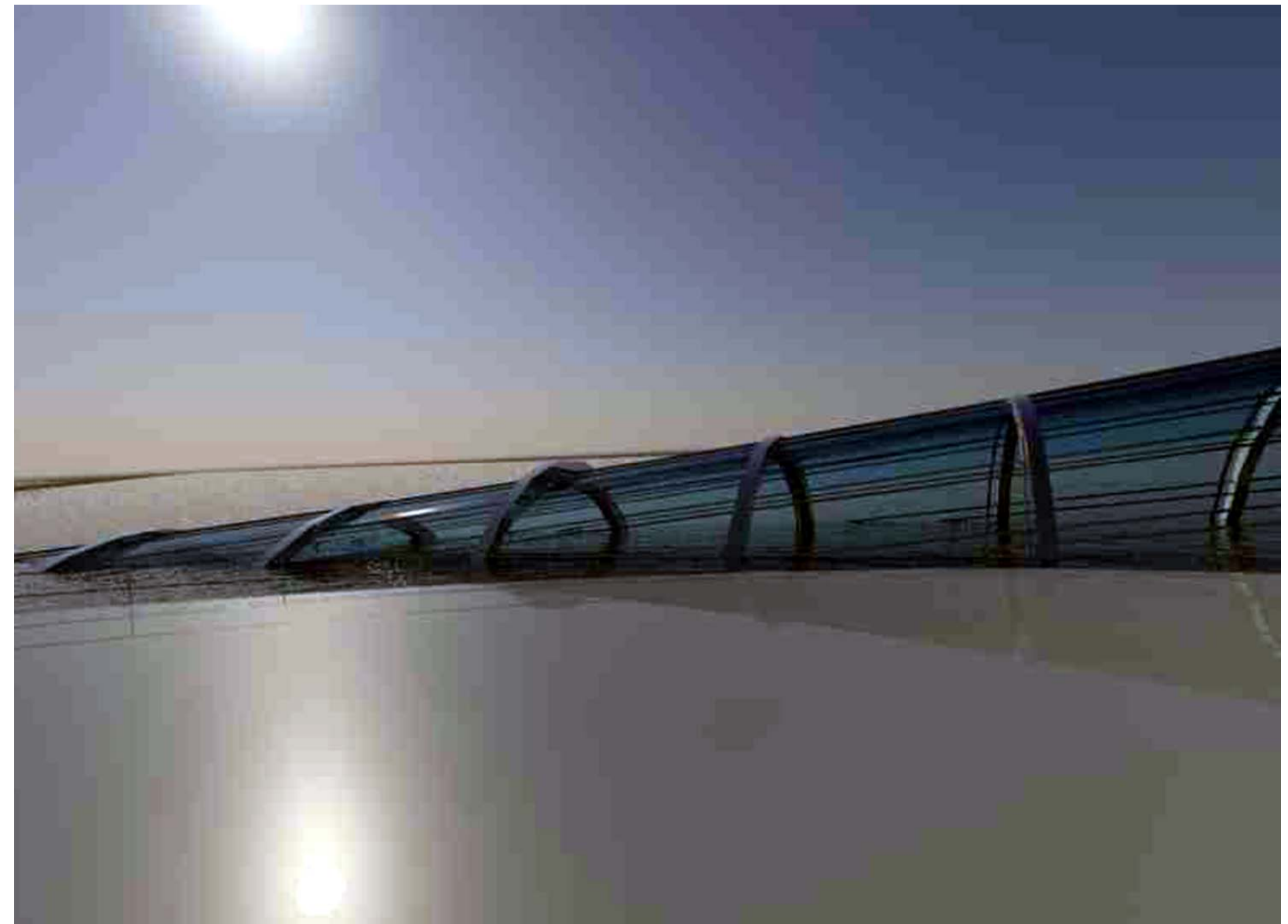
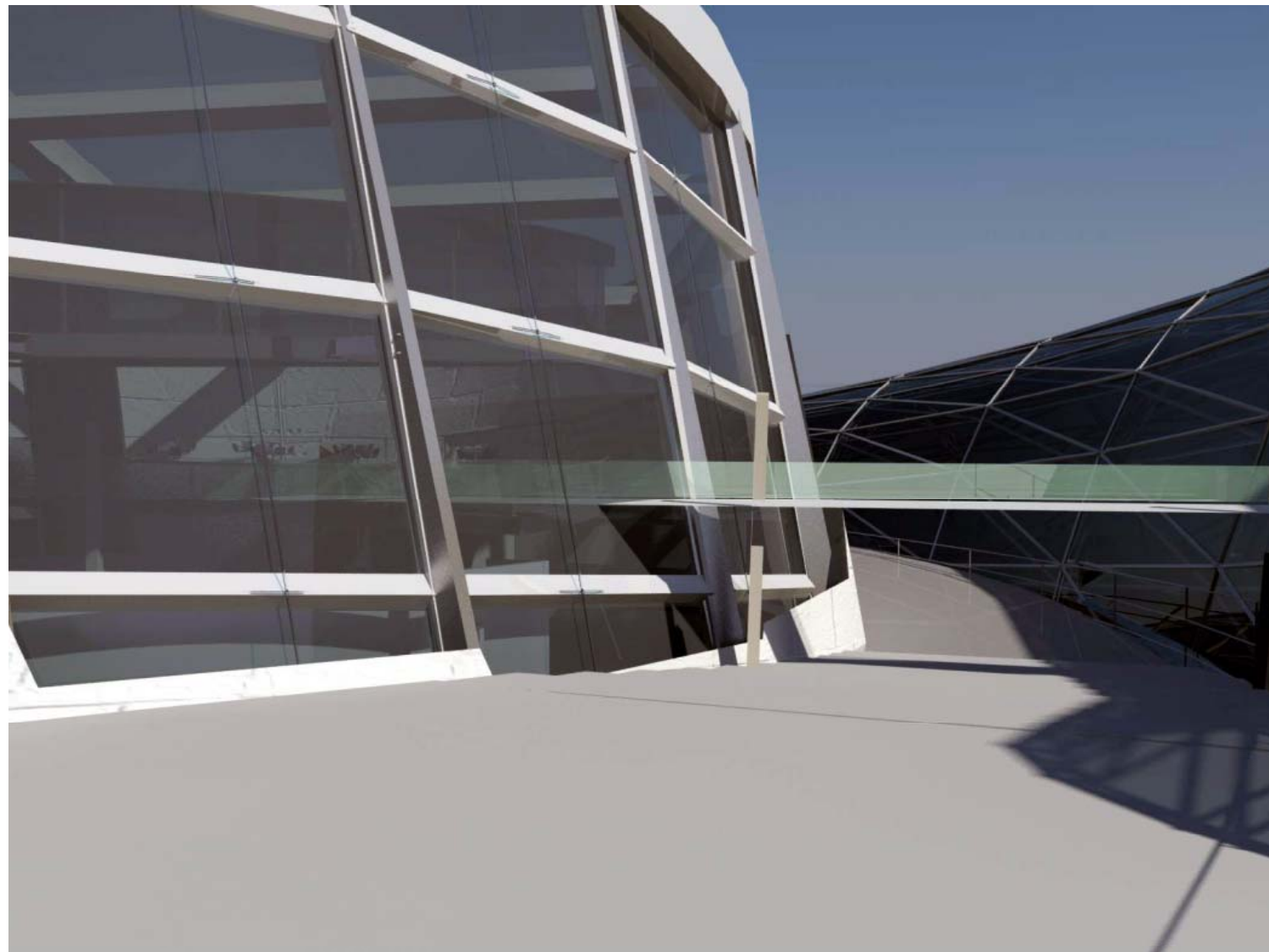


# **BUILDING/SITE JOURNEY**



## BUILDING/SITE JOURNEY

The journey starts on land where a part of the site is, the transition between water and land at the entrance platform. The tilted cylinder shape of the main entrance volume solicits for sky connection. The underwater exhibition space is connected to the sky where the visitor spends a moment of recognition between water and sky.



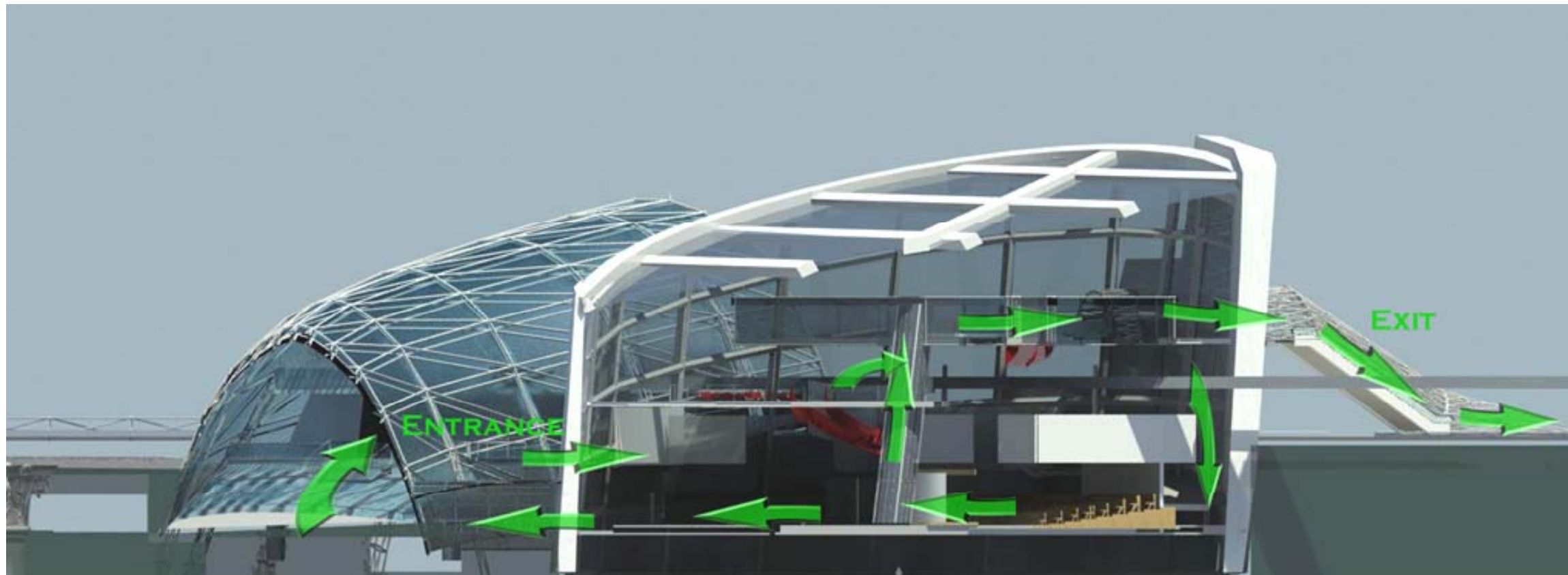
# BUILDING/SITE JOURNEY

## The anticipated building tour:

The main entrance through a series of large stairs that take us under the first floor pedestrian bridge that connects the museum with the library. The stairs arrive at a large floating platform where the main entrance of the cylinder volume is located. The ground/entrance floor includes reception and tickets area with the main exhibition rooms, on this floor comes a circulation ramp, that gives us the choice to go up to the first floor or down to the underground floor; where a large auditorium is confronted by large stairs used for scheduled shows or simply watching the holograms screens. This lobby area leads to the underwater tunnels, through the tunnels we arrive to the main submerged glass building. Here comes an open view to some unique monumental pieces, the glass submerged building has a wide view on the harbor seabed where the important ruins and monuments are located. The building has a double height with a mezzanine floor to allow a full view of the large pieces.

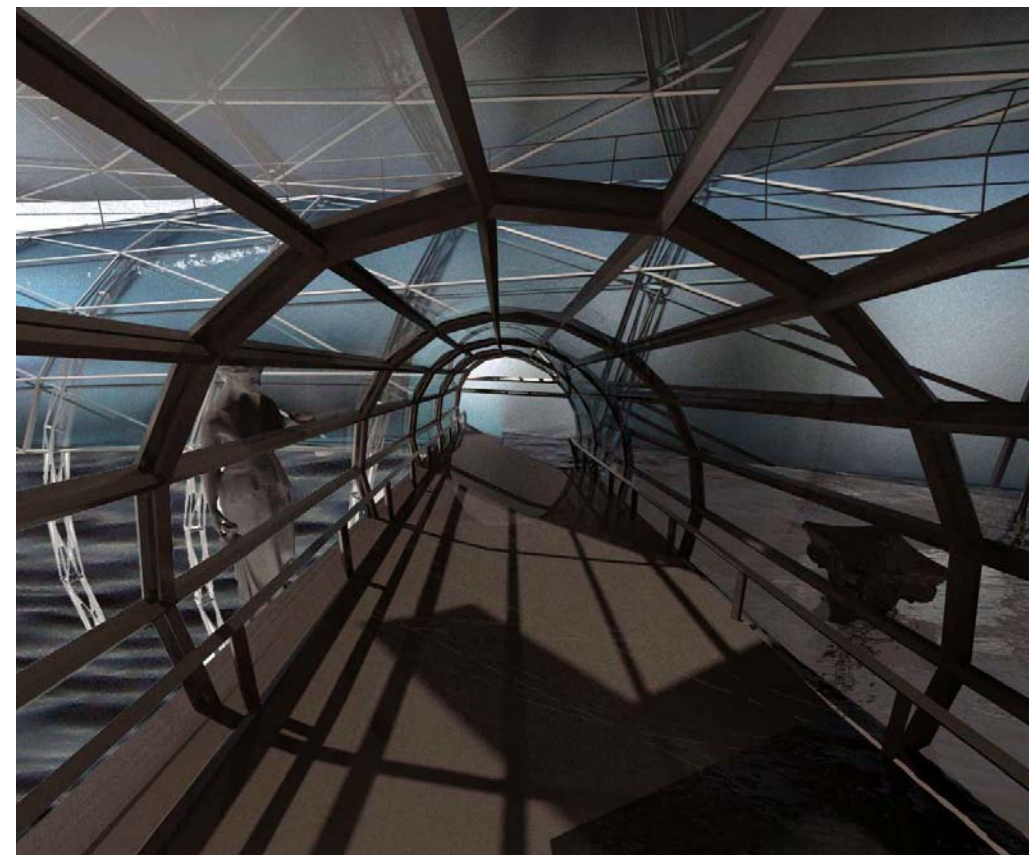
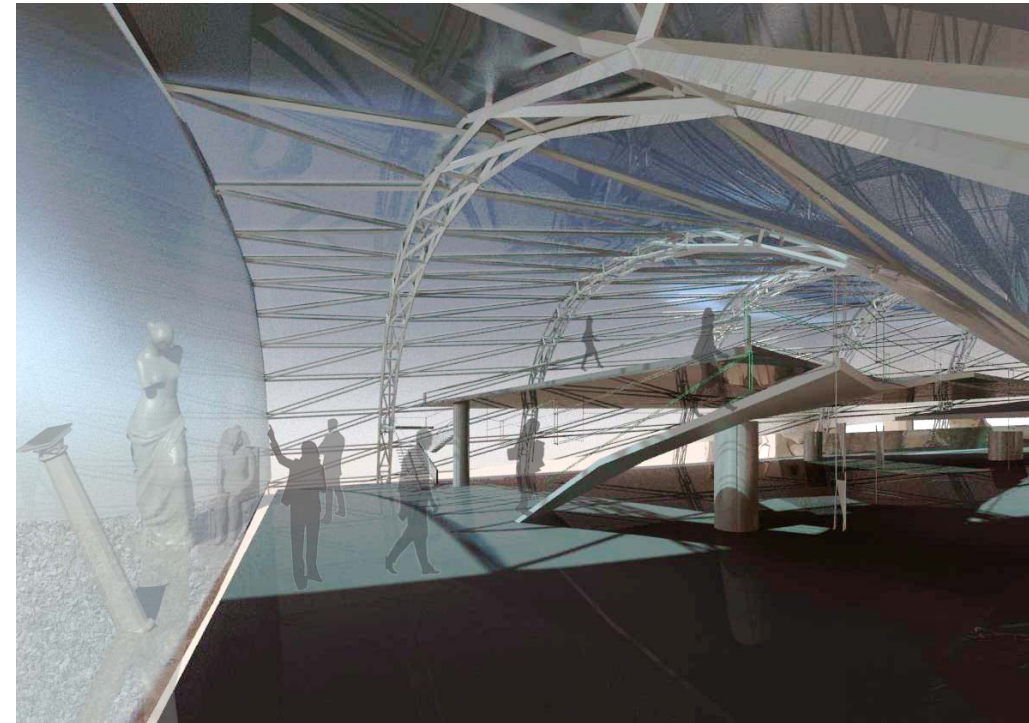
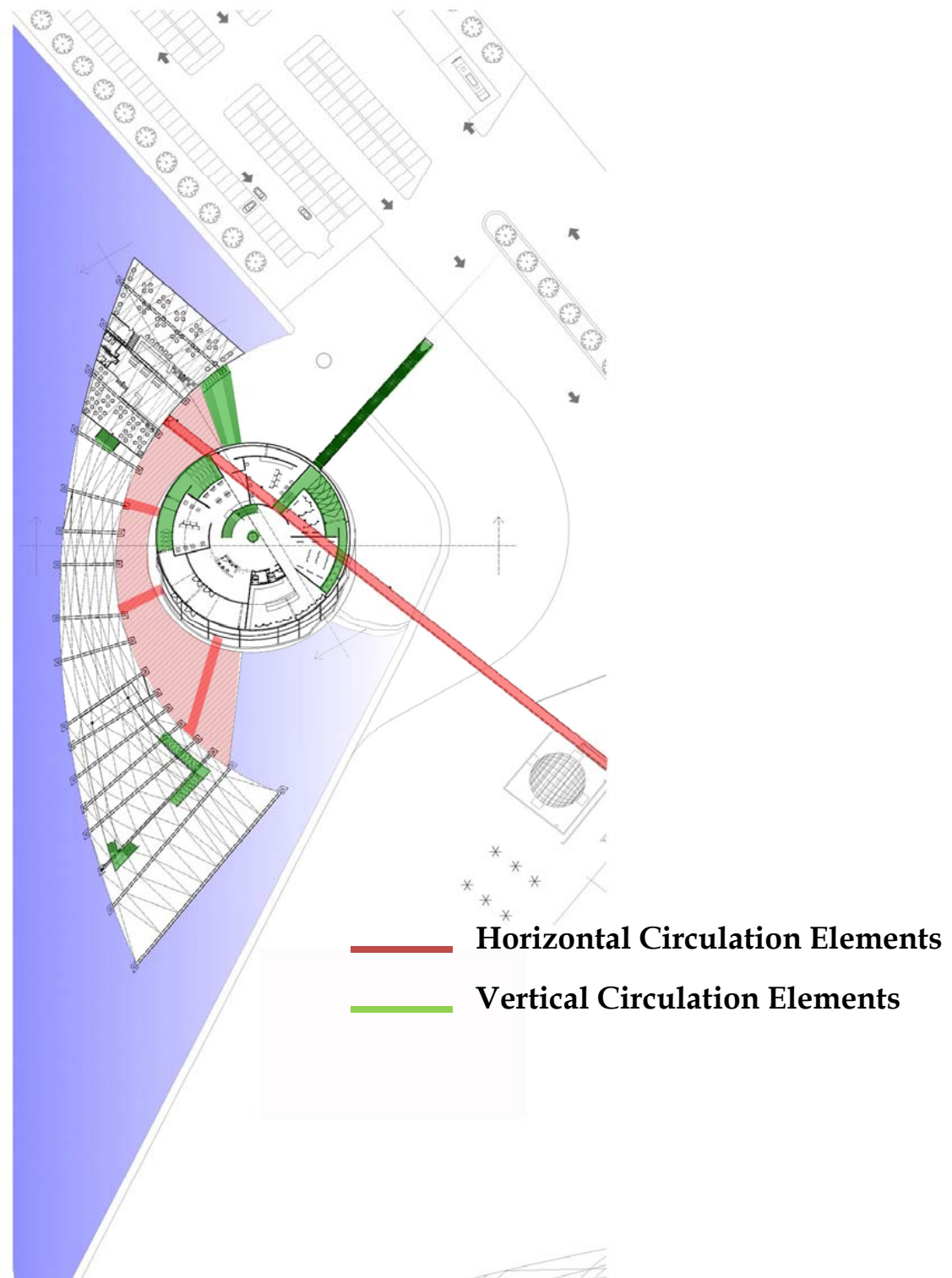
Back to the cylinder volume, on the first floor is located a mezzanine large cafeteria that opens to the main entrance lobby. This floor is considered as a break in the Journey. It's the point of connection between all complex volumes. The pedestrian bridge coming from the library crosses over the first floor to arrive at the amphitheatre on the first floor.

On the second floor is located another series of exhibition spaces that end with an escalator which takes us to the final phase of the Journey to the outdoor exhibition space where the Journey ends outside the building and finally an outdoor Cafe.

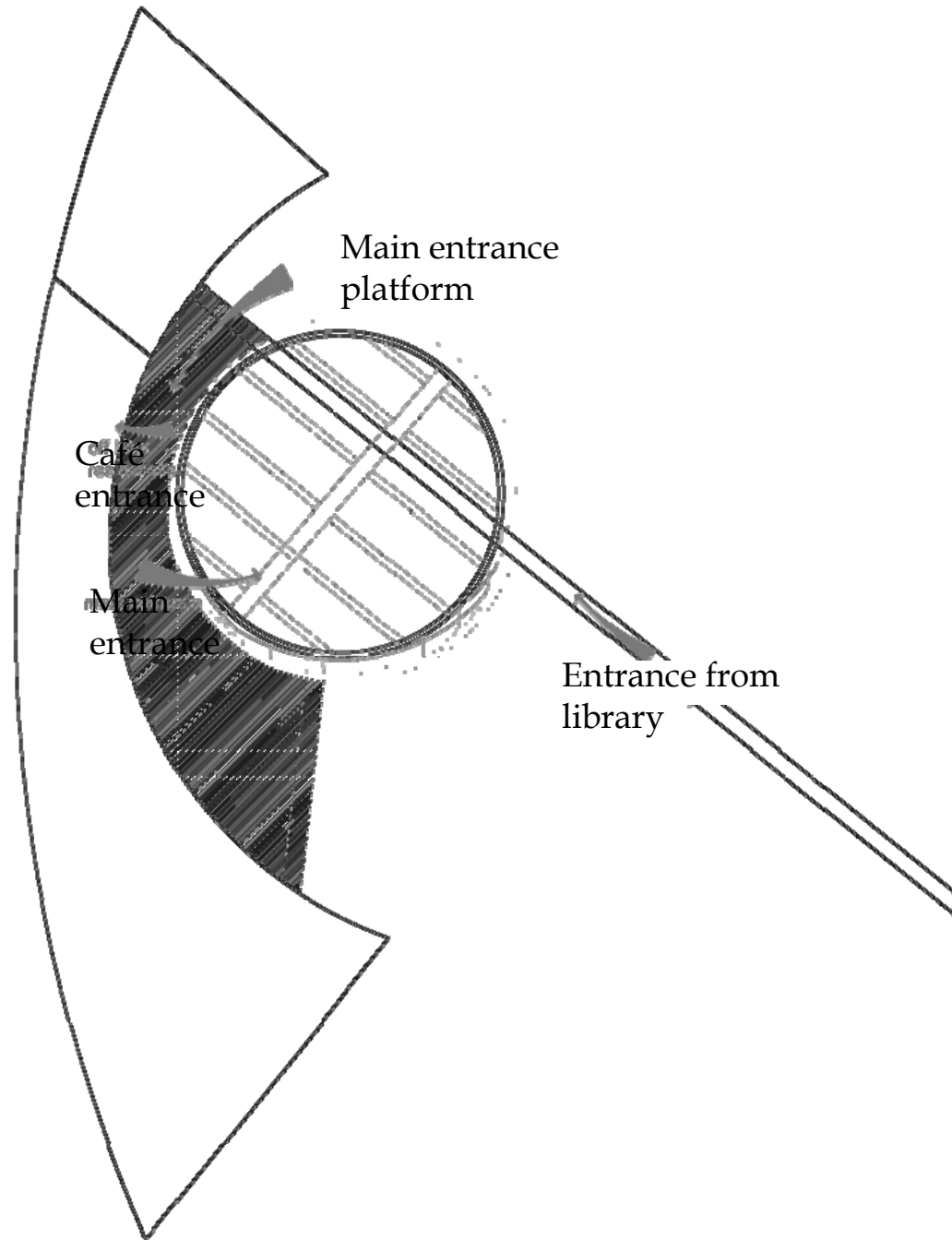


# BUILDING/SITE JOURNEY

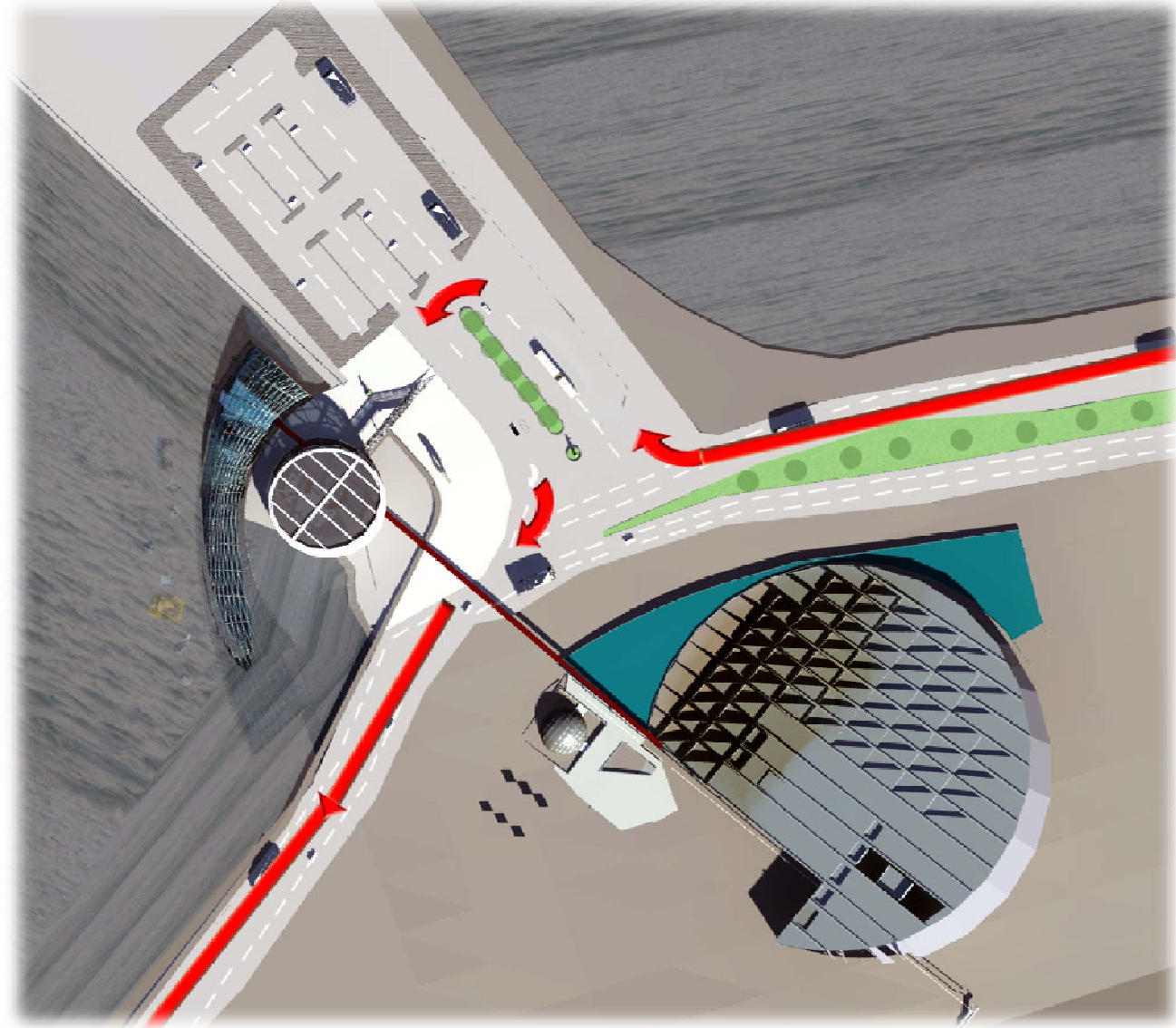
The relationship between the three elements (land, sky and water) and their exploration, is achieved by the various horizontal and vertical circulation elements expressed in ( staircases, elevators, escalators, bridges, tunnels, and ramps )



# BUILDING/SITE JOURNEY



**Pedestrian Circulation**



**Cars Circulation**



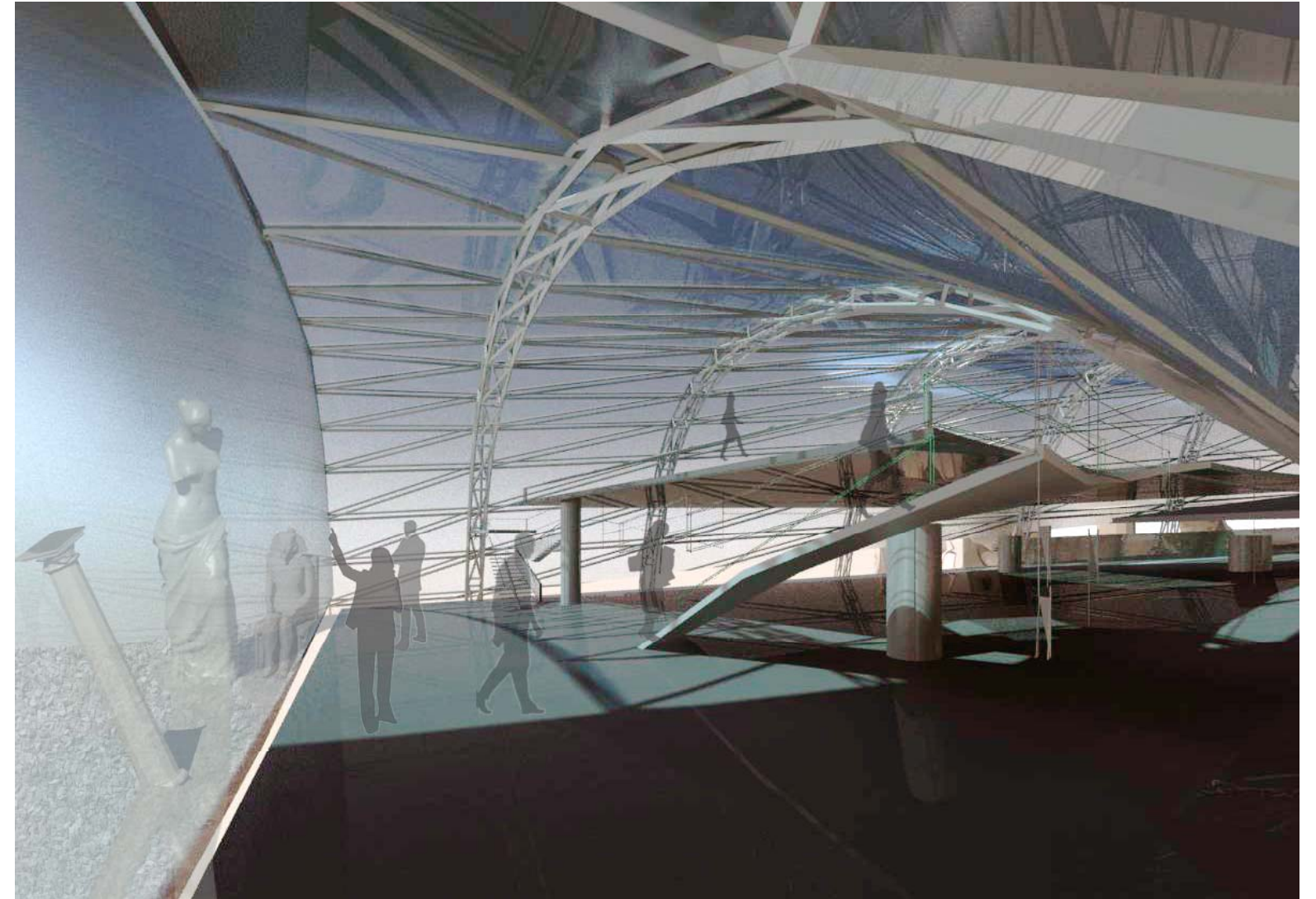
# LIGHTING JOURNEY

# LIGHTING JOURNEY

Main other elements studied in the project are the lighting conditions in several spaces and how daylighting can be used inside the exhibition rooms and underwater parts of the building and how it could be controlled to prevent weak lighting on monuments or glare inside the building.



Lighting condition at the main entrance (daytime)

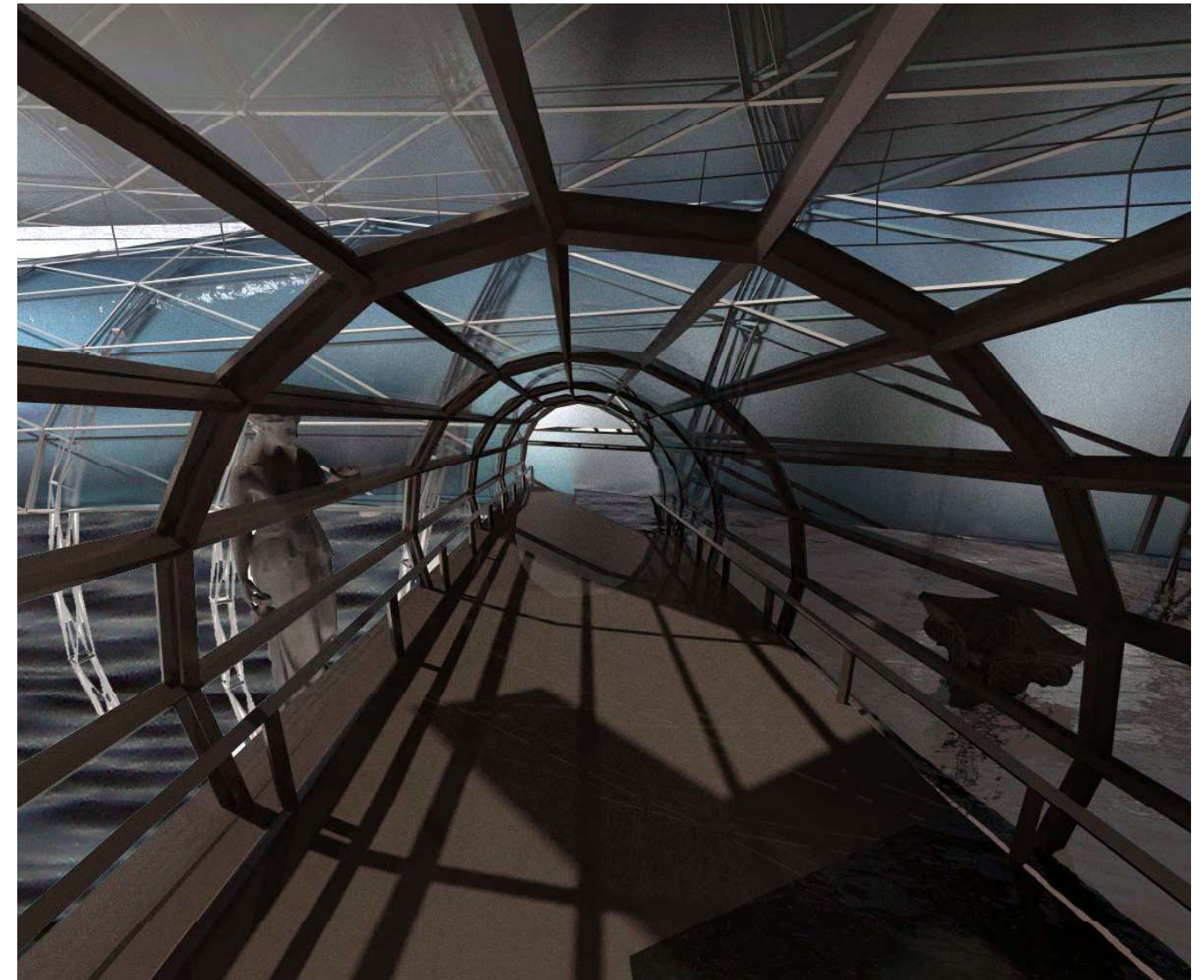


Lighting condition at the underwater exhibition (daytime)

# LIGHTING JOURNEY



Lighting condition at first floor cafe



Lighting condition at the underwater tunnel



# STRUCTURAL ELEMENTS/DETAILS



# STRUCTURAL ELEMENTS/DETAILS

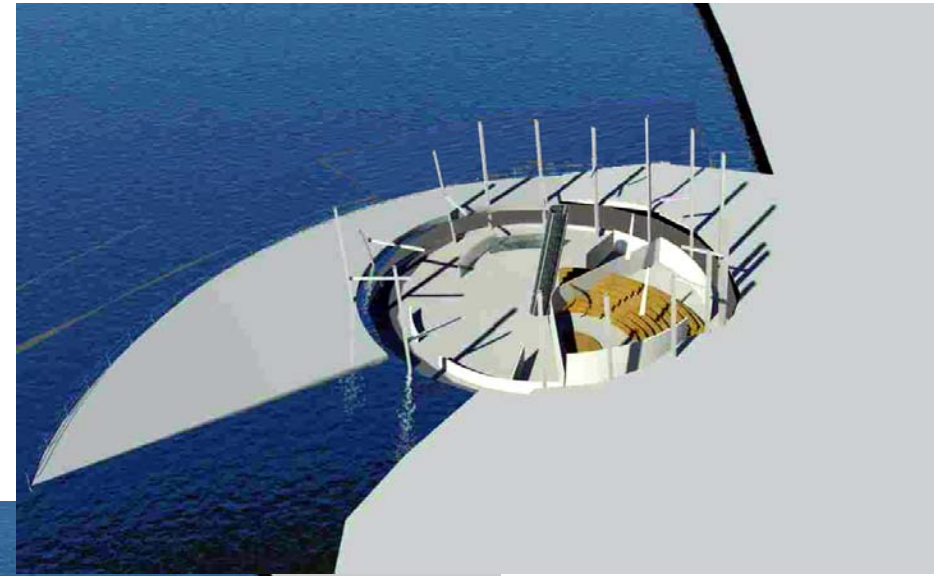
## Main Cylinder Structure

The main Cylinder structure consists of an array of steel columns that project along the cylinder perimeter, that hold the main wall and the curtain wall and project down under the water to carry the building loads down to the seabed.

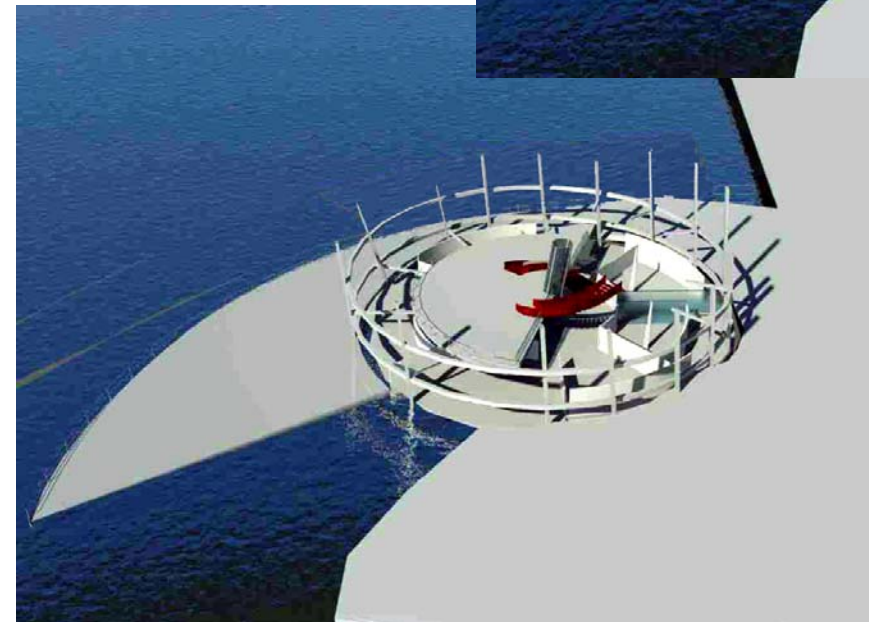
A series of rings assuring the placement of the columns holds the cylinder perimeter on each floor. An array of primary and secondary I Beams project out from each ring work with the central staircase wall to hold the floor slab.



cylinder structure



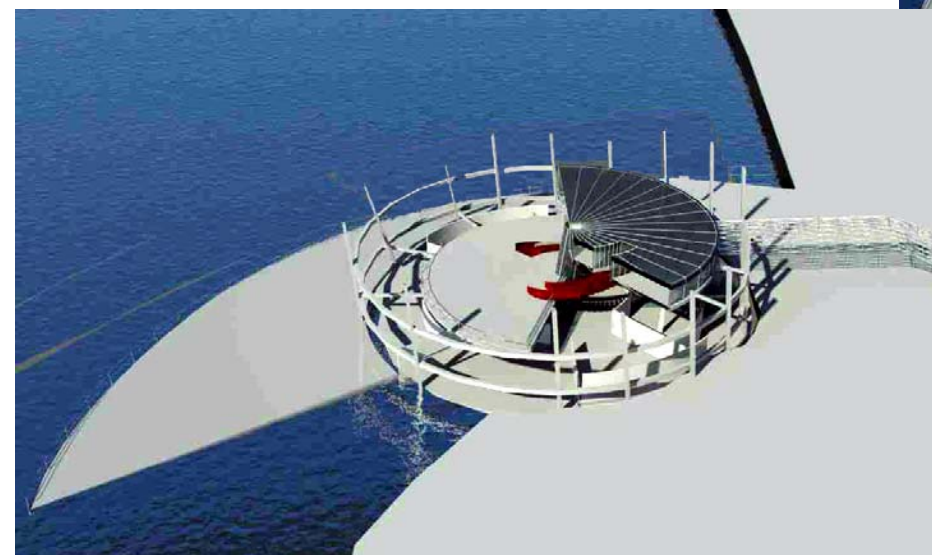
Underground floor structure



Ground floor structure

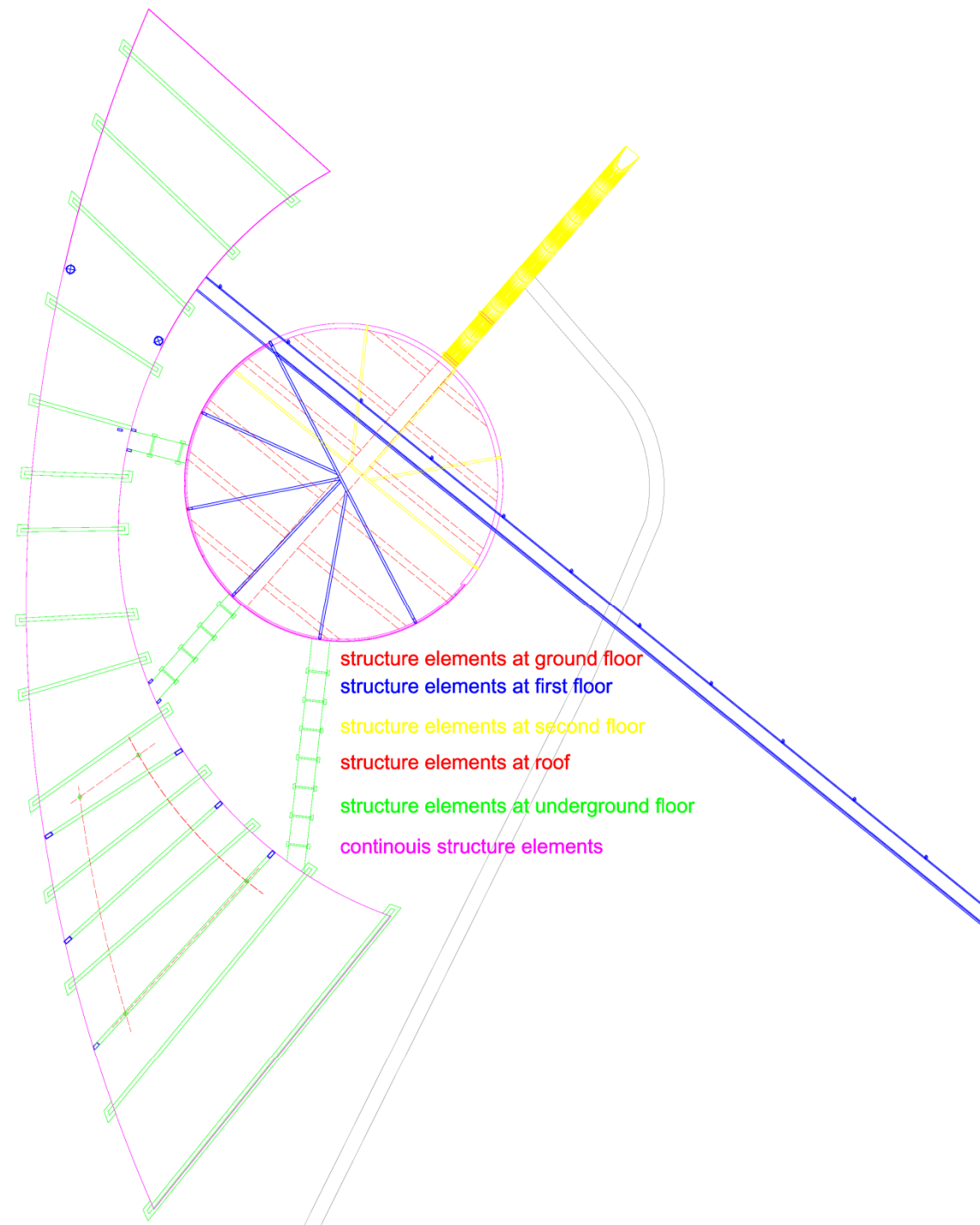


First floor structure

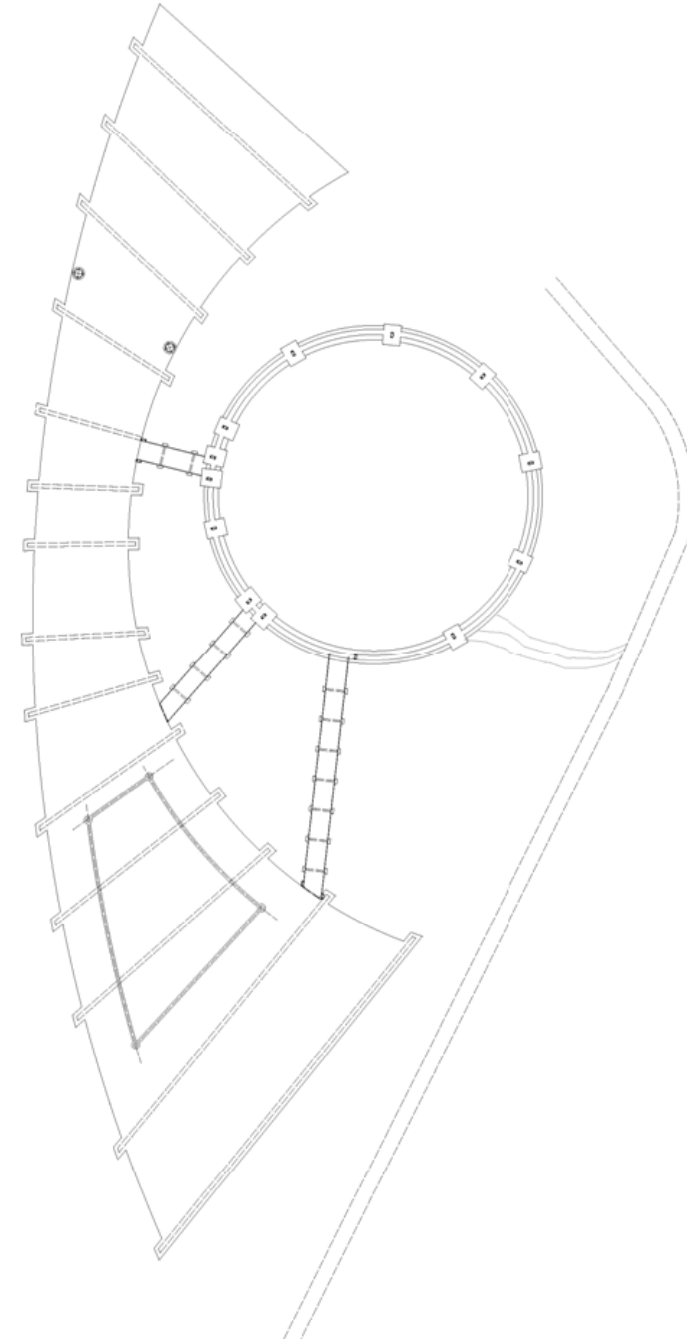


Second floor structure

# STRUCTURAL ELEMENTS/DETAILS



**floors structure elements diagram**



**Footing diagram**

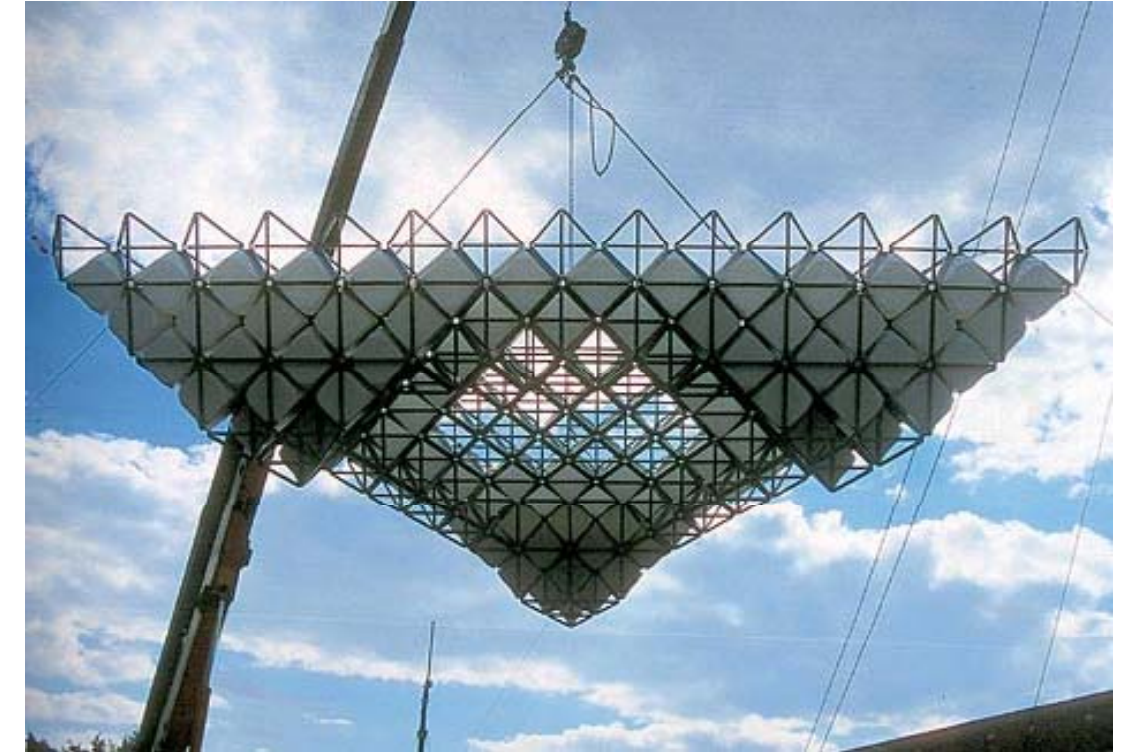
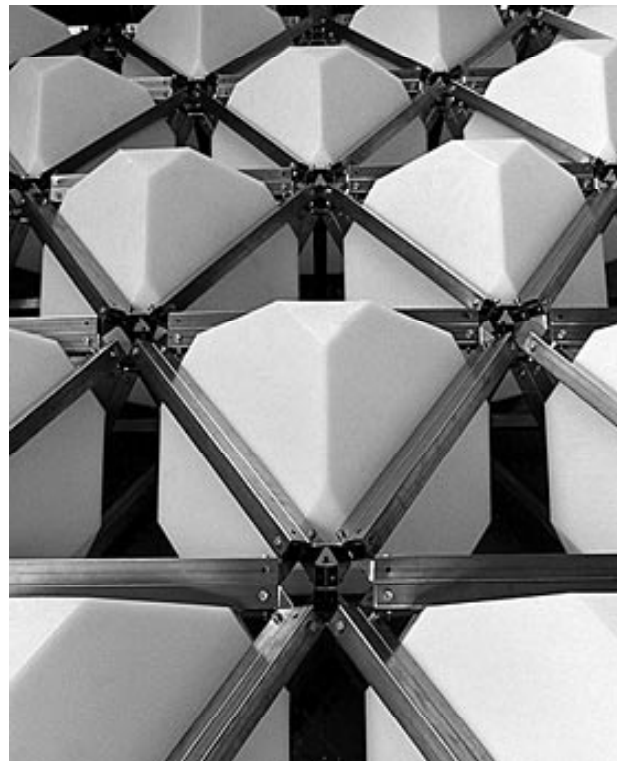
# STRUCTURAL ELEMENTS/DETAILS

## Entrance Platform

### Construction Idea:

The platform is constructed as an "octet truss" space lattice and is shaped as an equilateral triangle. Polyethylene tanks make the platform buoyant.

The tanks are built into tetrahedra of stainless, acid-resistant steel, which are assembled into a space lattice. The buoyancy of the tanks is reduced at low temperatures because they are made of flexible material (the area weather is quite stable so no major changes happening). They are concentrated in each corner of the platform. The pontoons are constructed from 3 layers of tanks and are shaped as tetrahedra with one vertex pointing downwards and a plane facing upwards *Ref [9]*.



Platform structure

# STRUCTURAL ELEMENTS/DETAILS

## Entrance Platform

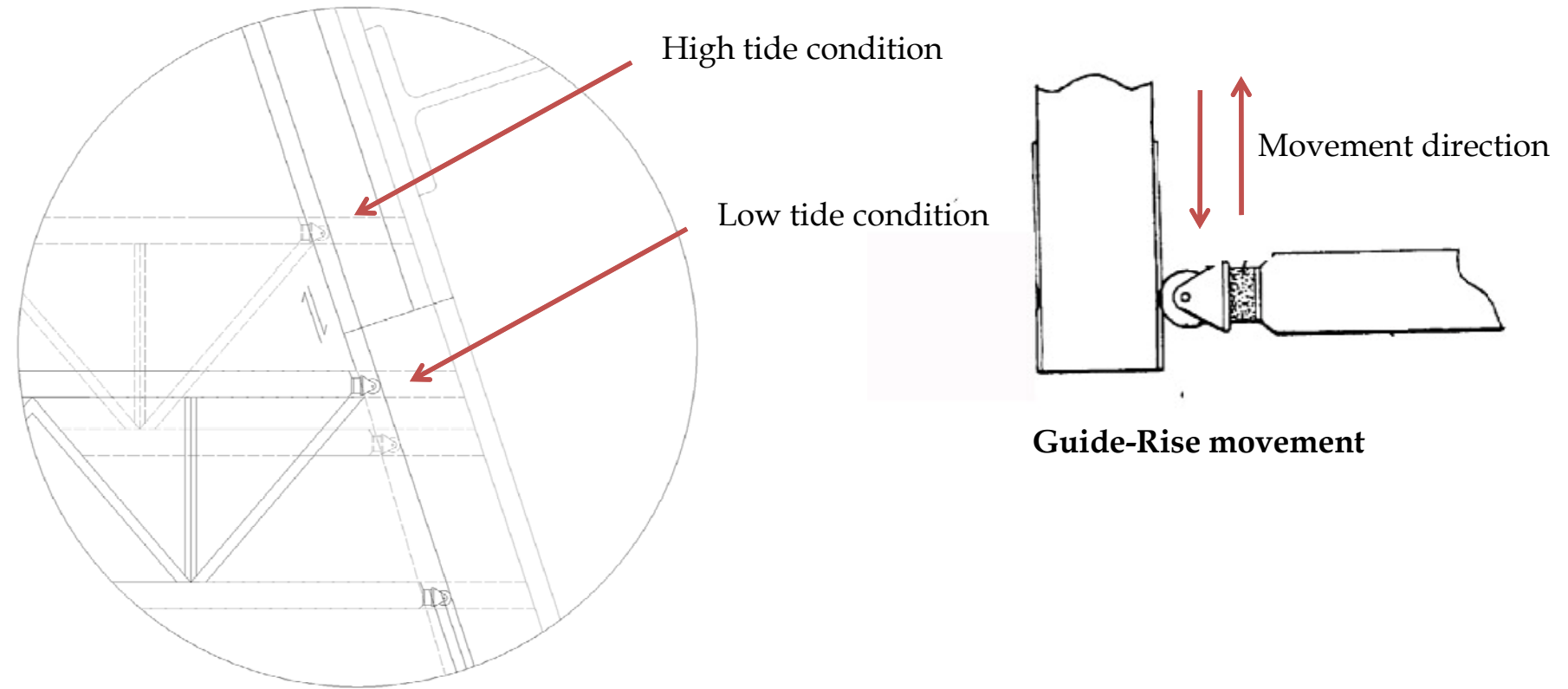
### Platform Movement

The platform movement consists of 2 major elements:

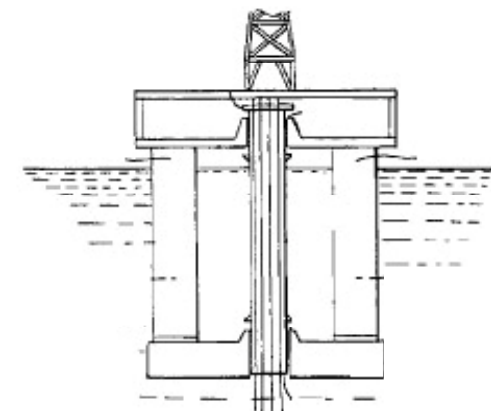
Riser: which is located on the platform itself, it's role is to rise and lower the platform in a vertical motion according to the water level.

Guide: which is located on the building. It works as a fixed vertical path for the riser.

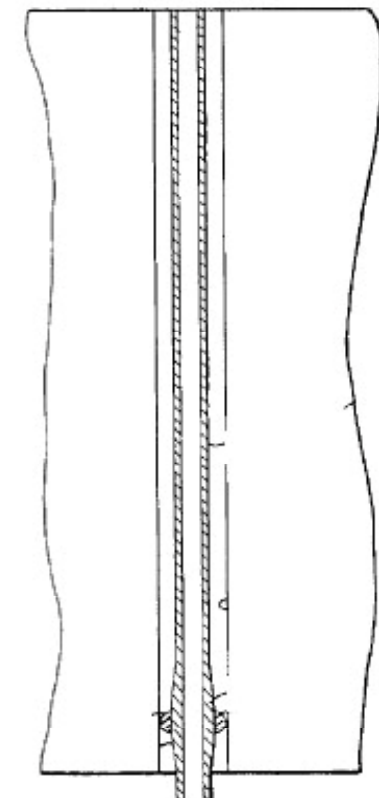
Both the guide and the riser work together in a motion similar to railways in different tide conditions to keep the platform in a horizontal stable condition.



Platform kinetic diagram



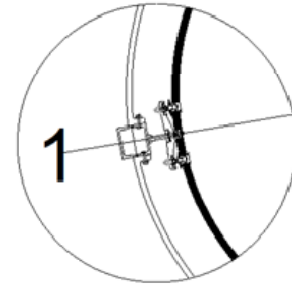
Guide side View



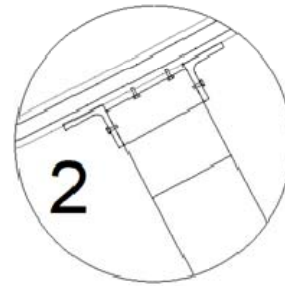
Guide elevation

# STRUCTURAL ELEMENTS/DETAILS

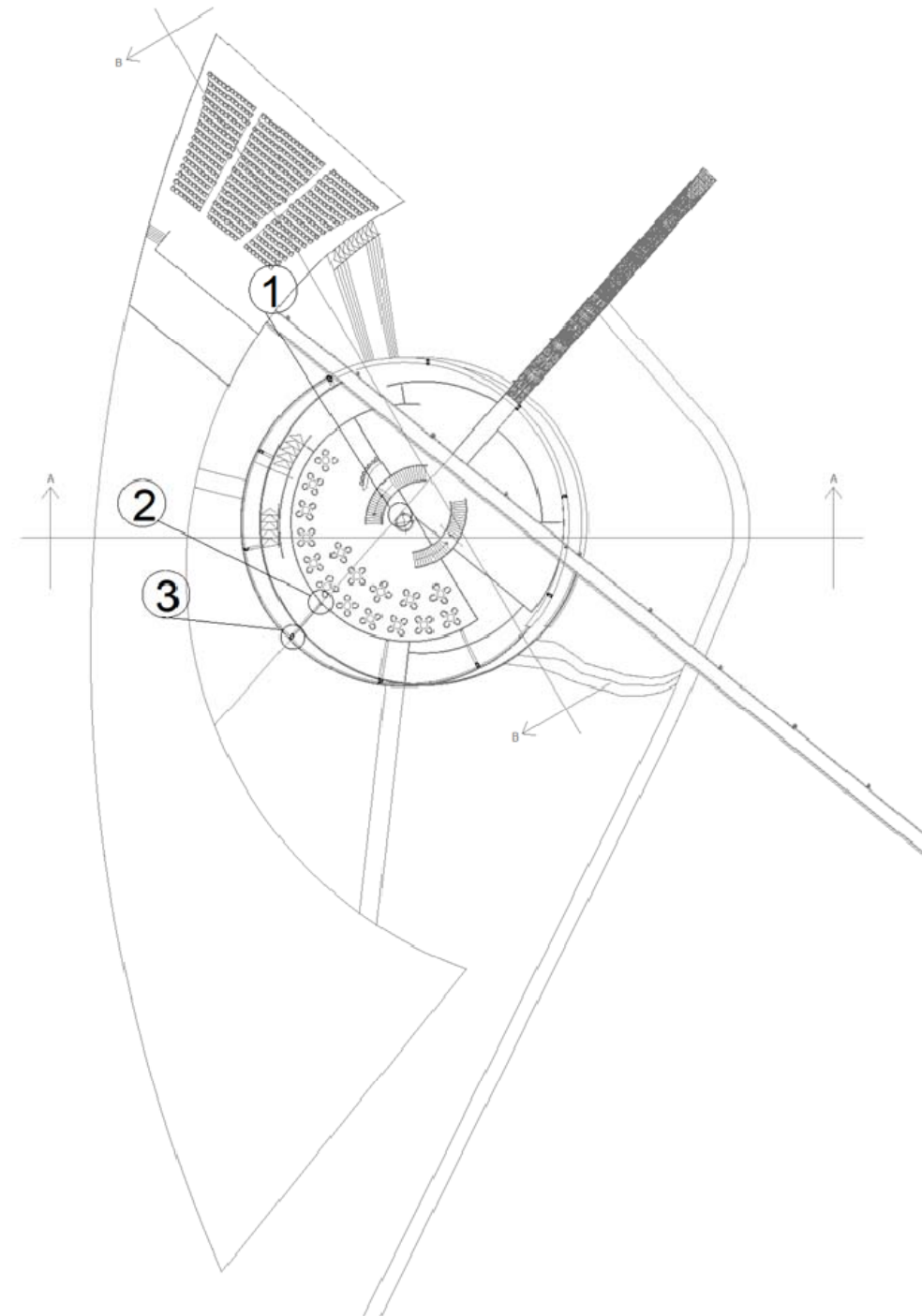
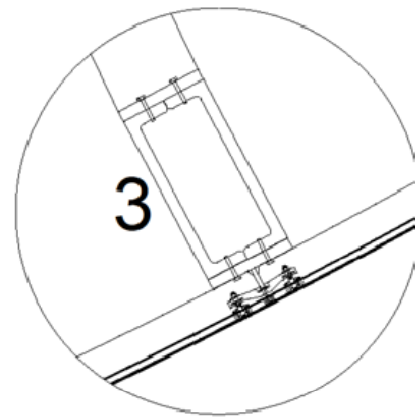
Elevator glass and structure detail



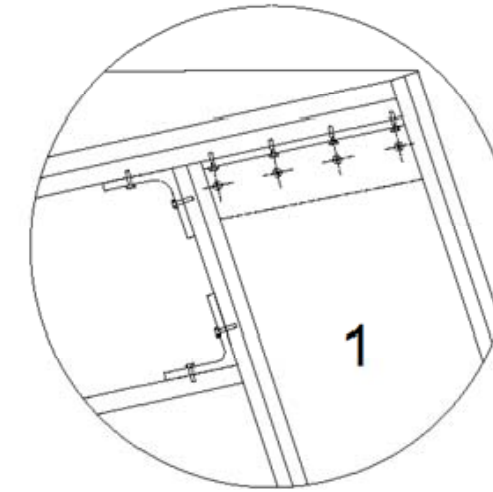
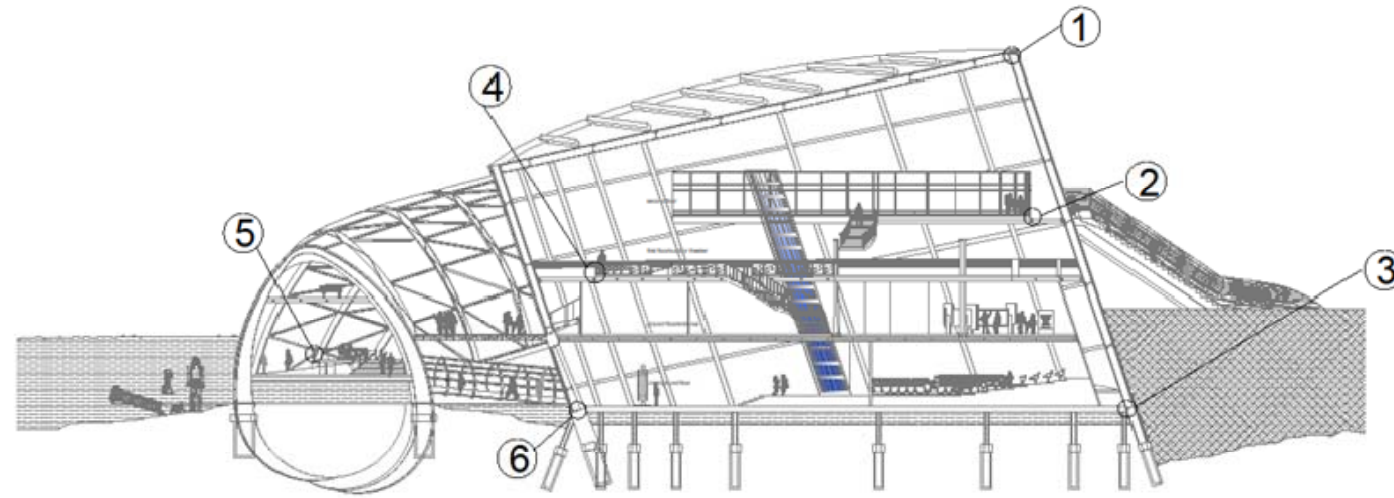
Primary to secondary beam connection detail



Curtain wall detail

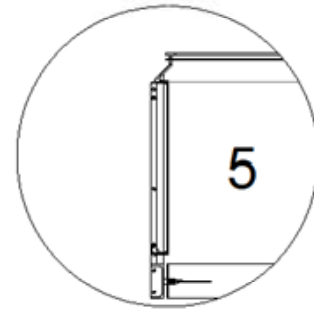


# STRUCTURAL ELEMENTS/DETAILS

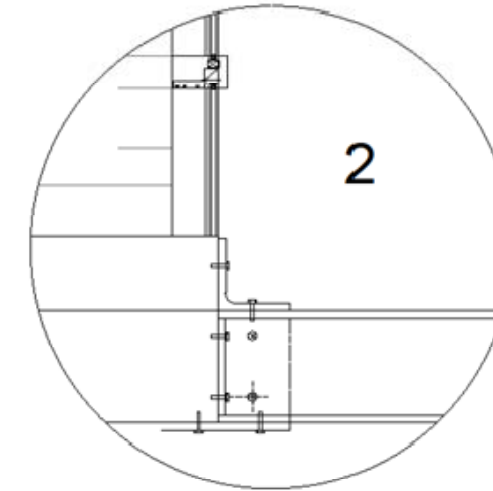


Column-roof detail

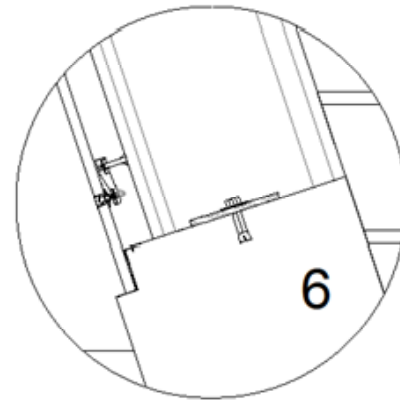
Handrail detail



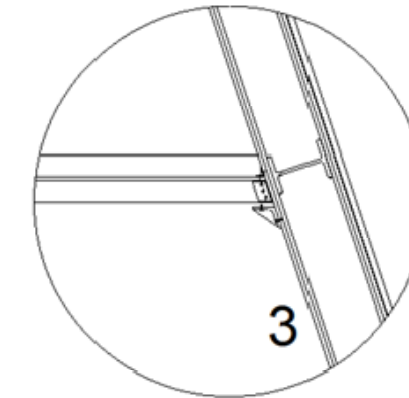
Glass wall and Beams connection detail



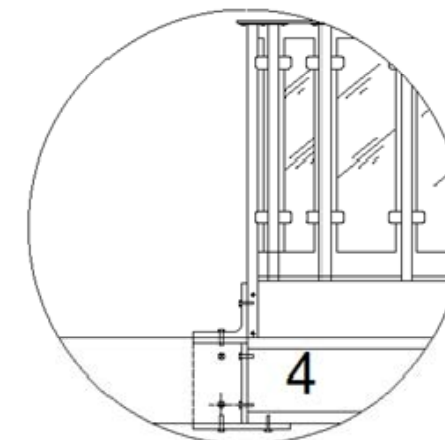
Curtain wall base detail



Slab-column detail



Slab-Beam detail



# STRUCTURAL ELEMENTS/DETAILS

## Daylighting Elements

### 1-Photochromic Glass:

Lighting behavior on the water surface during different times of the day and year depend on the lighting angle. While taking these in consideration Photochromic Glass is used in the building, since it automatically controls the amount of light projected to the inside of the building depending on the amount of light received by the glass as follows:

#### a) Strong light source:

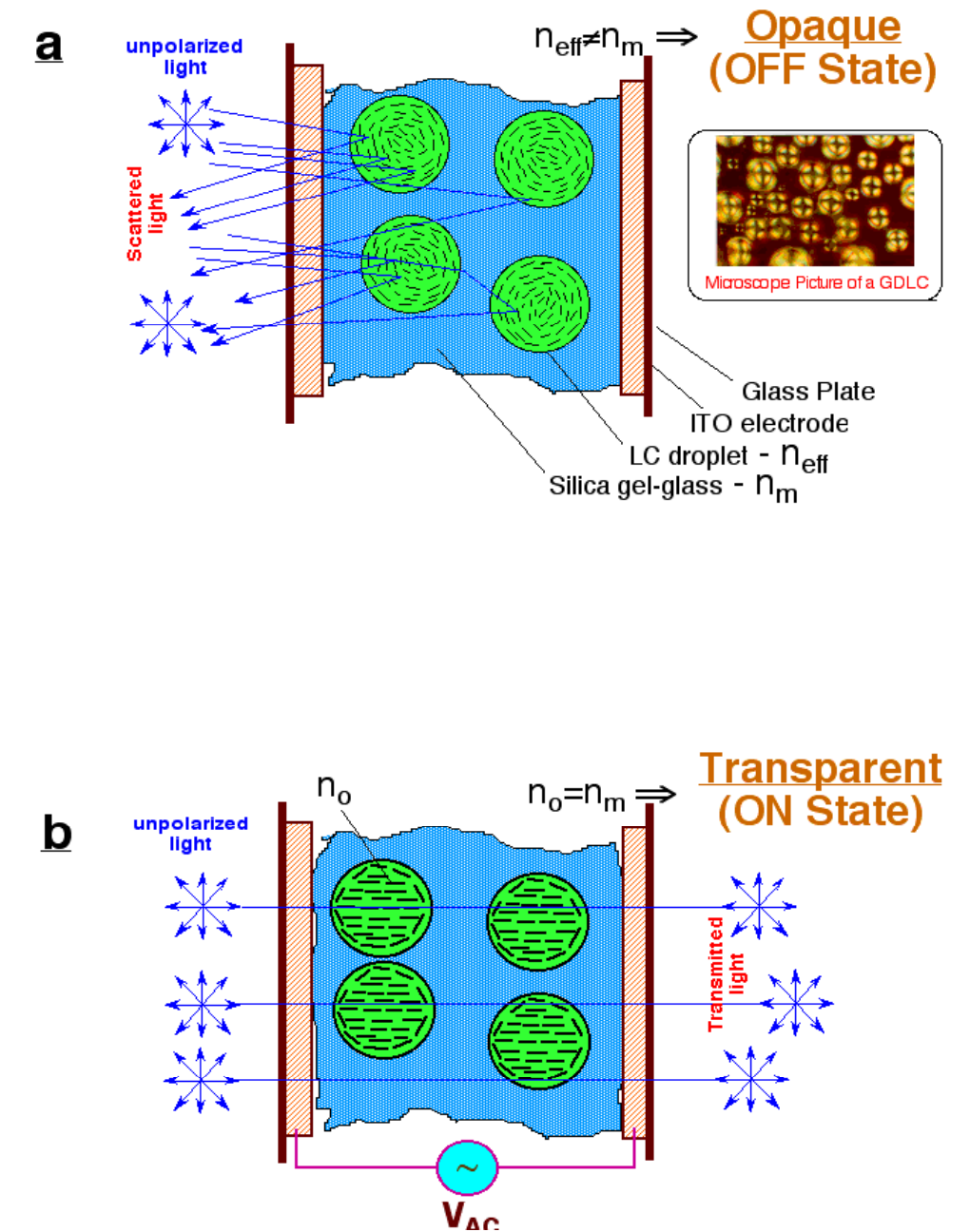
In diagram a the structure of the sub-microscopic particles of silver-halide that are affected by intense light are in a miss-aligned state. In this state, the transmitted light is deflected and the Photochromic glass would appear to darken (opaque).

#### b) Weak light source:

In diagram b the structure of the sub-microscopic particles of silver-halide that are affected by a less intense light source are in an aligned state. In this state, light is allowed to transmit past the sub-microscopic particles of silver-halide and the Photochromic glass would appear transparent *Ref [10]*.

### Sol-Gel GDLC Thin-Film Optical Shutter

(GDLC - Gel glass Dispersed Liquid Crystal)



# STRUCTURAL ELEMENTS/DETAILS

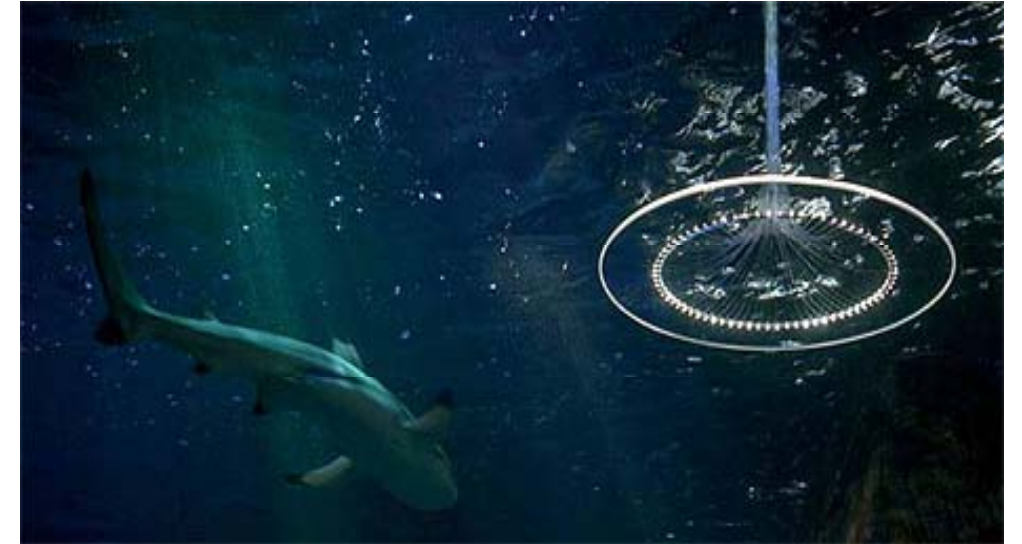
## Daylighting Elements

### 2-Fiber Optics :

Optical fibers are used to route sunlight from the roof to other parts of the building, thus maximizing the amount of energy applied to the target (the sun). They also help control the distribution of light.

#### a) Closed loop systems:

Track the sun by relying on a set of lenses or sensors with a limited field of view, directed at the sun, and are fully illuminated by sunlight at all times. As the sun moves, it begins to shade one or more sensors, which the system detects and activates motors or actuators to move the device back into a position where all sensors are once again equally illuminated. This type is used to bring light to the underwater monuments.



#### b) Open loop systems:

Track the sun without physically following the sun via sensors. These systems typically employ electronic logic which controls device motors or actuators to follow the sun based on a mathematical formula. pre-programmed sun path chart, detailing where the sun will be at a given latitude and at a given date and time for each day. This type is used to light the underwater parts of the buildings *Ref [11&12]*.





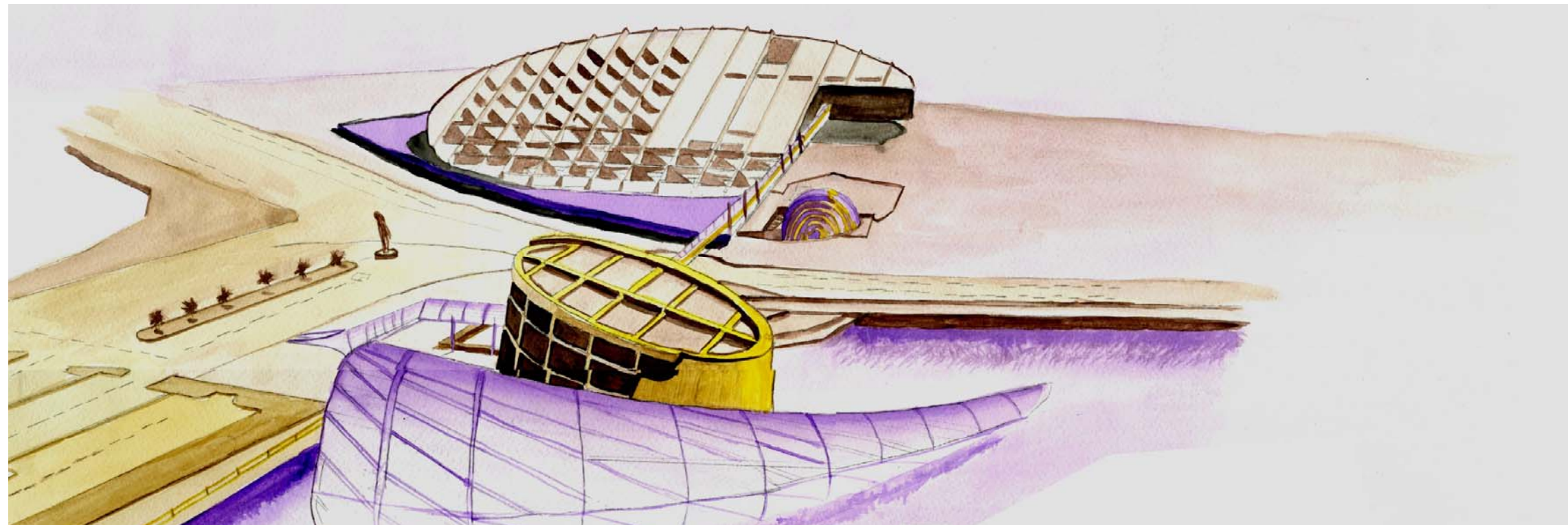


# CONCLUSION

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The proposed underwater museum is considered the first of its kind. The project is located on the magnificent coast of Alexandria, trying to solve the ambiguity of the Eastern Harbor. The monuments found in the harbor area have been the World's unsolved mystery for years. The closest neighbor to the proposed project is the famous Alexandria library which is one of the city's major symbols. All these conditions helped creating the project outlines including geometry, shape and proportions. Major design elements were taken from surroundings: nature elements (water, sky and land), geometry elements (The library) and the old Egyptian history (Ra God of the sun boats).

The proposed project is designed as a journey to discover the "Sunken City". The journey starts on land, continue on water surface level, through seabed level, then finally to the sunken ruins. The journey is to take the visitor gradually through these moments, where the presence of time starts to demolish and the sense of the history starts to built up.





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**All computer renderings, sketches and drawings are made by author.**