North Sea: Landscapes of Coexistence
Transitional Territories Studio 2018-2019

MSc4 Research Report

Junrui Liu

Recolonization of Offshore Platform

Abstract

This project is based on 2 issues, the degradation of the ecosystem in North Sea and the decommission of offshore platforms.

The ecosystem in the North Sea has degraded due to the resource demanding economic growth and intensive exploitation. A healthy ecosystem is important for human beings' health and stable climate environment.Also, To protect and restore the ecosystem of the North Sea, understanding the changing sea is quite important. According to Netherlands Institute of Ecology, ecology is the science of 21st century.According to NIOZ, there's a gap in the basic data of those non-commercial species in the North Sea. So, more relevant research is necessary.

Offshore platforms, which are symbols of the fossil fuel age, are expected to be decommissioned in the following decades in the North Sea. As symbols of fossil fuel age, they have heritage value. It is meaningful to adaptive reuse some of them. After being operated for several decades, the offshore platforms become artificial reef and have higher biodiversity than any other artificial structure. They also attract birds due to the food concentration. Although the current solution to deal with the decommissioned oil rigs is totally removal, there is a need to keep them and give some of them a new life due to their ecological value.

The offshore platform I am focusing on is the L10-A complex, the first offshore platform on Dutch continental Shelf. The gas field is going to stop producing in 2022, its future need to be considered. It is located in the Frisian Front area, which is both a bird reserve and an area with the highest biodiversity in terms of the total benthos.

This offshore platform has potential to support in-situ observation, analysis, and in-situ experimentation. It is also a perfect place to gather the basic data of some species due to the high bio-diversity in the area.

The proposal is transforming an offshore platform into a research center.Making the offshore platforms a place that supports the nature.

Key Words:Ecology, Offshore Platform, Decommission.

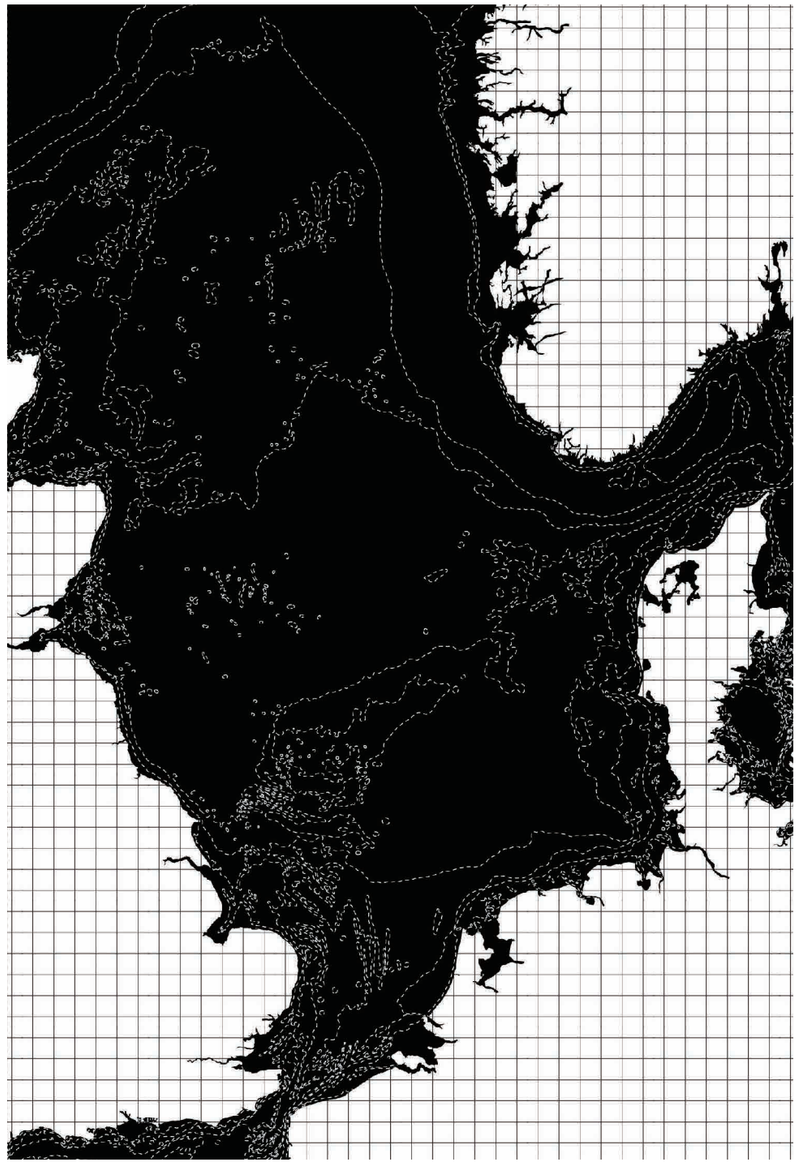
Territorial Analysis

1.1 Introduction of North Sea

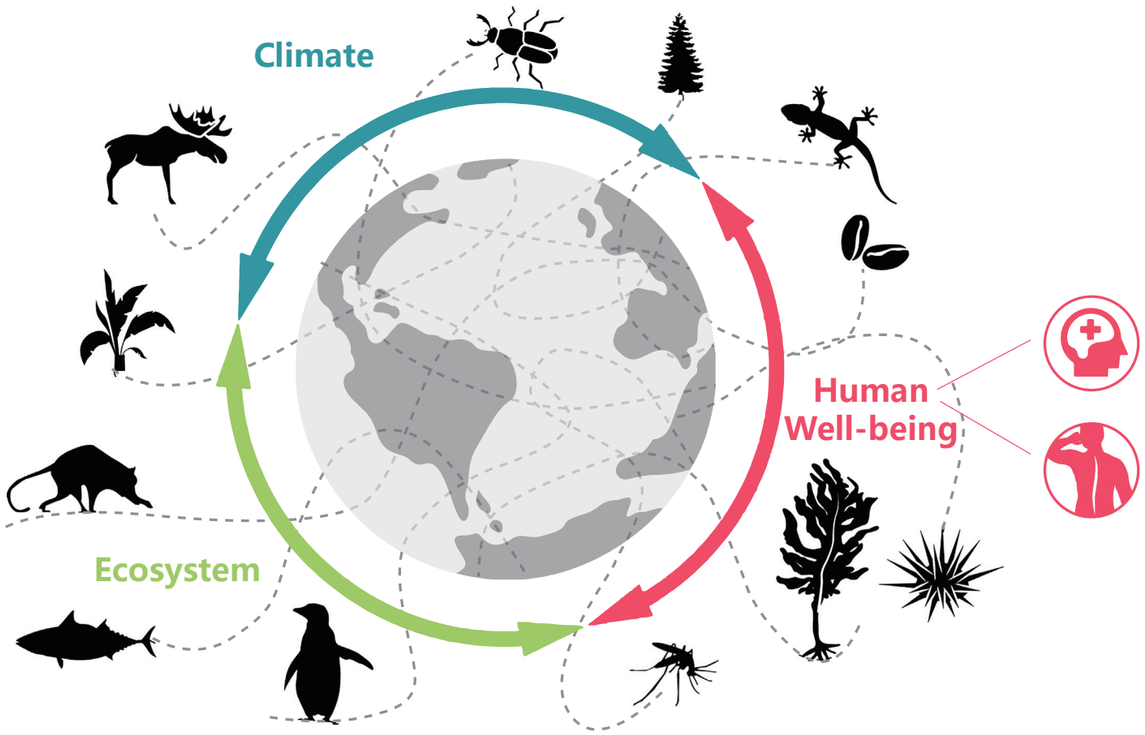
North Sea is a marginal sea of the Atlantic Ocean and is located between the UK , Denmark, Norway, Sweden, Germany, the Netherlands, Belgium and France. It is a shelf sea on the European continental shelf, it connects to the ocean through the English Channel in the south and the Norwegian Sea in the north. It is 970 kilometres long and 580 kilometres wide. The total area could be up to 570,000 square kilometers.

North Sea is an important site for fishing and shipping industry in the Europe. It is also frequently used for recreation and tourism. Recently, it has become a rich resource of energy like fossil fuels and green energy(wind, tide,wave).

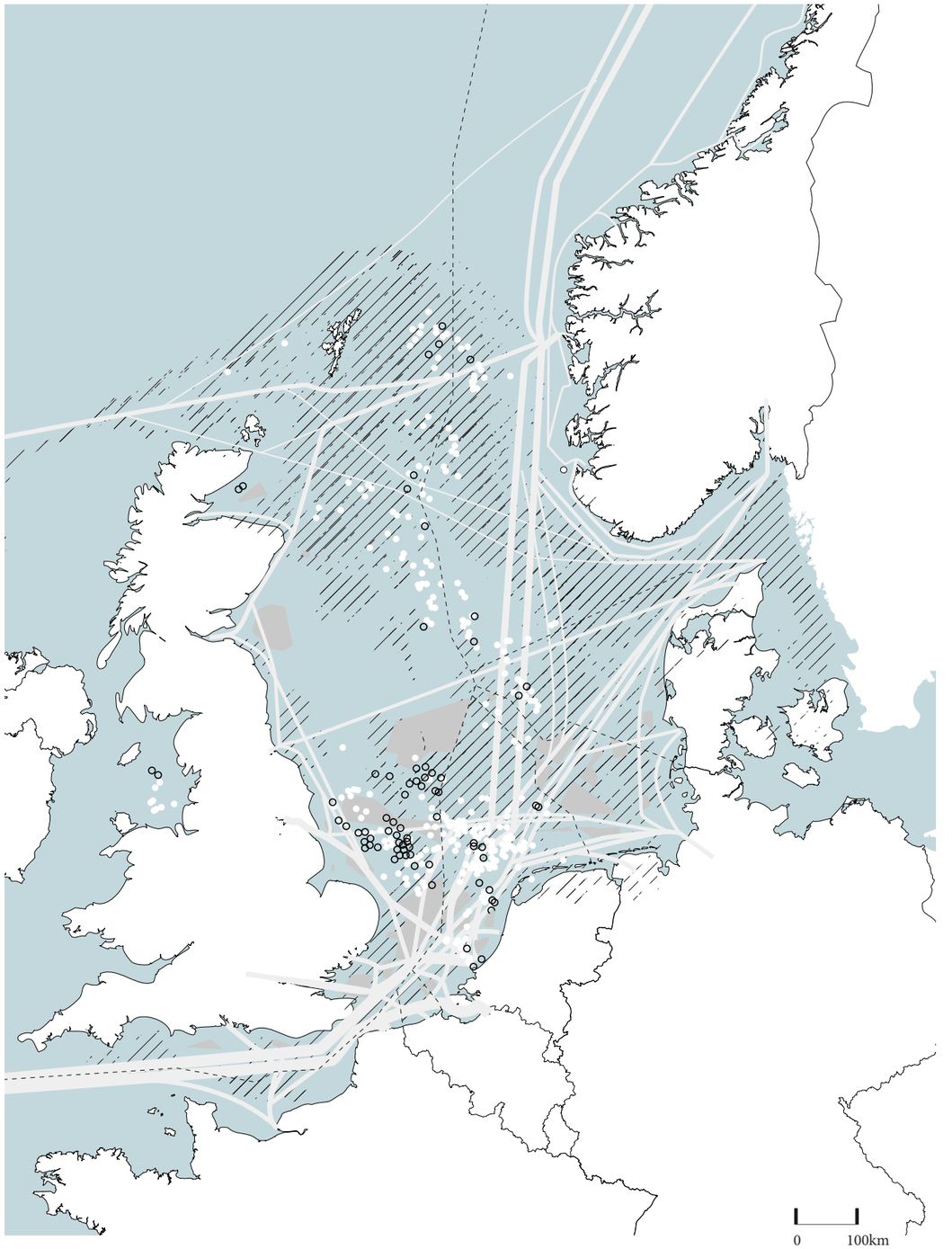
Throughout the history, the North Sea has been prominent in military affairs for a long time(especially in the World Wars). As for the geological aspects, in the north, deep fjords and sheer cliffs mark the Norwegian and Scottish coastlines, whereas in the south, the coast consists primarily of sandy beaches and wide mudflats. Due to the dense population, heavy industrialization, and intense use of the sea and area surrounding it, there have been various environmental issues affecting the sea's ecosystems.The ecosystem has already degraded



1.2 Ecology Analysis



A healthy ecosystem is quite enssential. Because it would contribute to a stable climate environment and the mental health as well as physical health of human beings.



North Sea is the busiest marine territory in the world. A huge amount of activities , such as shipping, oil and gas harvesting,fishing have already degraded the ecosystem.

Activities on the North Sea

Source: New Geographics

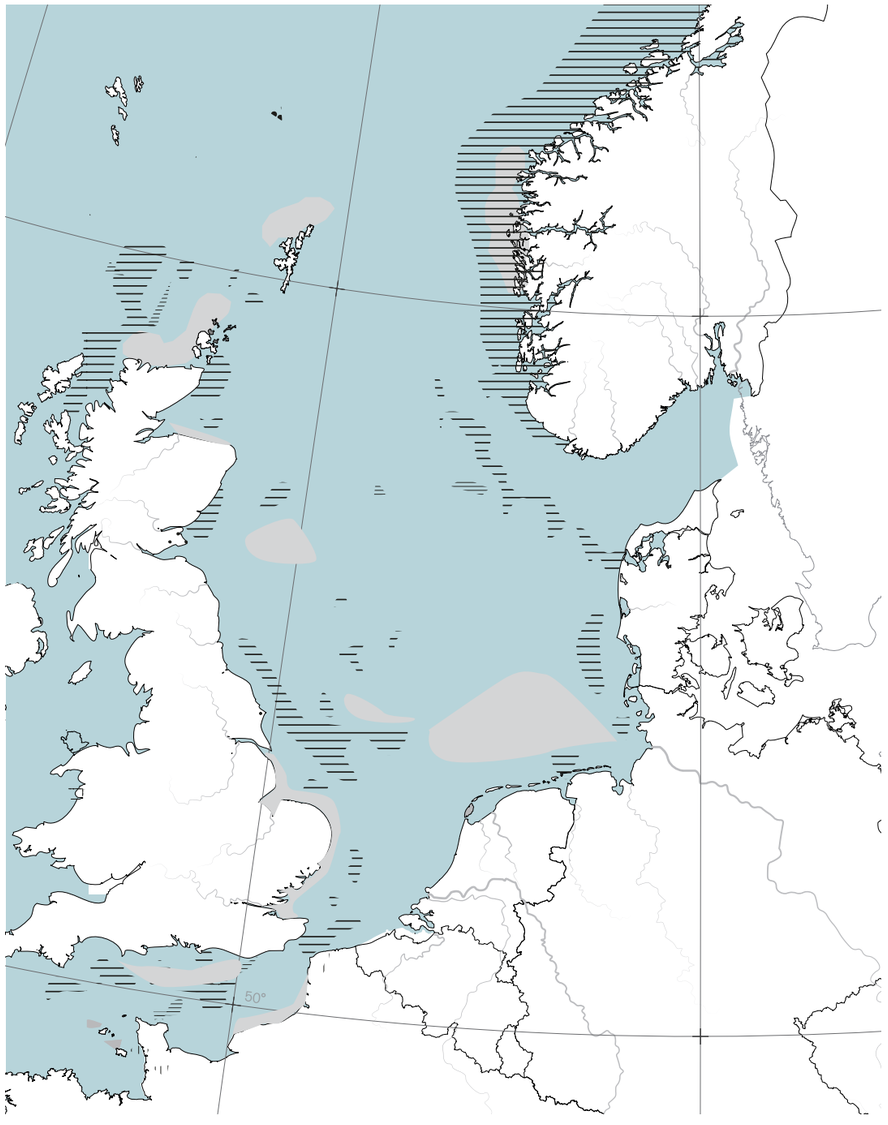
01 Highly Intensive Bottom Trawling Area
02 Wind Farm
03 Shipping Rounts
04 Decommissioned Offshore Platforms
05 Working Offshore Platforms

1.2 Ecology Analysis

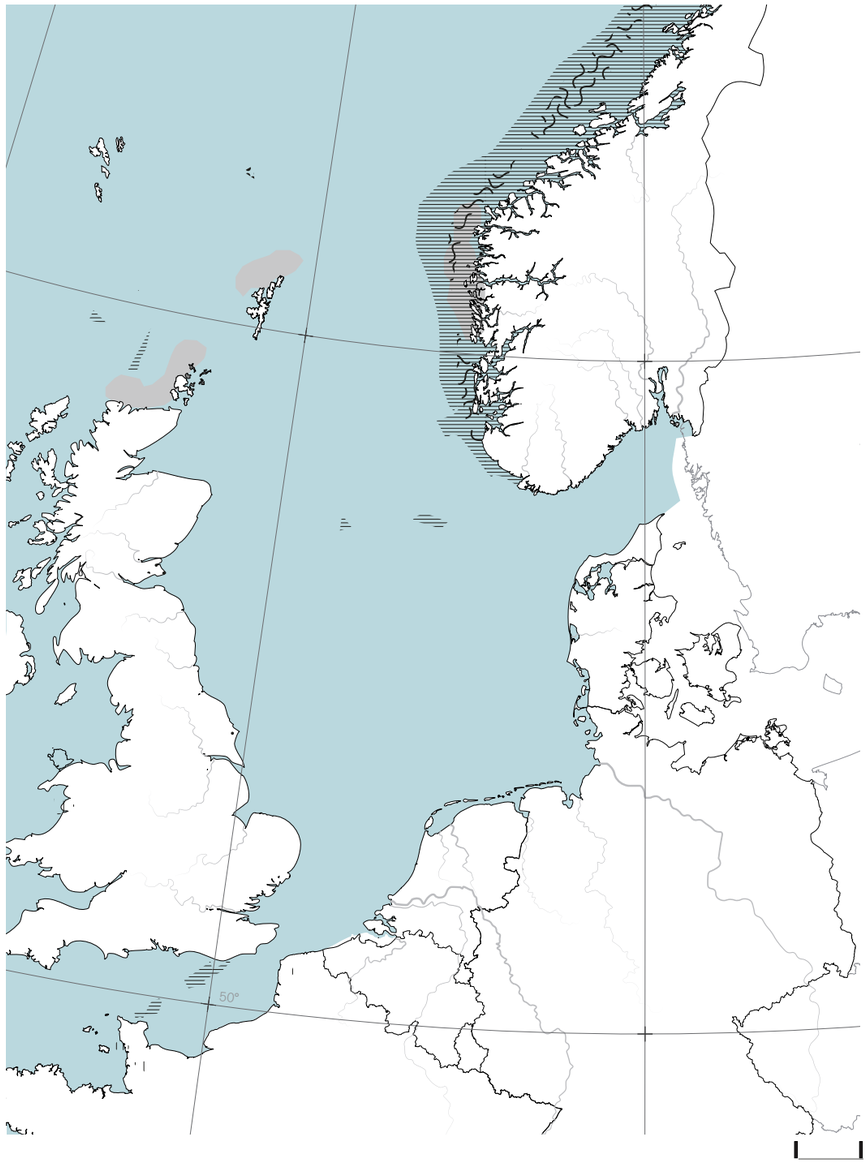
Comparison of the Hard Substrate in the North Sea

Hard Substrate is essential for underwater ecology. They provide place for creatures to attach, to hide and to hunt. A large part of the North Sea was covered with rocks and oyster/mussel reefs. They were helping the ecosystem to flourish. However, due to the bottom trawling in the fishing industry, the sea bed is nearly cleaned up now.

1883



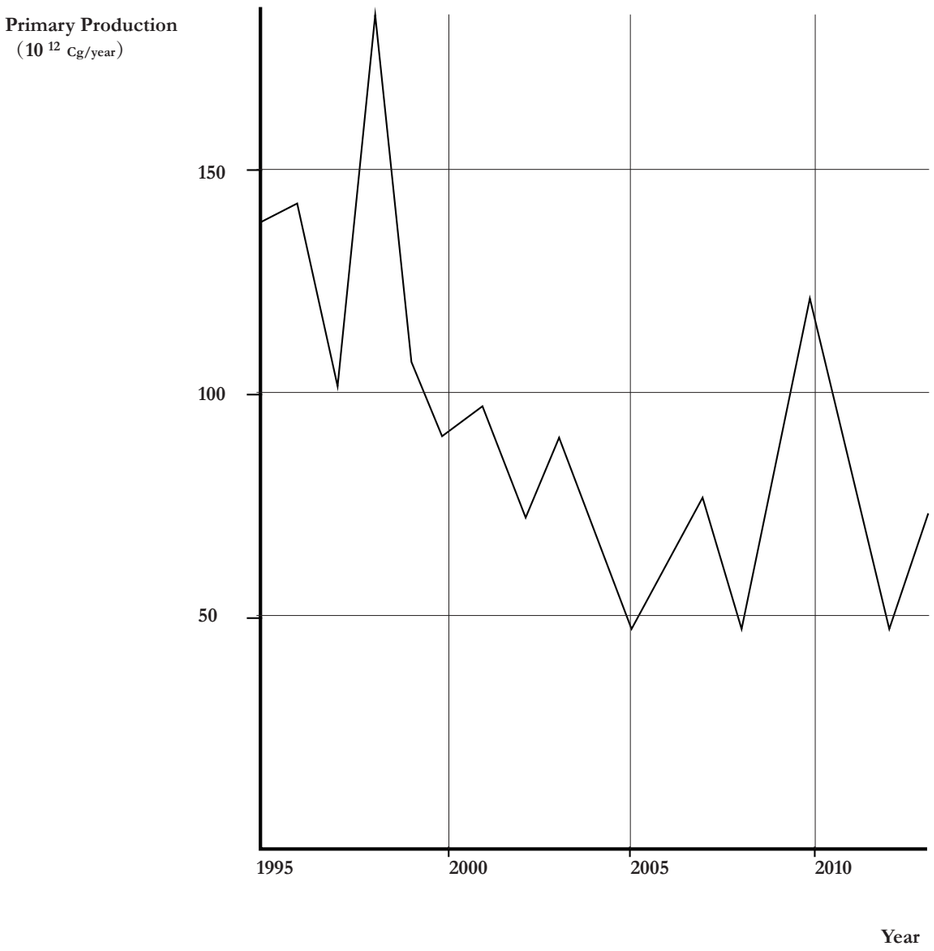
Now



1.2 Ecology Analysis

Change of Primary Production in North Sea

Data Source:(*A decline in primary production in the North Sea*, E Campuzzo)



The primary production is the base of the food web of the sea. The declination of the primary production is a signal of the declination of other species.

Problems of the Ecological Research in North Sea

Data Source: Royal Netherlands Institute for sea research

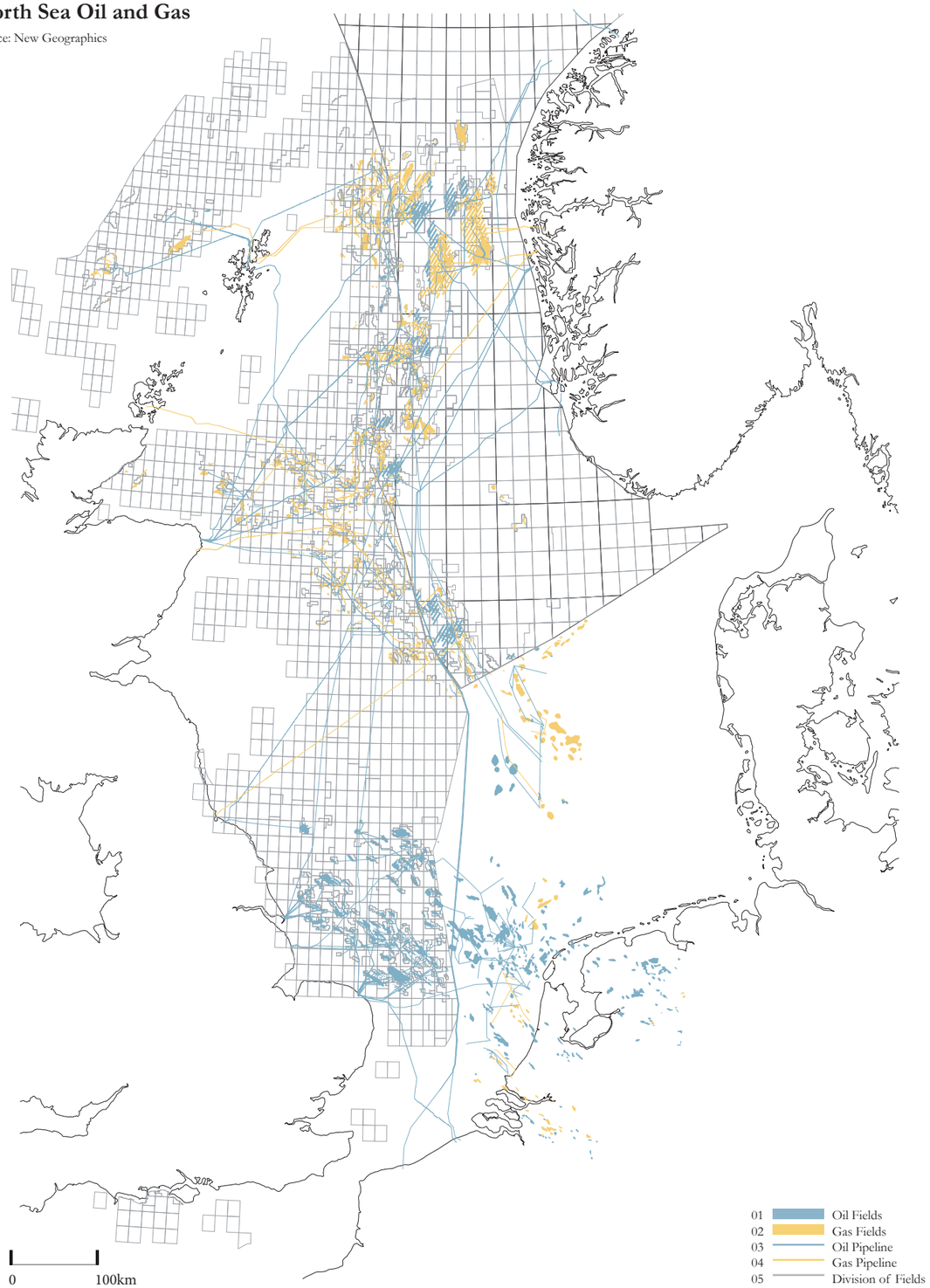
Basic Data

Ecological Research is the basis of ecology protection. Now, only the data of some specific species are complete (mainly commercial species).

1.3 Offshore Platform Analysis

North Sea Oil and Gas

Source: New Geographics



The exploitation of oil and gas resources in the North Sea started in 1964, when the UK launched the Continental Shelf Act. This act extended the land regime areas outside territorial waters including seabed, subsoil and resources.

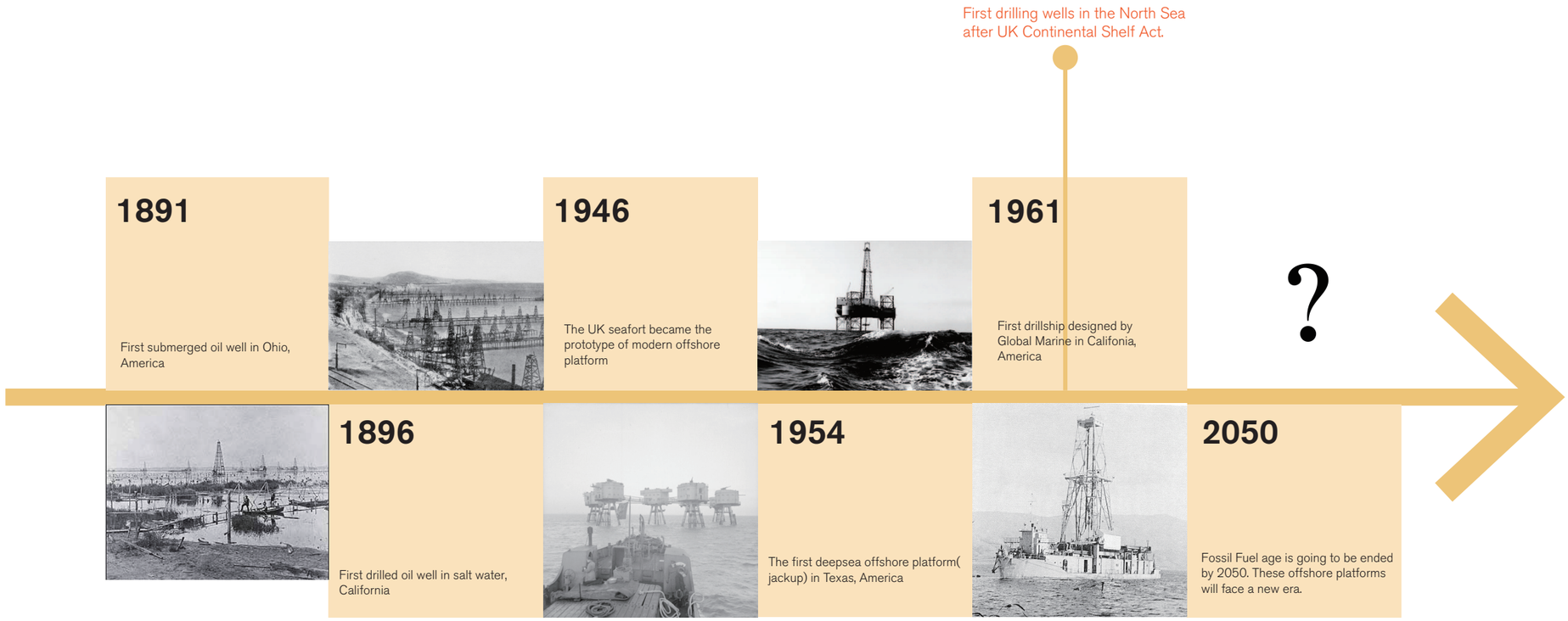
The offshore oil and gas industry in the North Sea extracted the subsoil natural resources started producing the most important resources that endorse the process, evolution and prosperity of the society in the the surrounding countries.Two decades ago, the North Sea was one of the world's largest sources of oil and gas. Offshore platform is an architectural tool to achieve this goal. Taking the UK sea forts as prototype, offshore platforms started to dominate the North Sea landscape.

However, the production of offshore oil and gas has peaked in 1999. Now, more than 50% of the oil and gas have been extracted. With the declining fossil fuel reserves and the increasing use of green energy, 600 offshore platforms are going to be decommissioned. The fossil fuel age is expected to stop in 2050, thinking of the future of this platforms thus become essential.

1.3 Offshore Platform Analysis

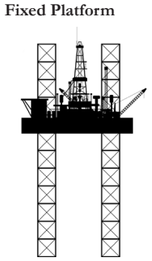
History of Offshore Platforms

The first submerged oil platform was built in 1891 in America. Then, the seaforts built during WWII in the UK became the prototype of offshore platforms. After that, more and more new technologies in building offshore platforms have been developed. The building activity of offshore platforms in the North Sea started in 1964, now, 176 offshore rigs are quite active in the North Sea Area. However, with the fossil fuel age being expected to terminate by 2050, the future of the existing platforms need to be reconsidered.



Type of Offshore Platforms and the Depth They Could Apply to

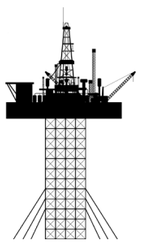
Fixed Platform



Jackup Platform: Up to 120m

Concrete Gravity Platform: Up to 450m

Jacket Platform: Up to 450m



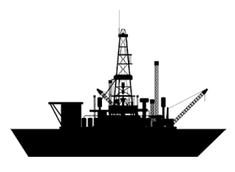
Complient Tower: 450m and 900m

Floating Platform

Sea Star:150-1000m

Floating Production System:450-1800m

SPAR Platform:600-3000m



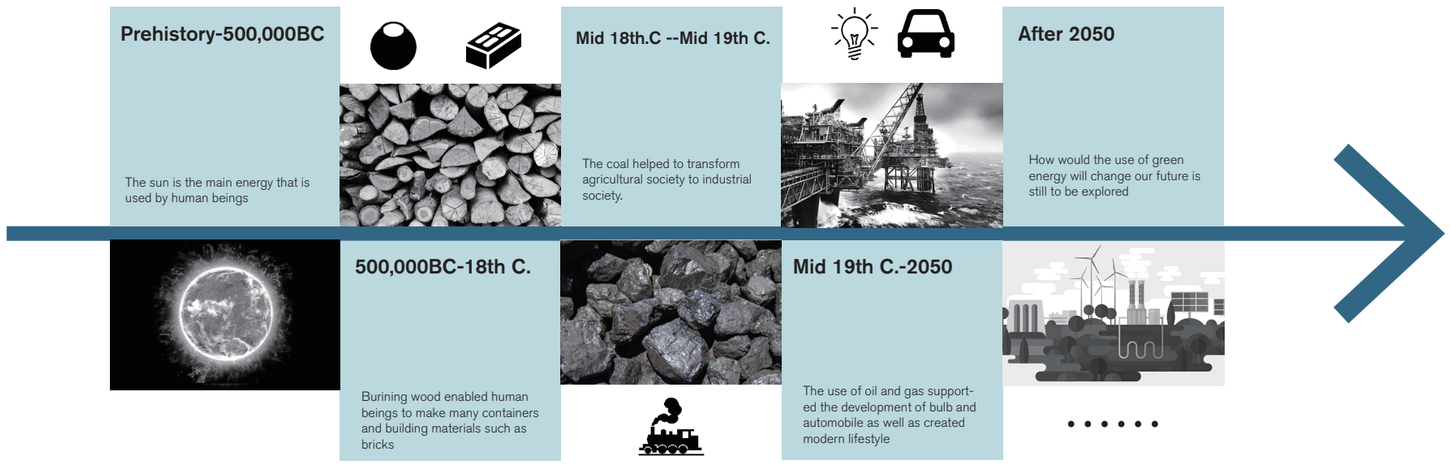
SPAR Platform: more than 3000m

1.3 Offshore Platform Analysis · Heritage Value

History of Energy Use and Their Impacts on Human Society

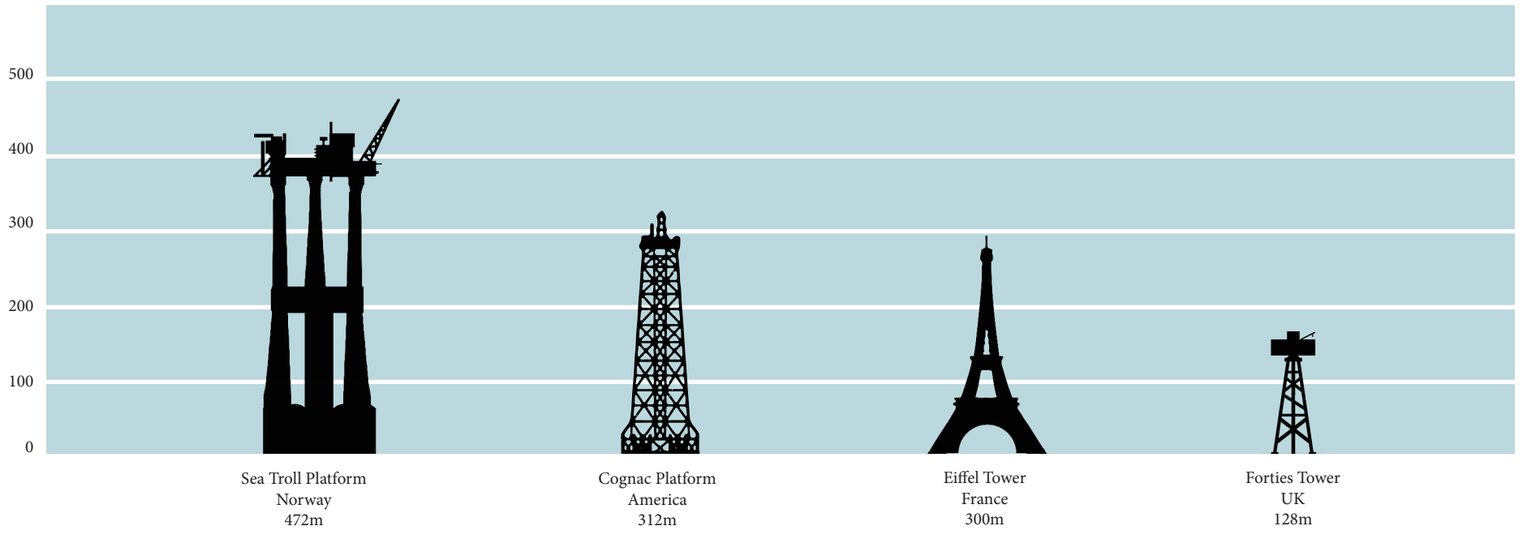
Energy is the fundamental elements for the survival, revolution and reproduction of human society. For example, the use of coal supported the Industrial Revolution in the 18th century. It is quite essential in stimulating the development of social economy and technology.

Offshore is the big story of the oil industry and the late twentieth century of North Sea. As the age of Gas and Oil is going to end, these offshore platforms will become symbols of the oil an gas industry. A part of them should be kept and made accessible for future generations so that they can learn and document an important part of human society.



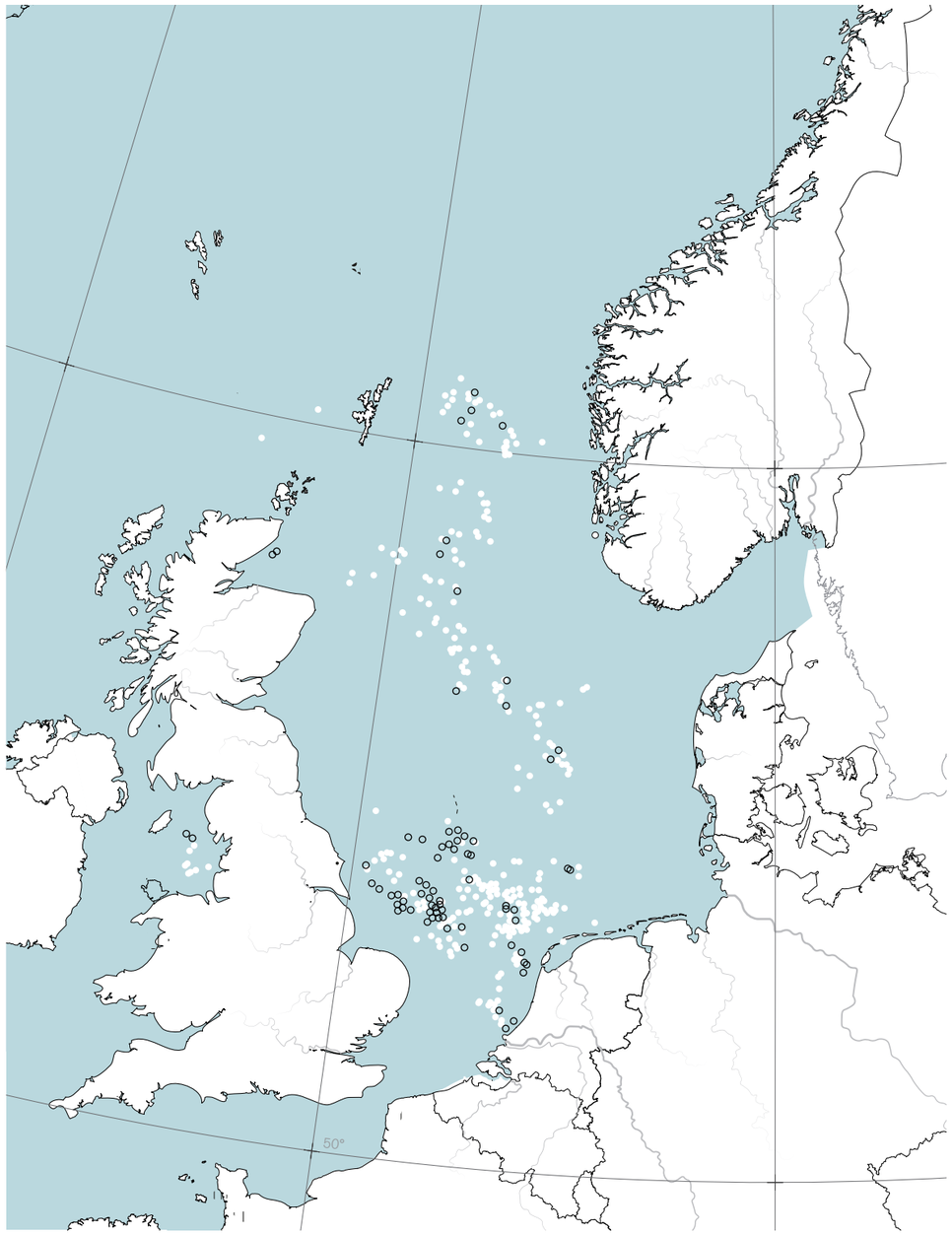
Comparison between Offshore Platforms and Eiffel Tower

Moreover, these offshore platforms could also be a part of the highest structure in the world. When talking about the high structure, people always think of skyscrapers. However, the height of these giant structure could be up to 500 meters. For example, the height of the Troll Platform in the Norwegian sea built in 1995 was once the highest man-made building in the world. These structures are valuable to reserve so that people could know and learn from them.



1.3 Offshore Platform Analysis · Ecological Value

Distribution of Offshore Platforms



Collage of Non-human Occupants on Offshore Platforms

Offshore oil and gas platforms always lead to many ecological disadvantages.However, during a rig's productive years,significant marine lifes come to live on and around the structure. The shape and complexity of the structure lead to significant species diversity, even better than the natural reefs. Moreover, these platforms attract seabirds to rest, to hunt and take refuge during storms. Keeping them is quite valueble in in order to avoid the loss of established ecological groups, the disturbance of the sea bed.

1.3 Offshore Platform Analysis · Ecological Value

Non-human Occupants on North Sea offshore platforms

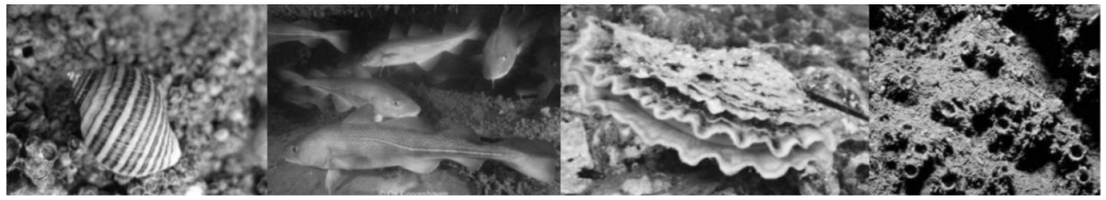
The same ecologizing process happens in the North Sea also.

(North Sea oil platform has become artificial reef Source: https://www.wur.nl/upload_mm/8/b/0/ca1e4761-0e1c-4770-8914-c297a4ea8822_Joop%20Coolen%20IMARES%20-%20Introduction%20to%20PhD%20project%20Oil%20and%20Gas%20meeting%2028-11-2013.pdf)

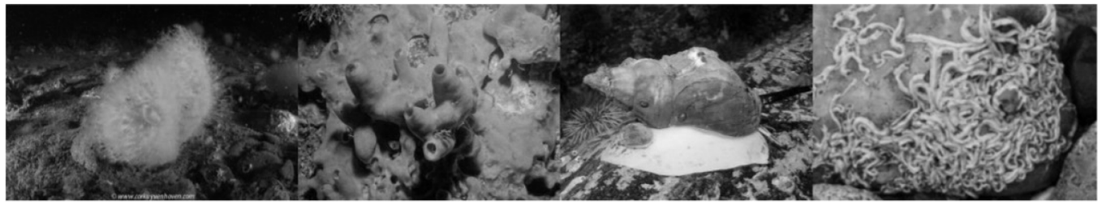
(North Sea oil platform has become artificial reef Source: https://daily.jstor.org/can-oil-rigs-grow-into-ocean-reefs/)

Some Species that might be Found on the Offshore Platforms in the North Sea

Data Source:(North Sea Reefs, *Joop Coolen*)



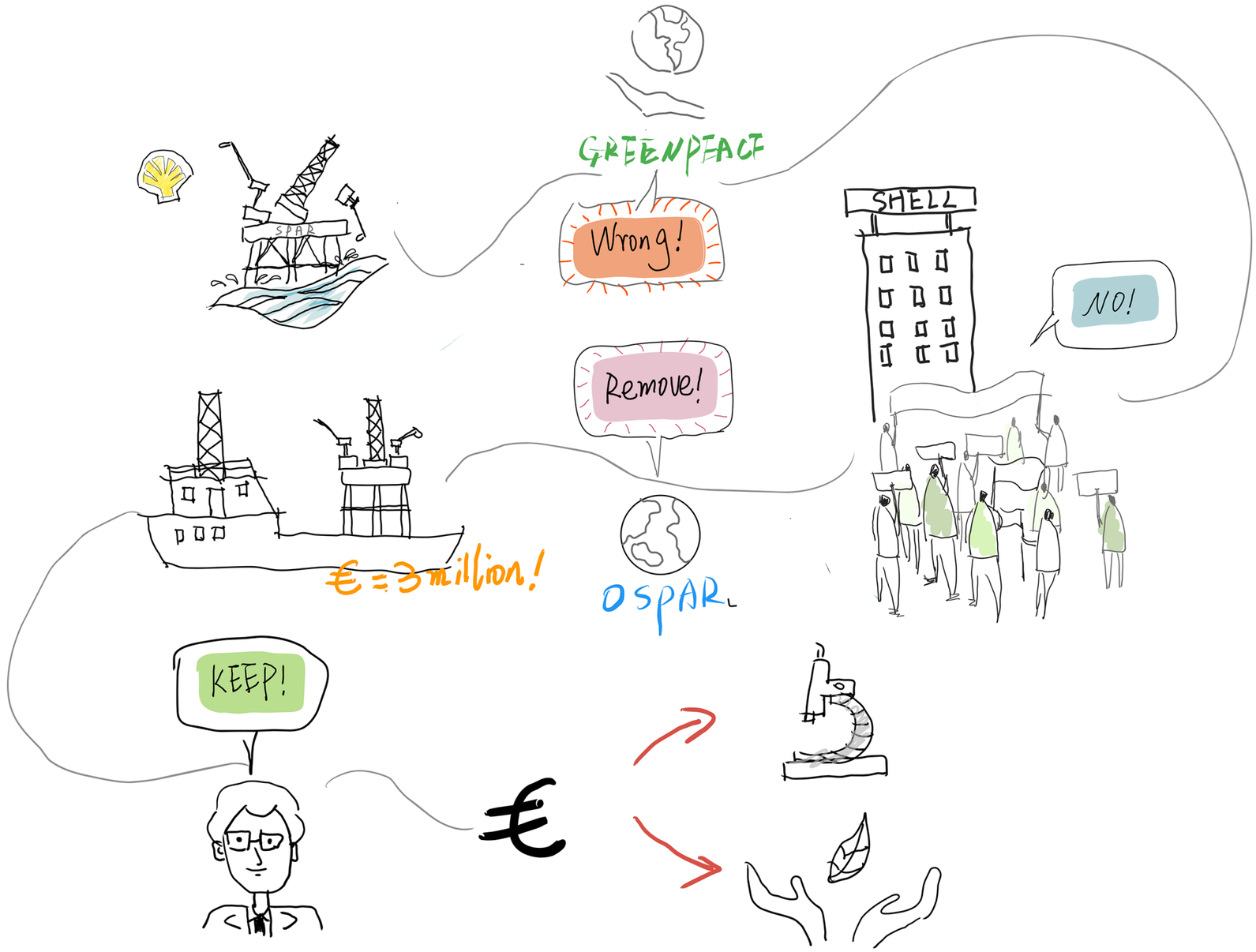
Dog Whelk Cod Edible Oyster Sabellaria Room



Dead man's finger Sponges Whelk Encrusting worms

1.4 Debate on Rigs to Reef in North Sea

In 1995, the oil giant Shell decided to dump an oil platform in the North Sea after careful calculation and site selection. This platform has the potential to act as artificial reef and help the environment.



This action led to a public protest initiated by Greenpeace, an environment protecting organization. People were considering this kind of activity as waste dumping. They were arguing that oil companies are saving money by keeping the offshore platforms.

Since then, OSPAR required all the decommissioned offshore platforms should be removed in the North Sea. The removing cost could be up to several billions.

Some ecologists are now suggesting keeping these offshore platforms. Then the money saved in the process could be used to preserve the environment and support ecological study.

1.5 Territorial Problem Statement and Research Question

1.5.1 Problem Statement

1.The ecosystem of the North Sea has degraded due to the resource-demanding economic growth. Protection and restoration is necessary.

2.In order to conduct protection activities, the understanding of the ecosystem is basic. However, the basic data of the non-commercial species in the North Sea is still not complete

3. The offshore platforms are going to be decommissioned in the following decades, there might be a need to adaptive reuse or keep some of them due to their heritage values and ecological values.

1.5.2 Research Question

1.What are the methods to adaptive reuse these offshore platforms in order to keep their heritage value?

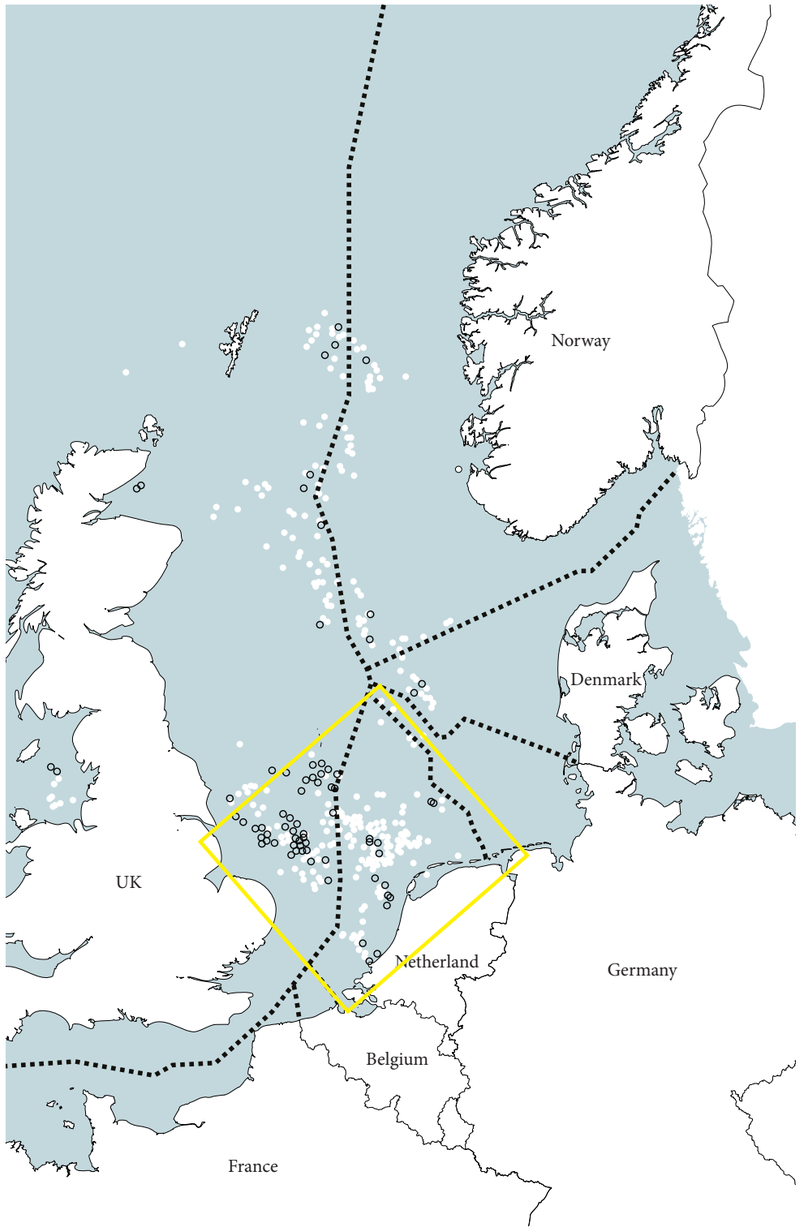
2.What kind of roles can these offshore platforms play in creating a better ecosystem?

Site Analysis

2.1 Site Analysis

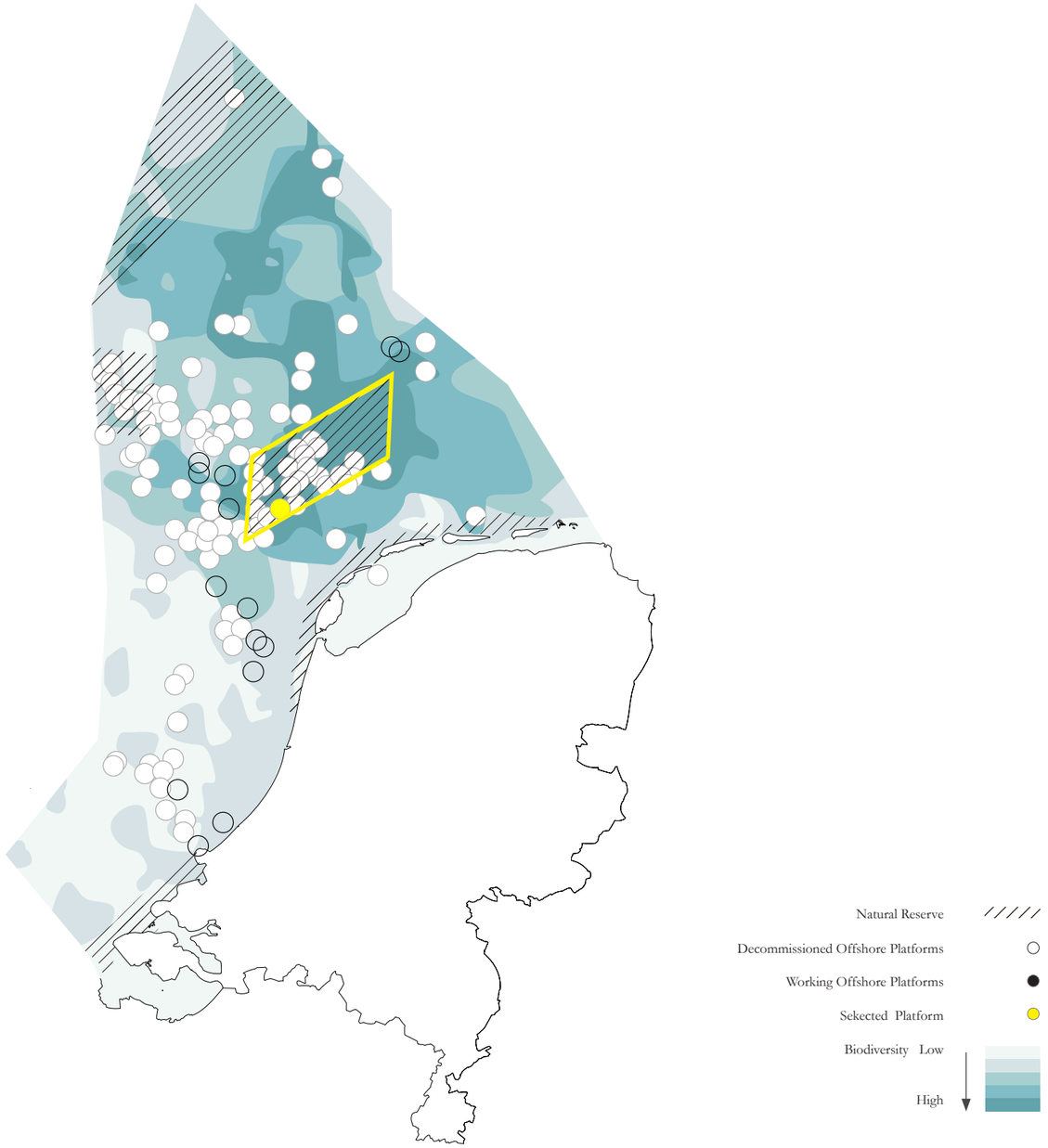
Country Scale

This project will focus on the Netherlands. The Netherlands is the largest gas producer in the North Sea region and it has the most dense distribution of offshore platforms.



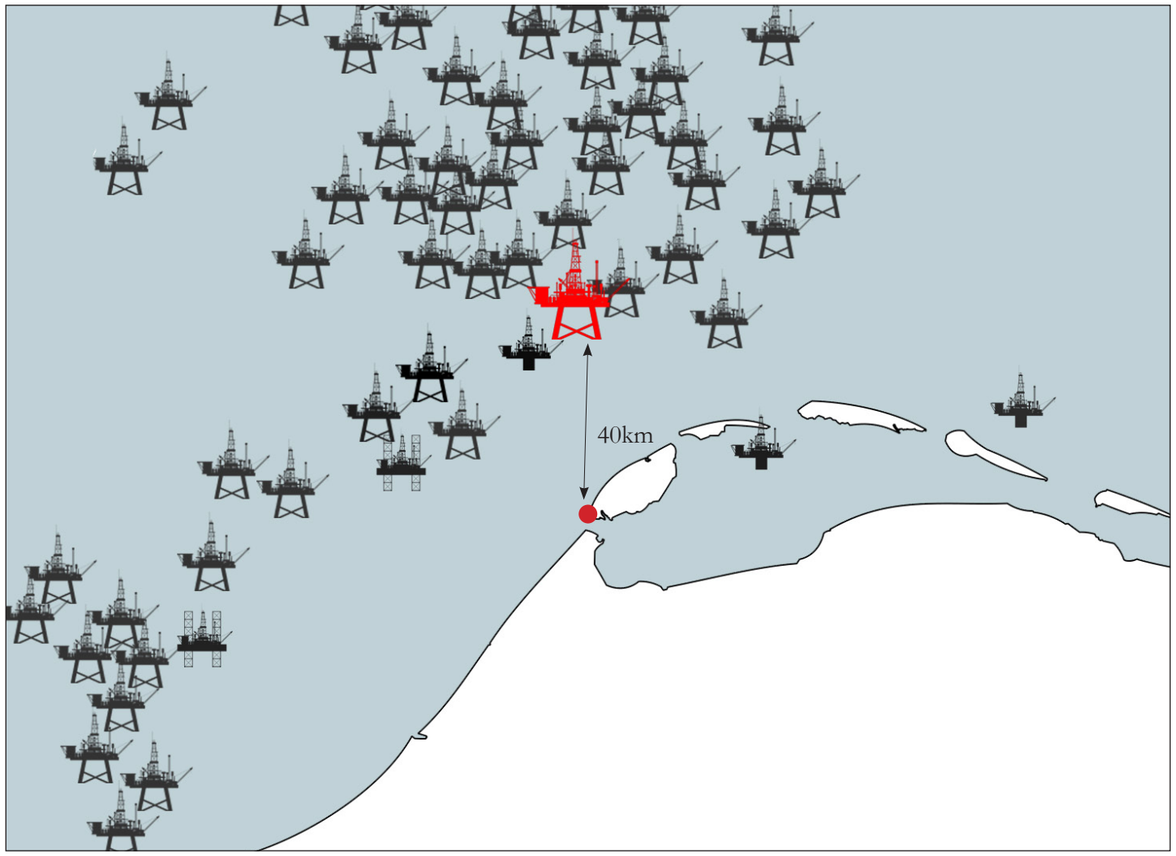
Regional & Architectural Scale

In the middle scale, this project will focus on Frisian Front, which is a slope between the shallower and deeper parts of the North Sea.With a very dense distribution of offshore platforms,it is a natural reserve designated by Natura 2000. It is one of the region that has highest biodiversity in the Dutch part of the North Sea. Apart from 1000-1200 marine species, this area is also with high bird value. There are many birds that can only be seen in this area.Frisian Front is a slope between the shallower and deeper parts of the North Sea.



Architecture Scale

The selected platform is L10A complex. It is consisted of 4 individual jacket platforms, namely L10-AC, L10-AR, L10-AP, L10-AD. L10-AD is the first platform in Dutch Continental Shelf,40km from Texel Harbour, which makes the platform more accessible. The Texel islands is a popular tourism destination.The L10 field is going to stop production before 2022, which means these platforms could be put into new use very soon. The current transportation method to go to the platform is by helicopter, however, this way of arrival would disturb the ecosystem around and is not convenient for a larger group of people who will be present on the offshore platforms.



01 Port of Texel

02 Jackup Platforms

03 Jacket Platforms

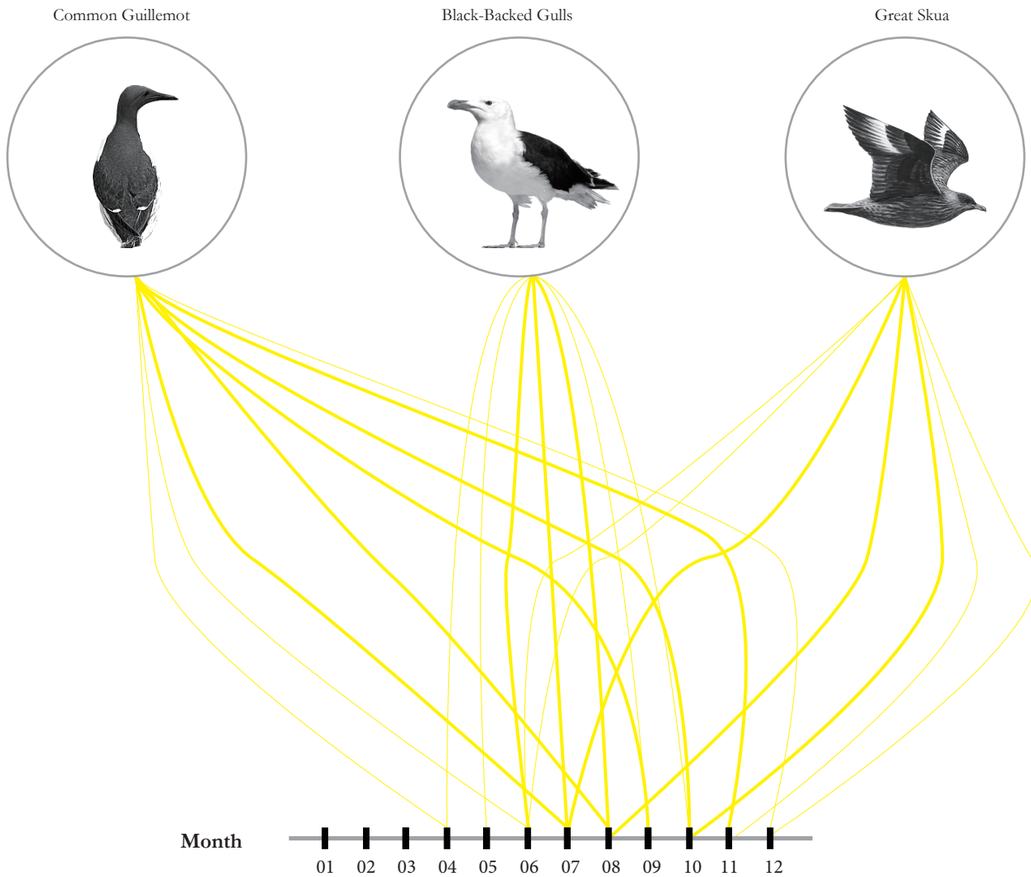
Marine Species

Magafauna

Macrobenthic species

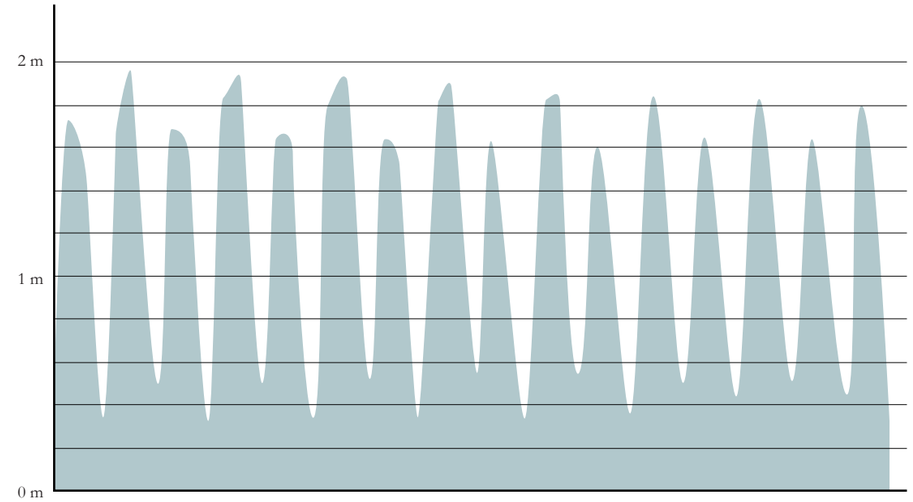
Frisian Front has the highest concentration of megafauna and macrobenthic species in the Dutch part of the North Sea. This area provide a heaven for researchers to study these species.

Bird Species



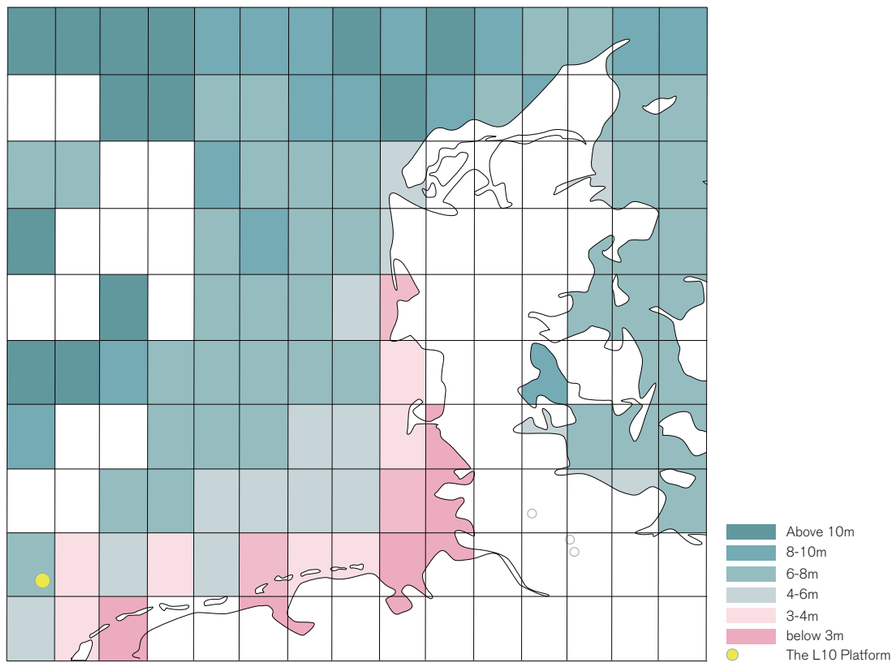
Common Guillemot, Black-backed Gulls, Great Skuas are the species that are aimed to protect in this natural reserve. Common Guillemots mainly come to this area to forage between July and November. Black backed Gulls come to this area to forage between June and August. Between August and October, Great Skua would migrate through this area. The Great Skua consisted 1% of the total European population. There are always 20000 Common Guillemot residing in this area. The number of Black-backed Gull is also considerable.

Tidal Chart of the Frisian Front

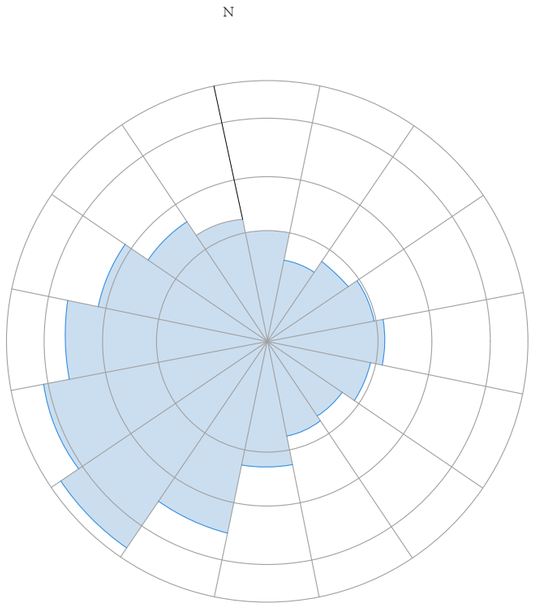


The height difference of the tide in the Frisian Front is between 1m and 1.5m.

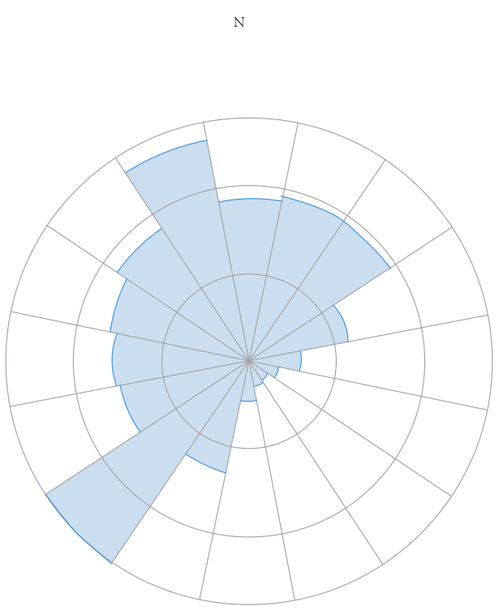
Underwater visibility



Wave and Wind Rose in the Frisian Front



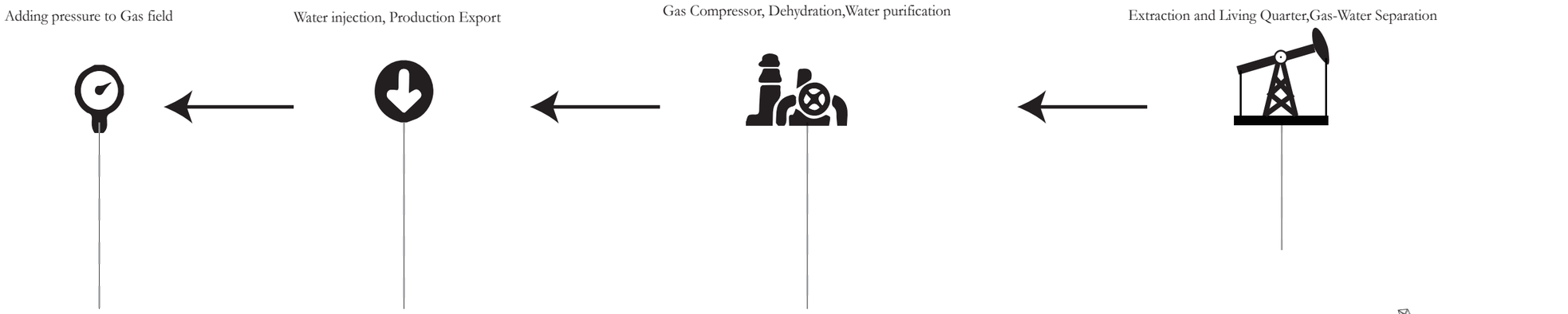
Wind Rose

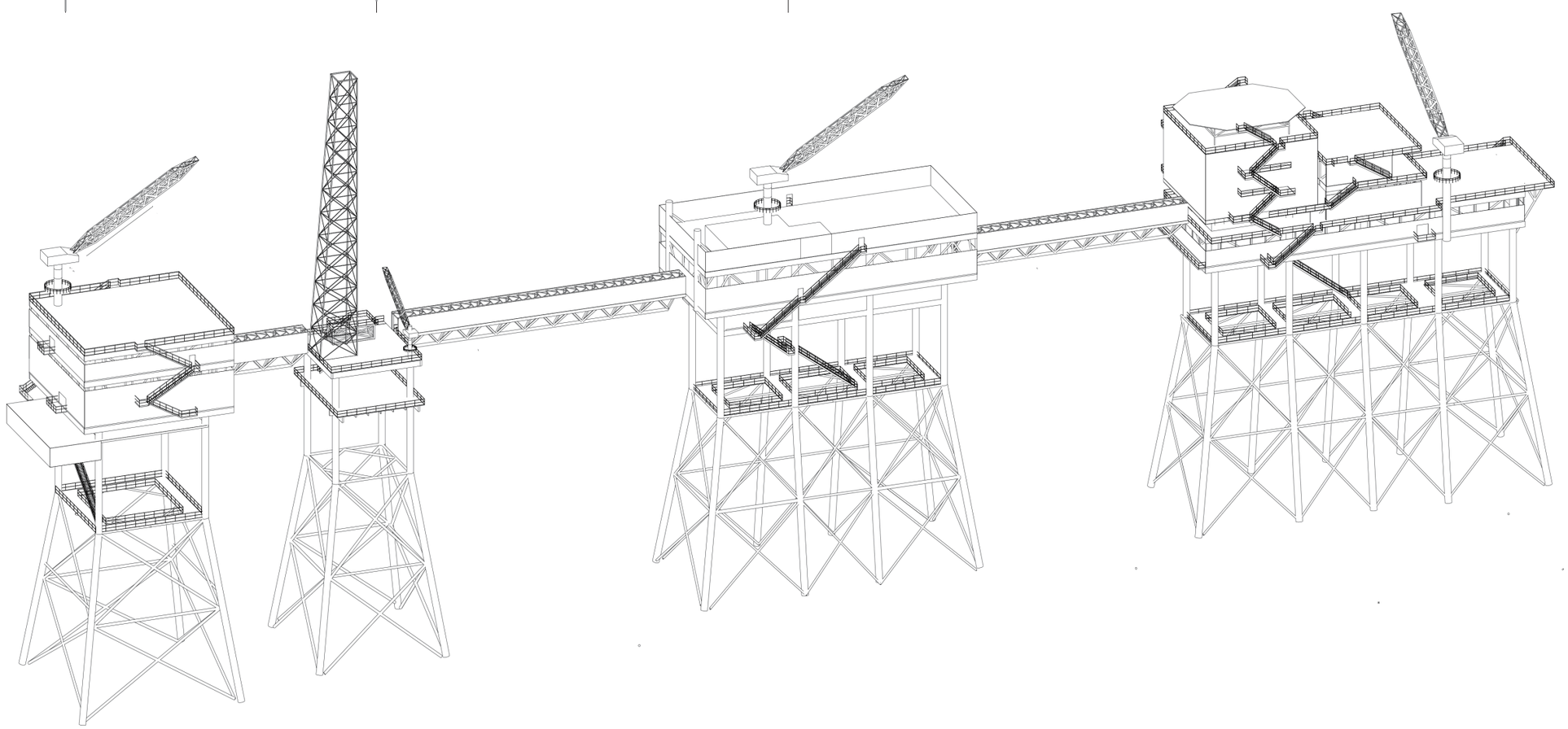


Wave Rose

2.2 Existing Platform Analysis

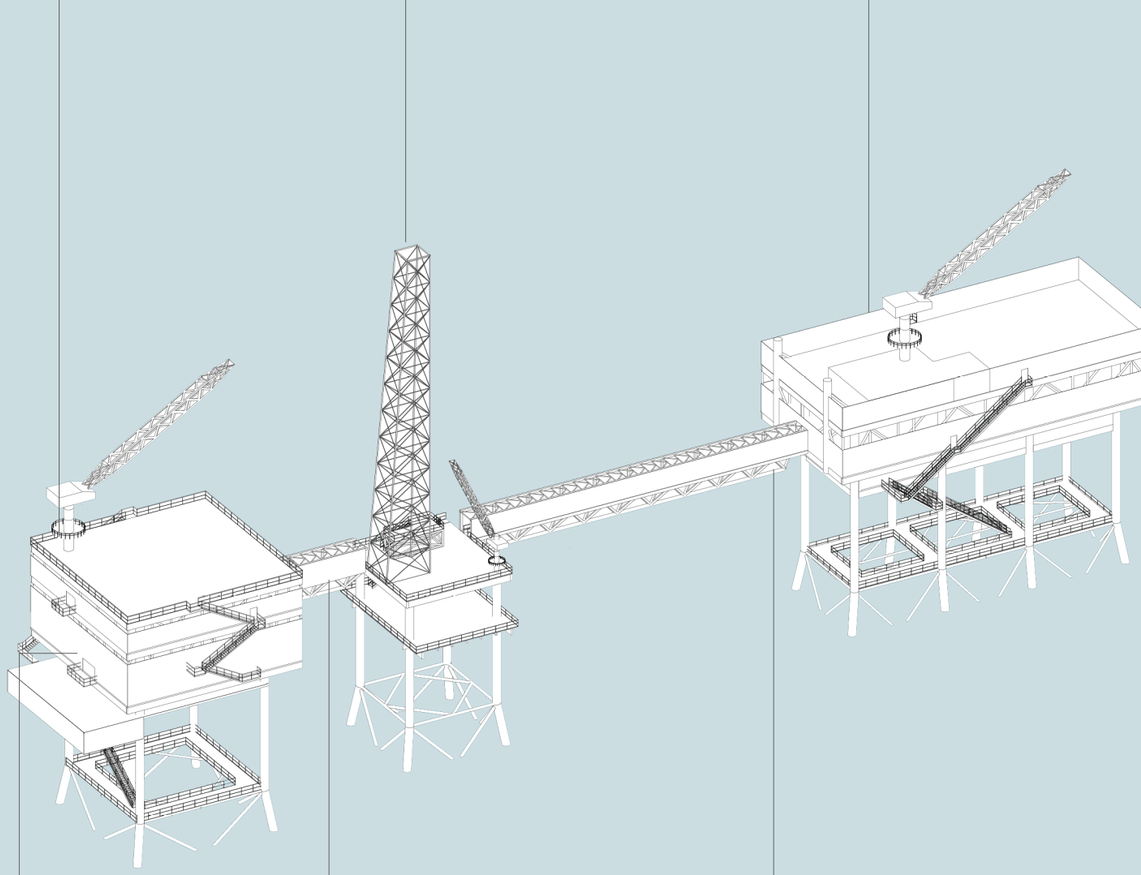
Introduction of existing Platform





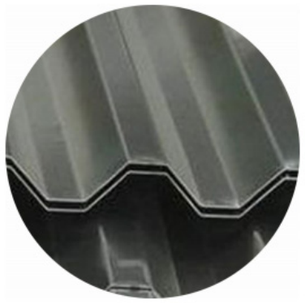
Year of Construction	1987	1975	1975	1972 Oldest
Name	L10-AC	L10-AR	L10-AP	L10-AD
Function	Compression Platform	Riser Platform	Production Platform	Drilling Platform

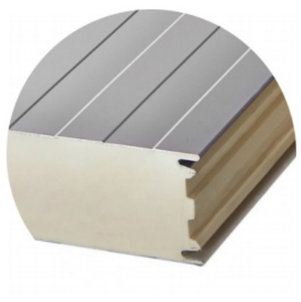
The wall of the platform is made of non-insulated corrugated steel plate. The most impressive part of the platform is its strong structure. In the open layout, these structure are very important in people's spatial experience. The experience on the bridges is fantastic. When walking on those bridges, people don't have broad view, but when they raise their head, they see the sky, when they look down, they see the waves.



The Materialization of Existing Platform

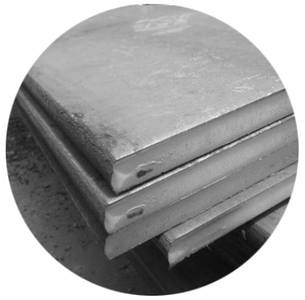
Wall





The exterior wall of existing platform is made of corrugated steel, which is non-insulated. For some parts, there are some interior walls made of insulated steel sandwich panel (For example. the living quarter). These walls are quite closed without consideration of views. The platform is totally functional and work like

Floor



The floor of the offshore platforms are always covered with steel grating floor and steel plate.

Structure

All the structural elements as well as handrails are made of steel with yellow coating. Yellow is quite important in offshore industry, it makes these platforms visible in order to ensure safe shipping.

The Ecological transition on L10A platform

The lower part of the platform attracts many creatures and is creating very high biodiversity.

Data Source**:**(RECON: Reef effect structures in the North Sea, islands or connections?, *Joop Coolen*)

2.3 Problem Statement Research Question (Architectural Scale)

2.3.1 Problem Statement

The Frisian Front (which the L10A platform is located in)hosts the highest biodiversity in the Dutch part of North sea. It also has the highest biodiversity of megafauna and macrobenthos. As a bird reserve, it is attracting a large number of birds every year. It is an ideal place to conduct marine ecological research.

The L10 A complex is the first offshore platform on the Dutch continental shelf. With the gas field going to stop production very soon, it would be abandoned. It has the potential to provide dry space for in-situ observation. experimentation and other research activities.

2.3. 2 Architectural Research Question

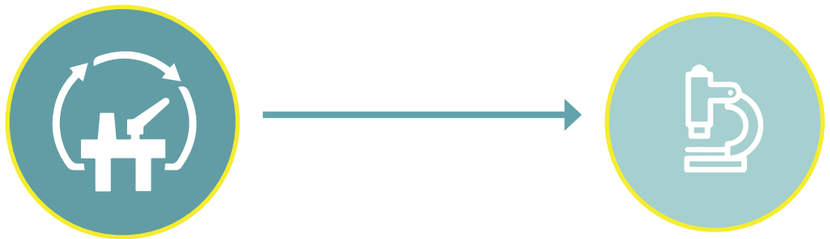
1.How can the L10A complex contribute to ecological research?

2.How can human beings and other species coexist on the platform without excessive interference towards each other?

3 How can the architectural intervention keep the heritage value of the powerful construction?

Project

3.1 Proposal



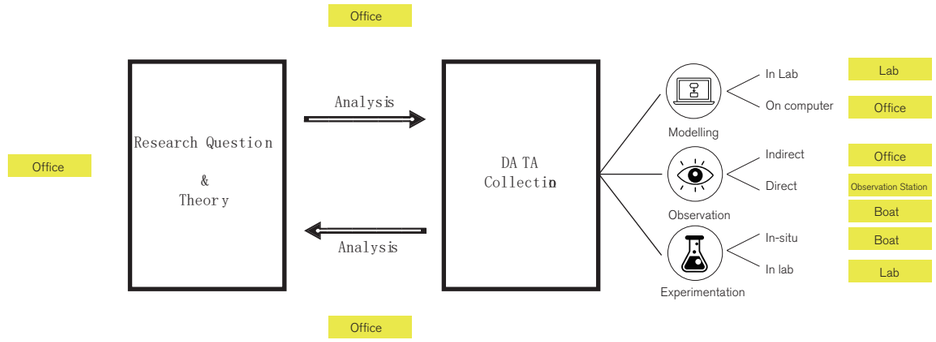
This project is proposing keeping the offshore platforms but use the money that oil and gas companies save to invest in ecological protection and research. I am going to transform the L10A complex into a offshore ecological research center .

Future users might be a core group of ecologists who conduct research activities and collect basic data systematically. The research center will also invite some students who work on their thesis and some volunteers to help. The cooperation with other individual companies, academic institutions and government agencies would also be possible. Other individual ecologists and amateurs will also be able to use the facility here temporarily.

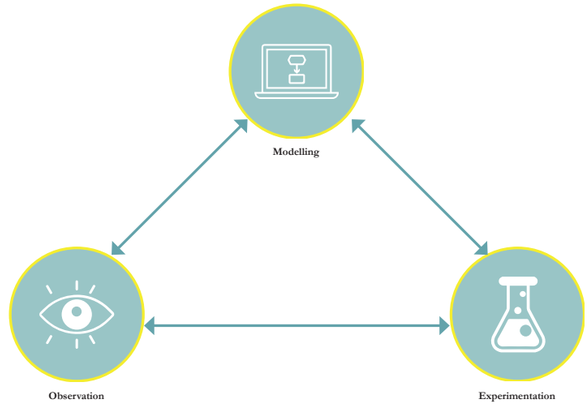
It will provide people with space to observe, do experiment, analyze and reflect. In this way, I aim to make the offshore platform which used to extract resource from the nature into a place that human beings learn from the nature so as to create a better human-nature relationship.

3.2 Ecological Research Process Analysis

Data Source:(Scientific Method for Ecological Research, *Ford,E*)



Lab, Office and Observation tower are the 3 main programs of the ecological research center. However, some experimentation and observation activities would require some boats. For example, analyzing the composition of the seabed, analyzing the composition of water,tagging animals, using drone to record bird activities, installing bio acoustic sonar, installing digital still camera, using DNA sampler and observing some other species that can't be seen around the platform.



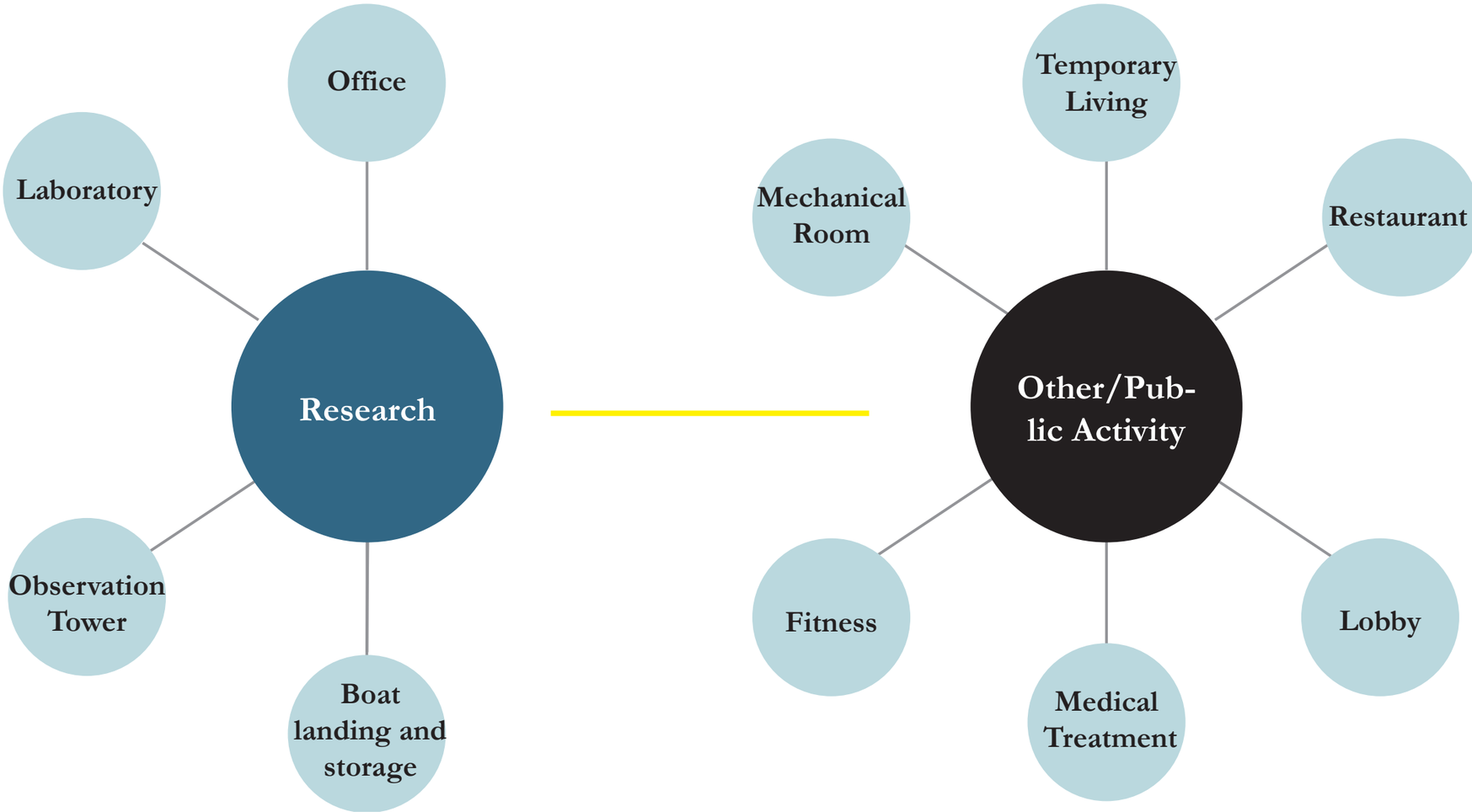
Observation:
Observation is the first method in Ecological research. It means keep watching the subject all through the research period and then publish the results. The important point is that researchers do not interrupt the life flow of the subject. All they have to do is observing and field work. It might be either be direct or indirect

Modeling:
In this method, actual field work is not required. Instead, researchers will create the life of the subject in laboratory. Due to the technological advance, there might be no need create physical models. Sometimes AI can create simulations that are capable of replicating the life style of the subject.

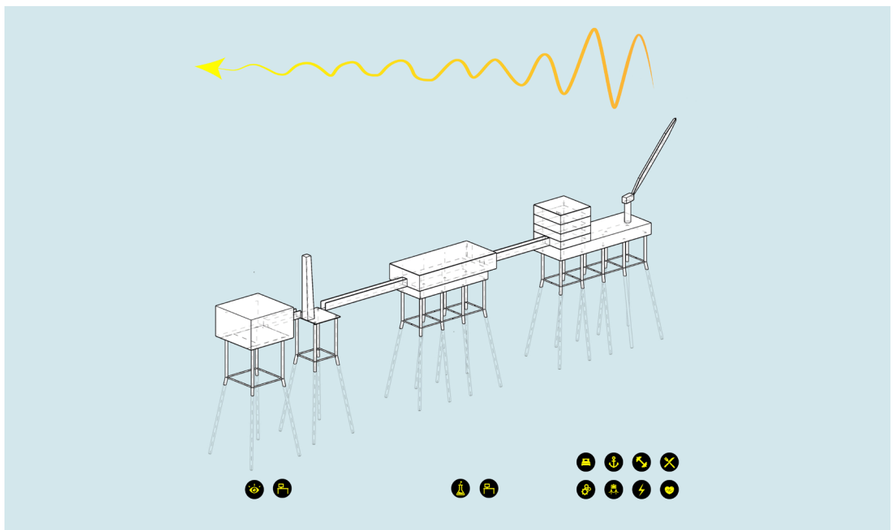
Experimentation:
This means disrupting the harmony of the ecosystem so as to find how the organisms in the ecosystem react to the change. These reactions are recorded and analyzed and then the outcomes are published as journals by the researchers

Each method is unique and will lead to different impacts on different topics. In many of the situation, these 3 methods have to be adopted at the same time.

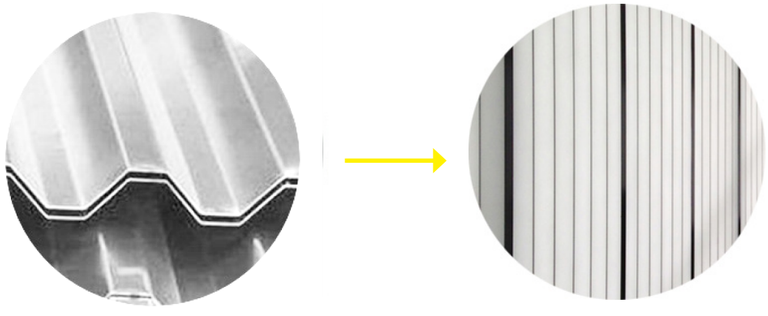
3.3 Program


Office
Laboratory
Research
Observation Tower
Boat landing and storage
Temporary Living
Mechanical Room
Restaurant
Other/Pub-lic Activity
Fitness
Medical Treatment
Lobby

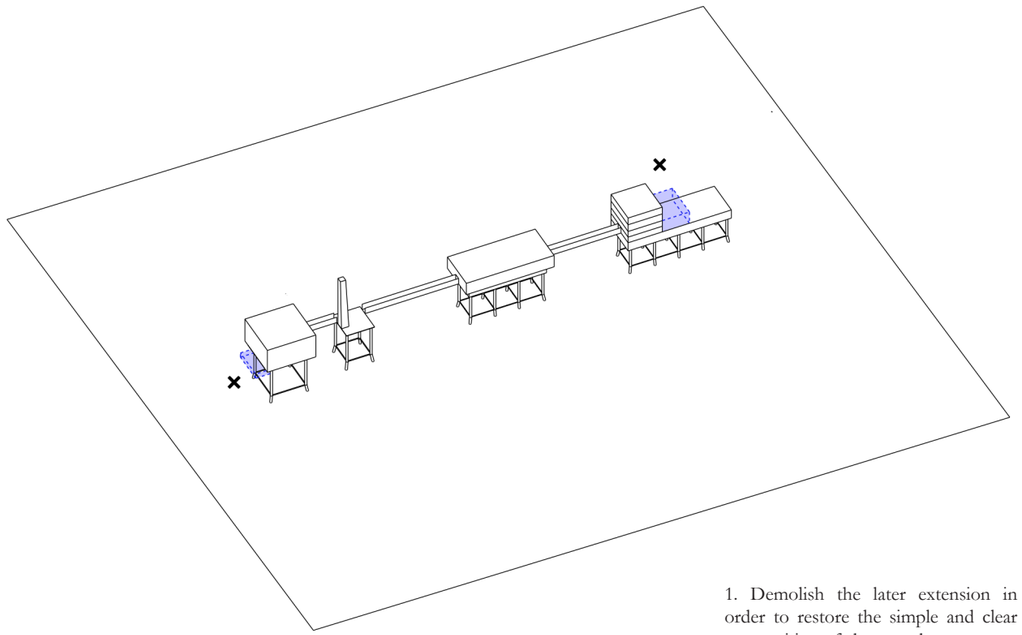
3.4 Concept and Intervention



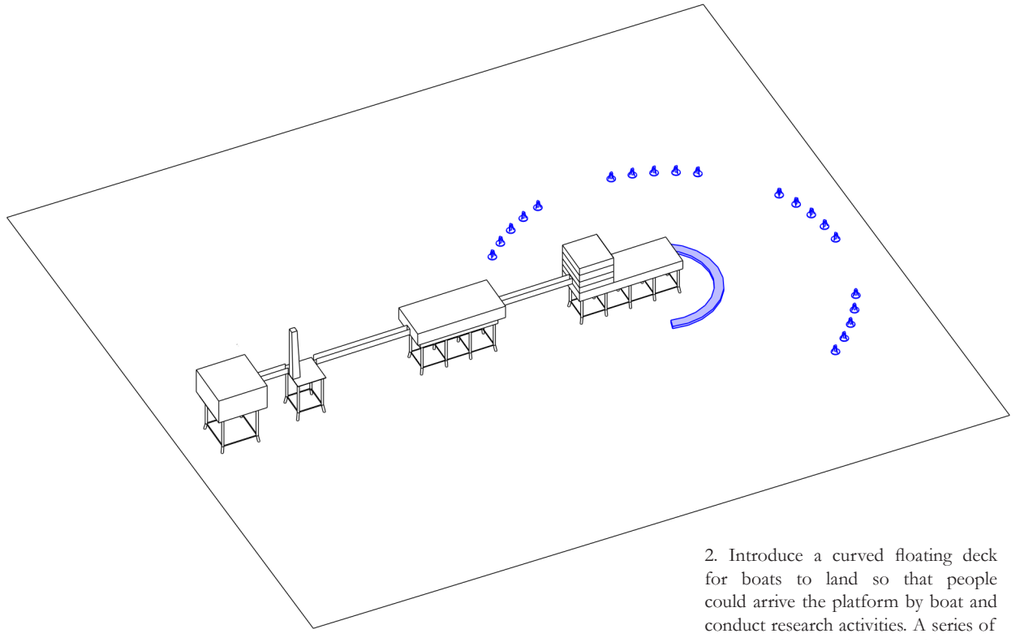
In this project, the platform on the right is the most noisy and busy part with entrance, public space, harbour, energy production and temporary living units. Because it is the former entrance of the existing complex, and it is large enough to hold all the activities. The platform on the left would be used for observing. It is isolated from other 2 platforms with the 90m long bridge and the outdoor platform in-between. As a result, the observing activities will have less interference and the result will be more objective.



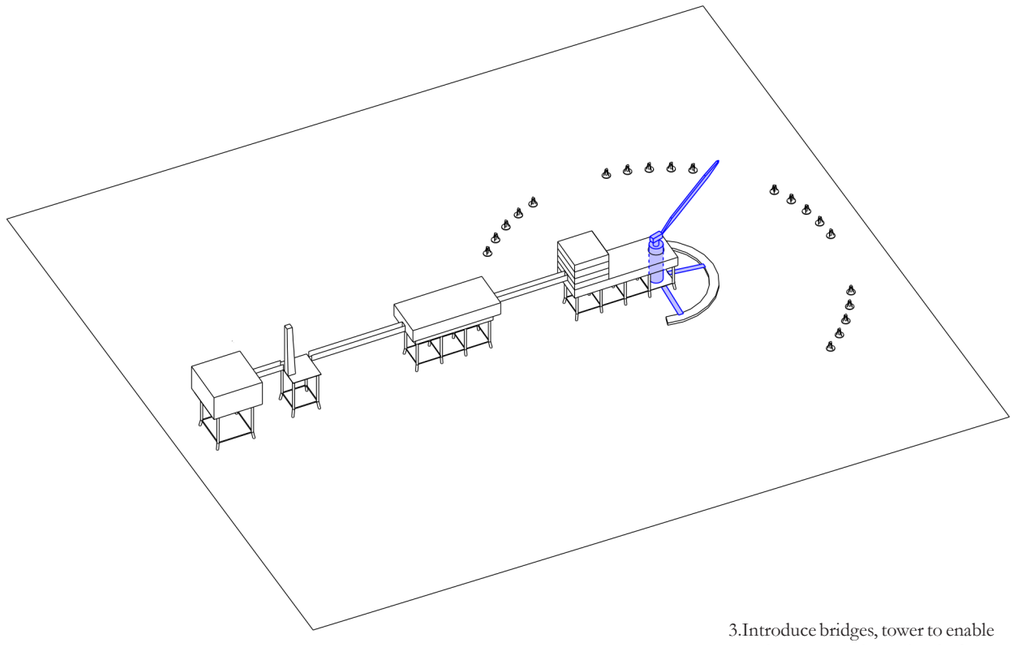
The facade of the platforms(not the bridge) is replaced by transluscent facade panel in order to get enough light. Moreover, this wall panel can have openings, so to create good view.



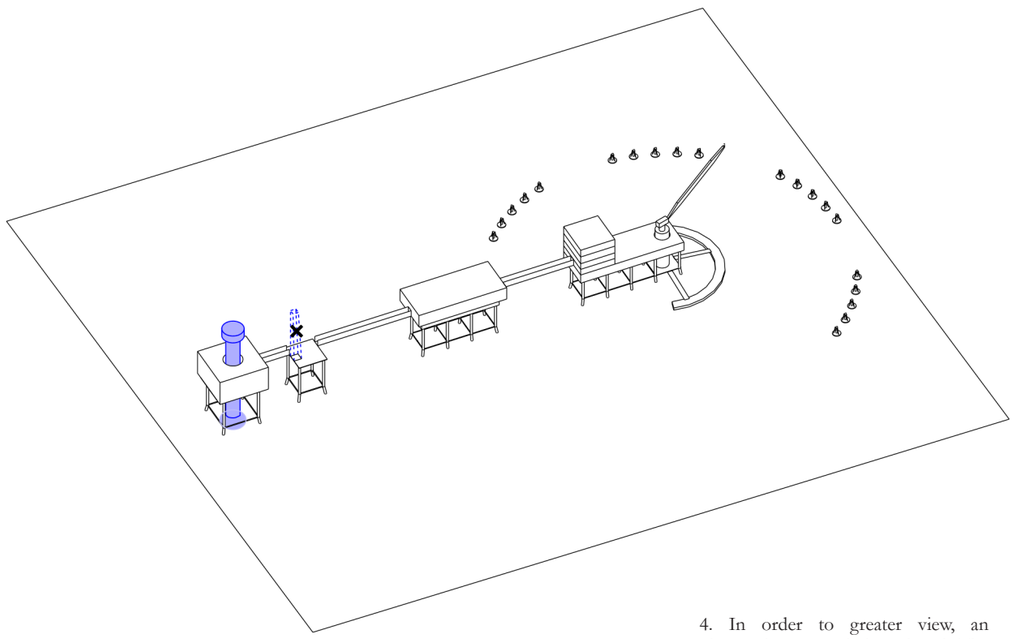
1. Demolish the later extension in order to restore the simple and clear composition of the complex



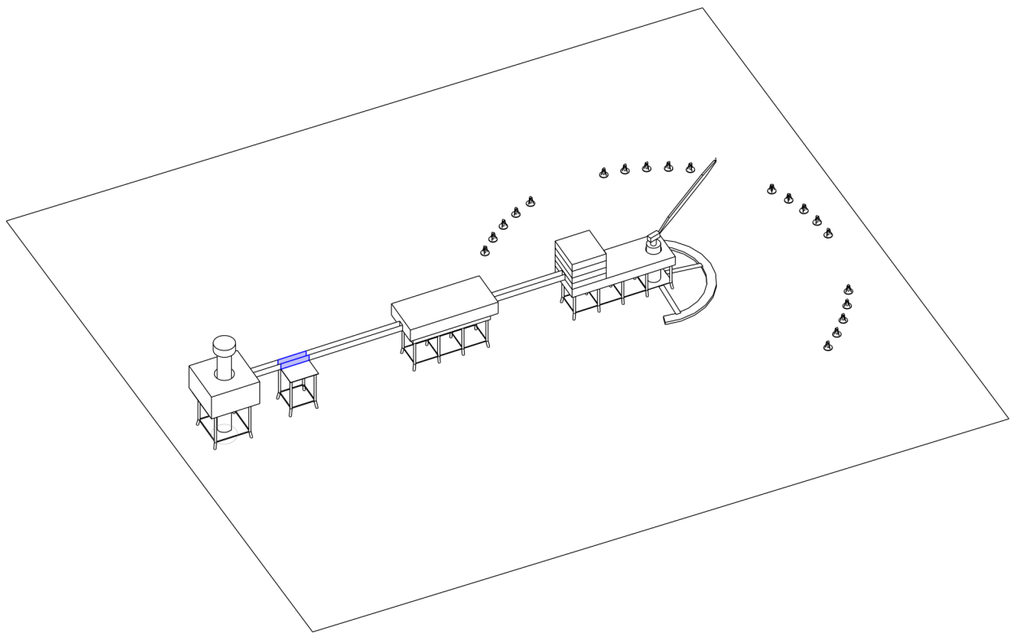
2. Introduce a curved floating deck for boats to land so that people could arrive the platform by boat and conduct research activities. A series of wave turbines are introduced in order to make the platform self-sufficient. (The platform used to get electricity by burning the natural gas from the gas field.)



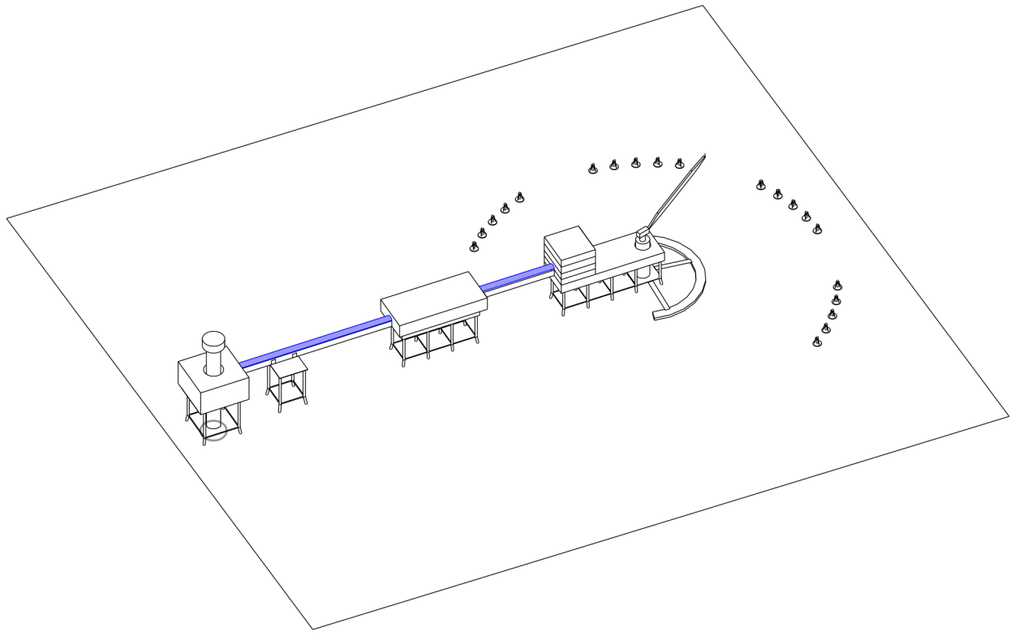
3.Introduce bridges, tower to enable people go up to the main platform level. The crane is used to transport small research boat,containers and other goods.



4. In order to greater view, an observation tower is introduced. The existing tower is demolished. (Can't provide enough space and not strong enough). Also, by introducing a new tower, the observation system become more integrated.

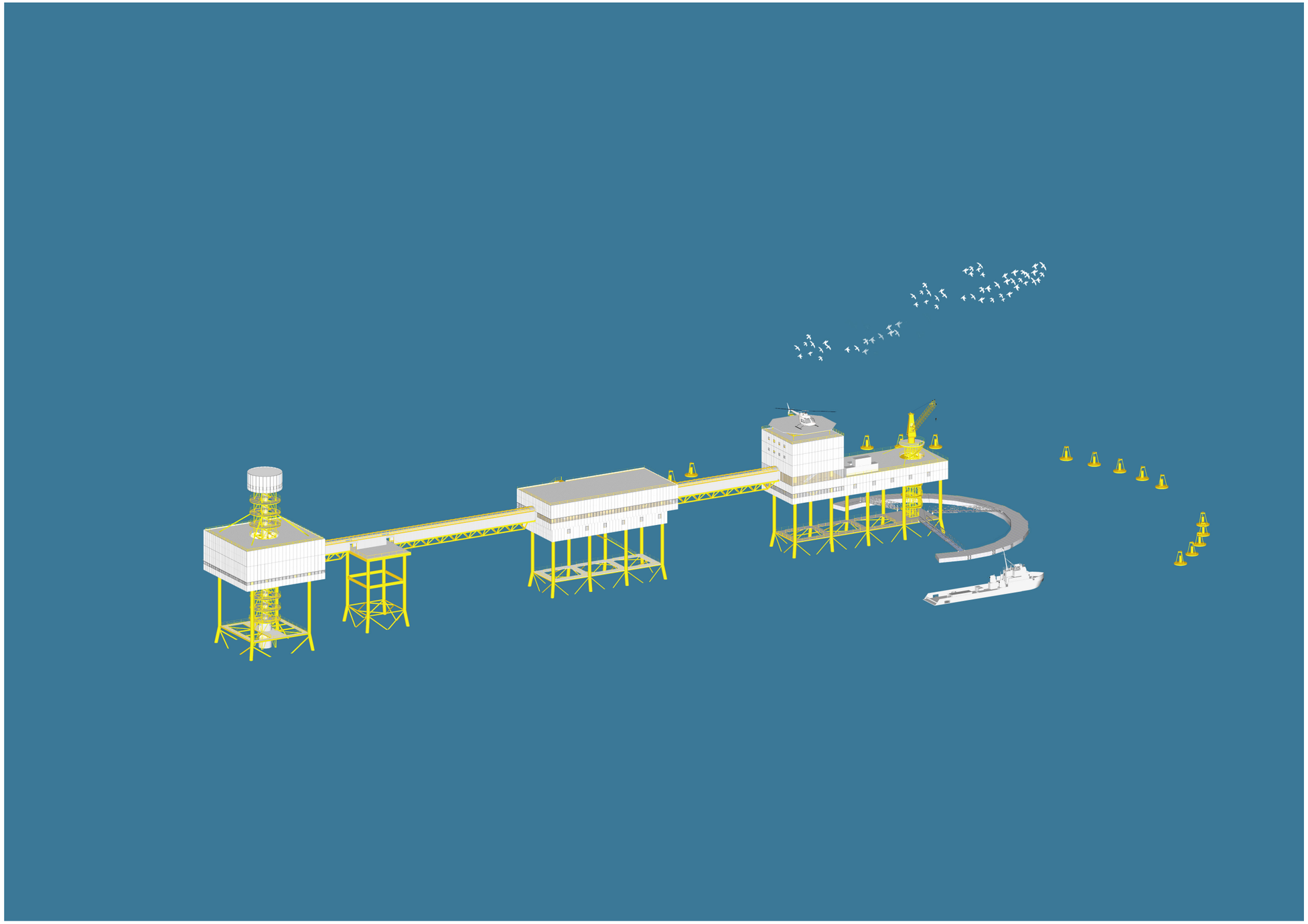


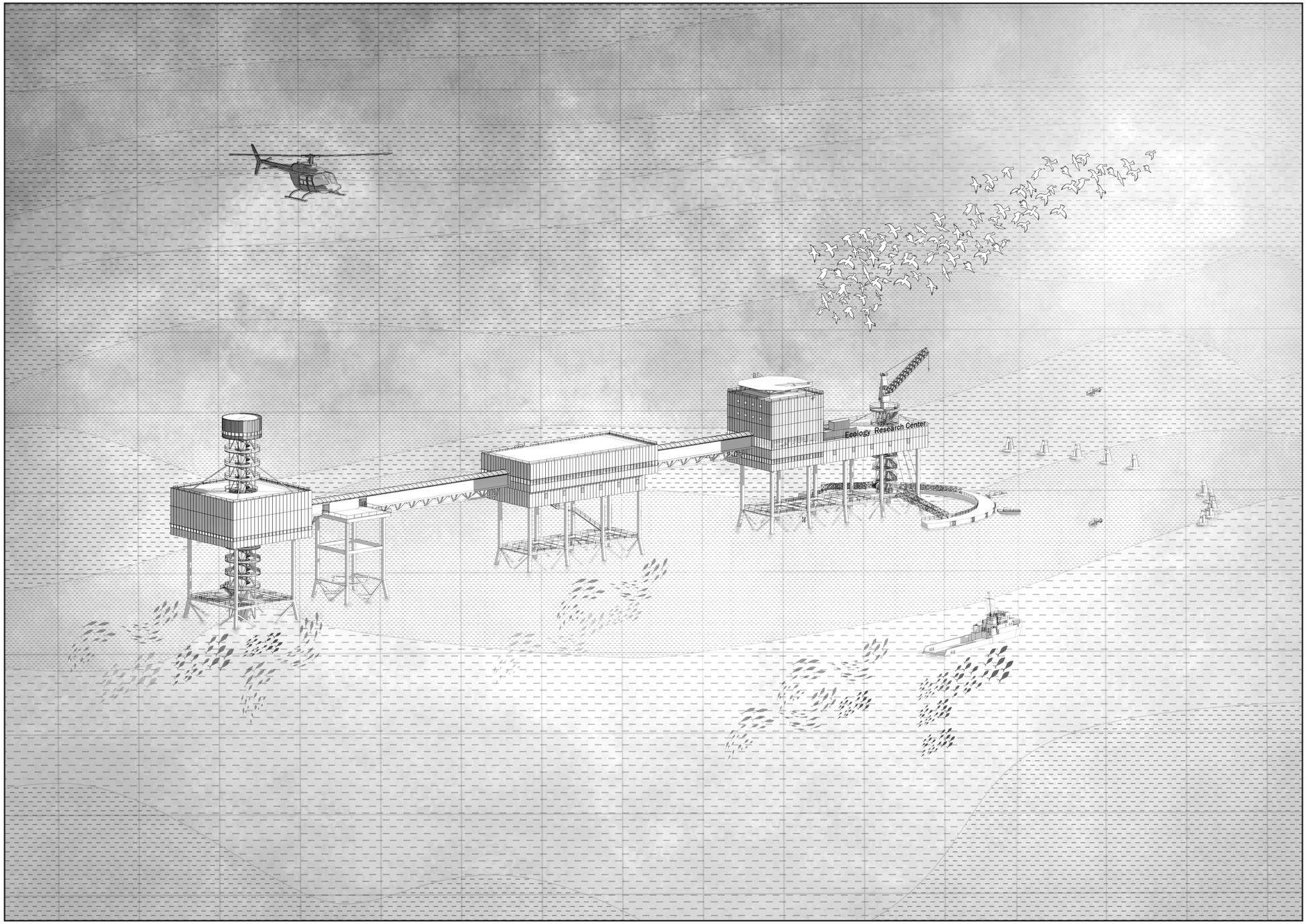
5.Connecting bridge to create a more continuous connection between the platforms.



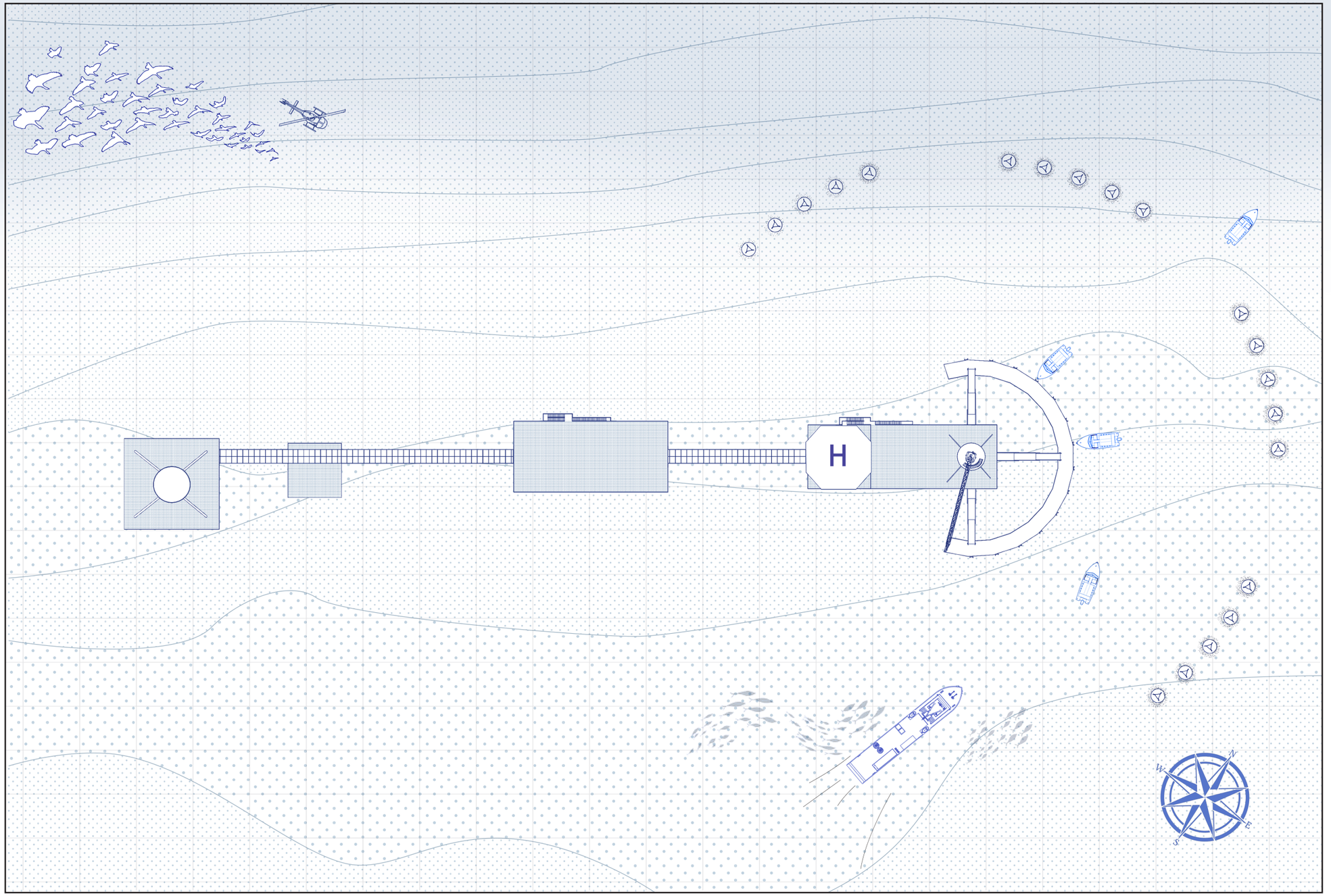
6.Introducing a glass roof to shelter the bridge.

3.5 Rendering

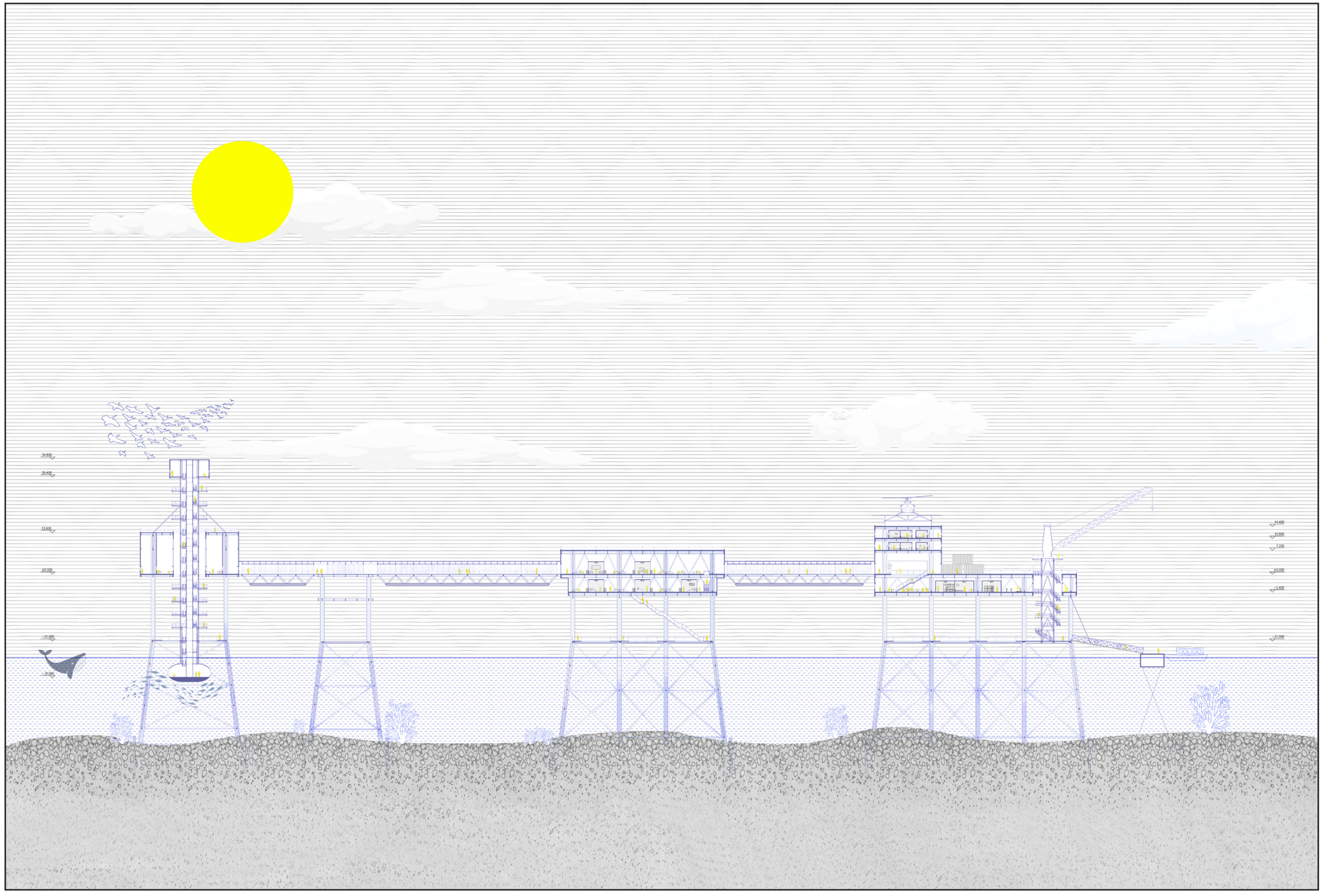



Ecology Research Center

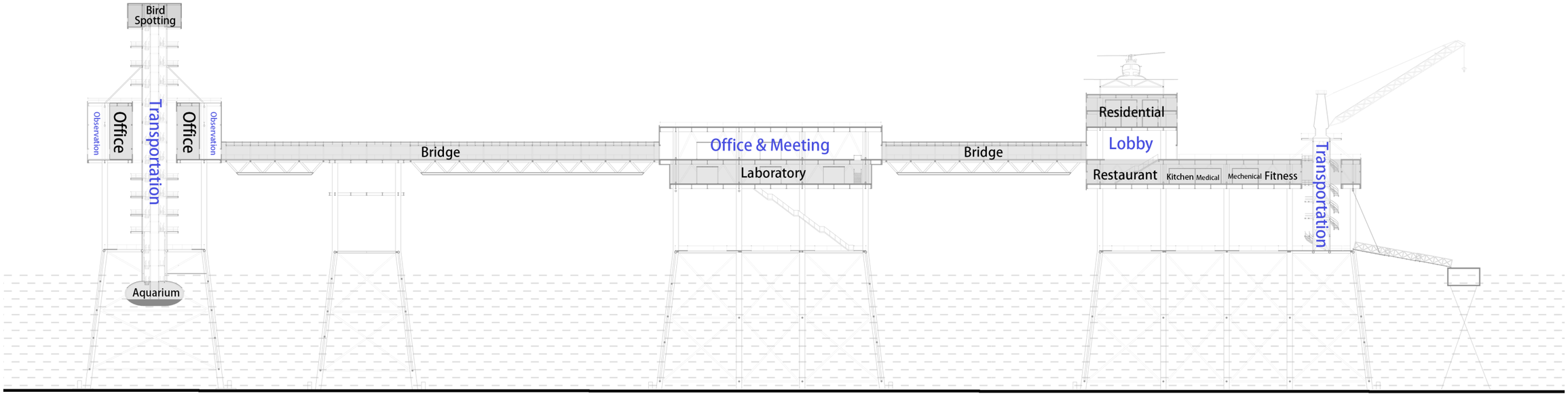
3.6 Master Plan



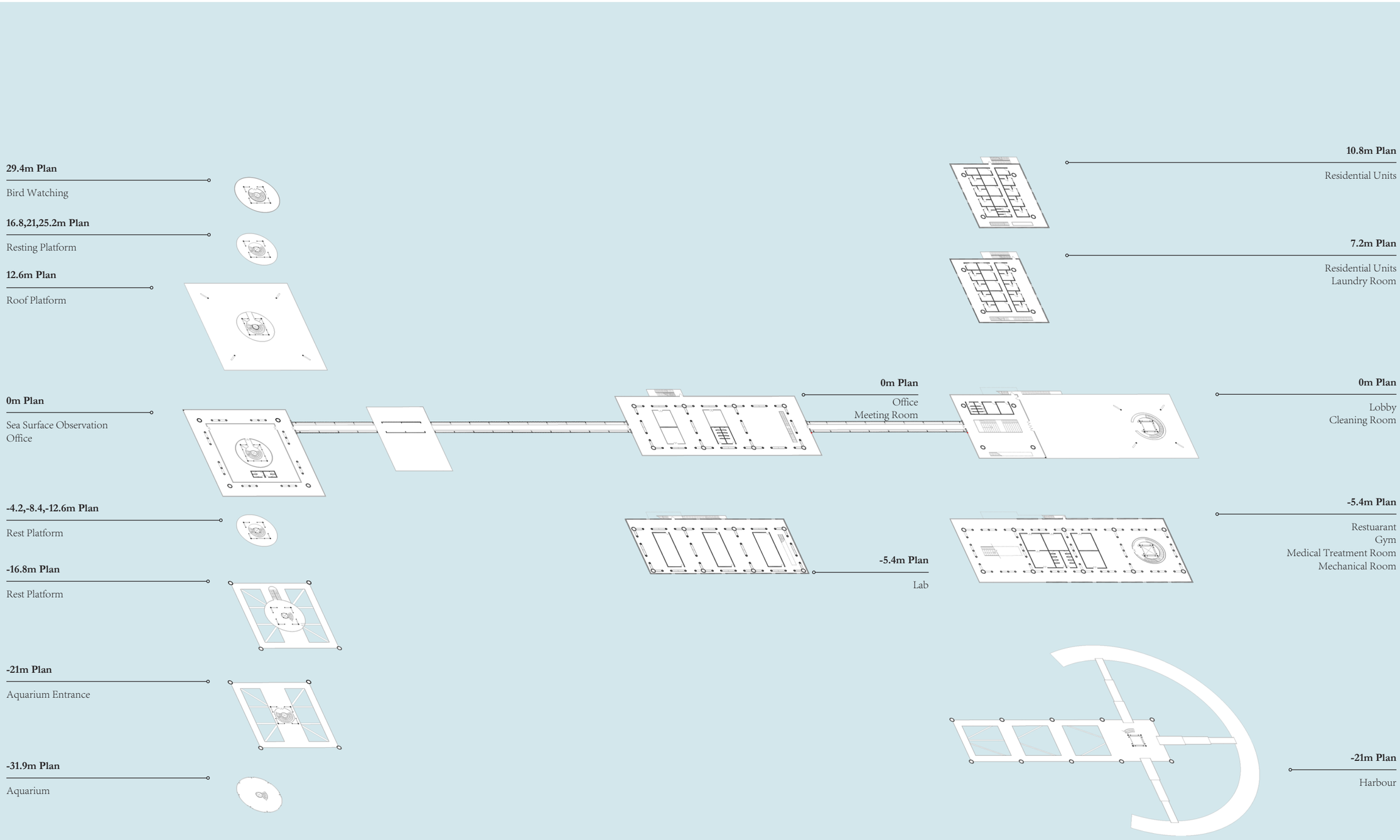
3.7 Overall Section 1:1000



3.8 Program

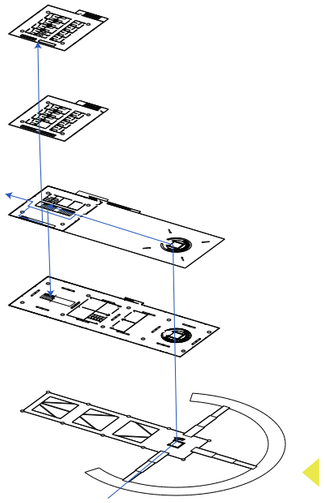

Bird Spotting
Observation
Office
Transportation
Office
Observation
Bridge
Office & Meeting
Laboratory
Bridge
Residential
Lobby
Restaurant
Kitchen
Medical
Mechenical
Fitness
Transportation
Aquarium

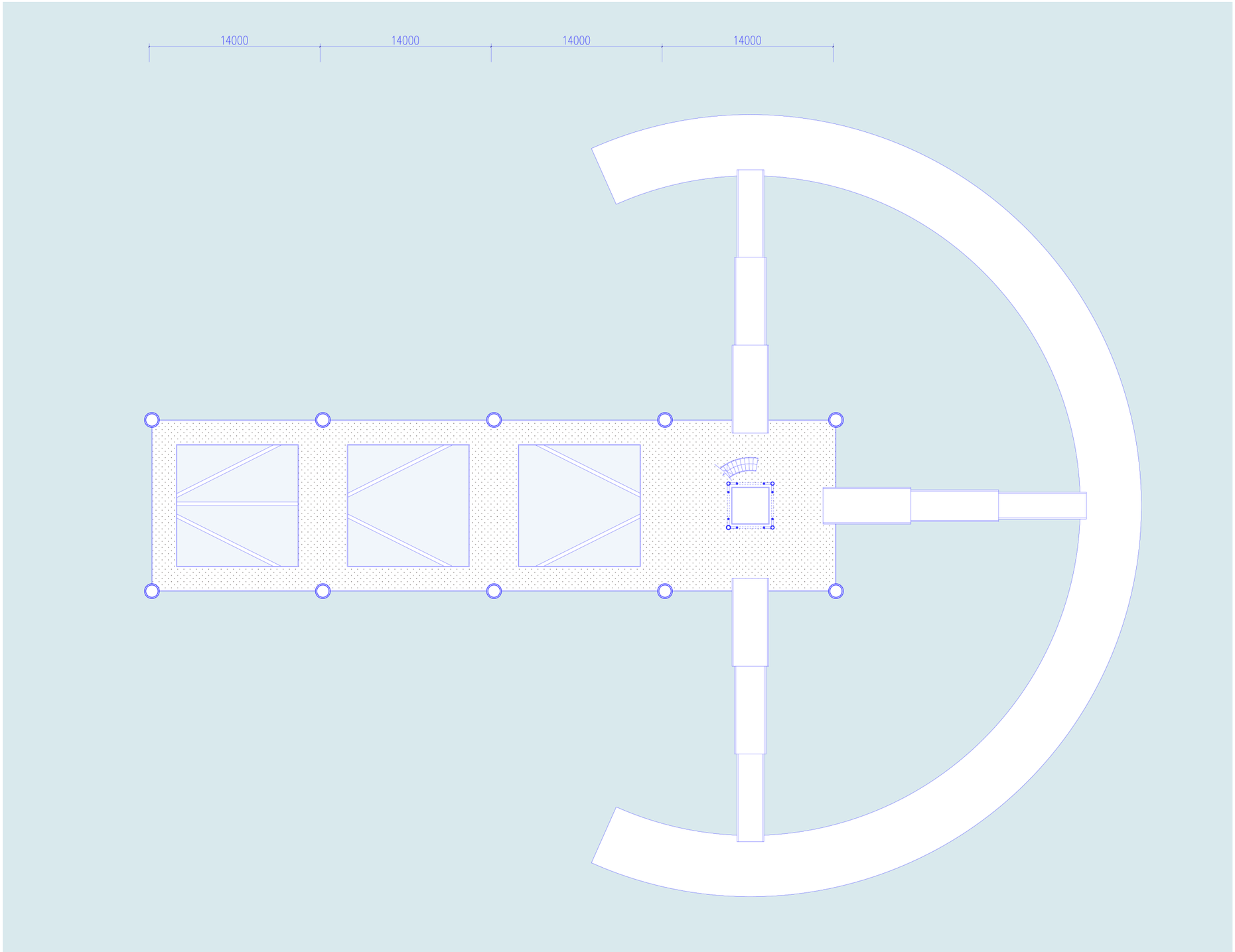
3.9 Overall Plan

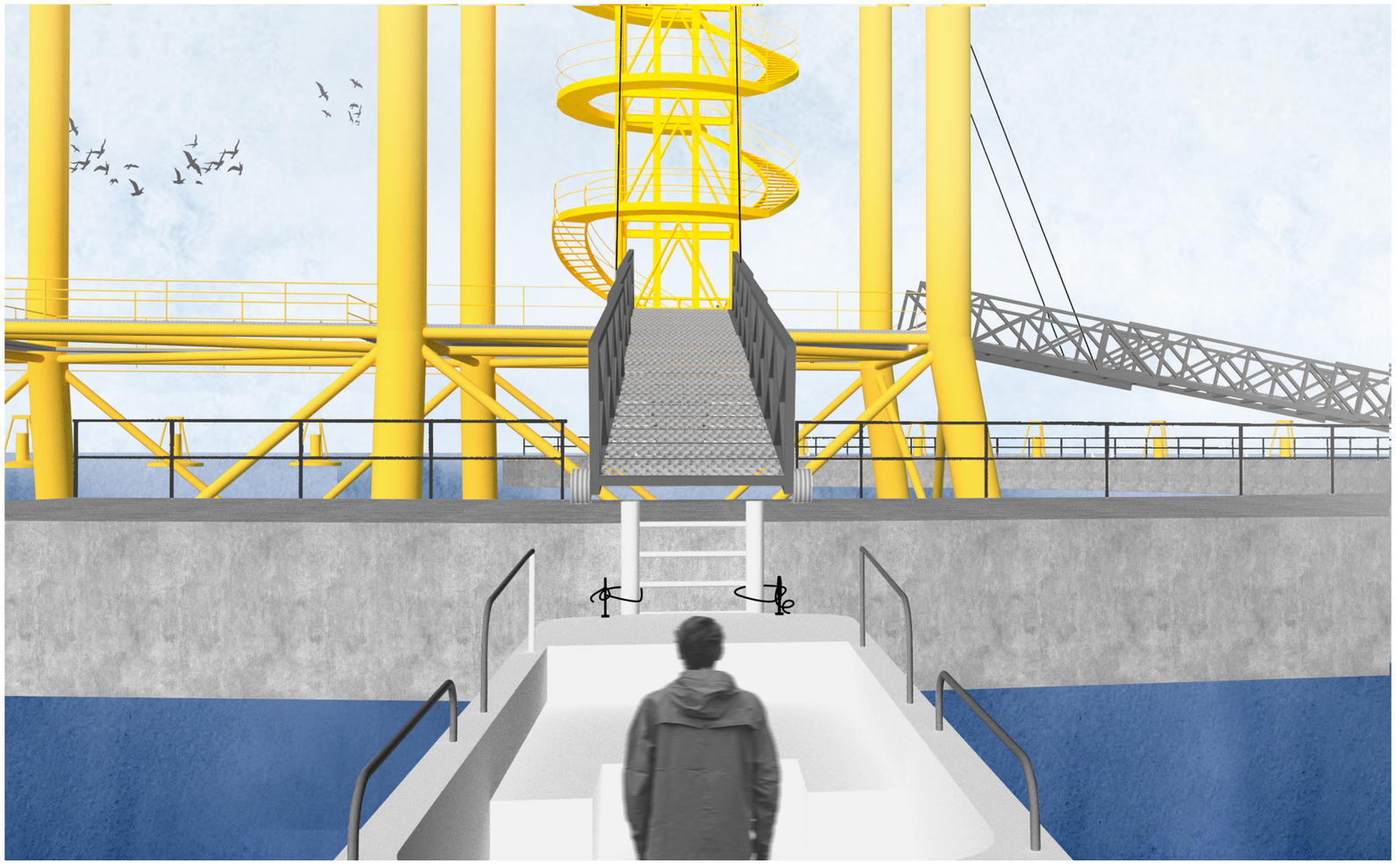


3.10 Plans and Renderings

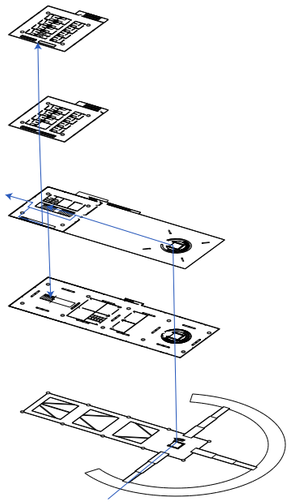
Lobby Volume (-21m Plan 1:300)

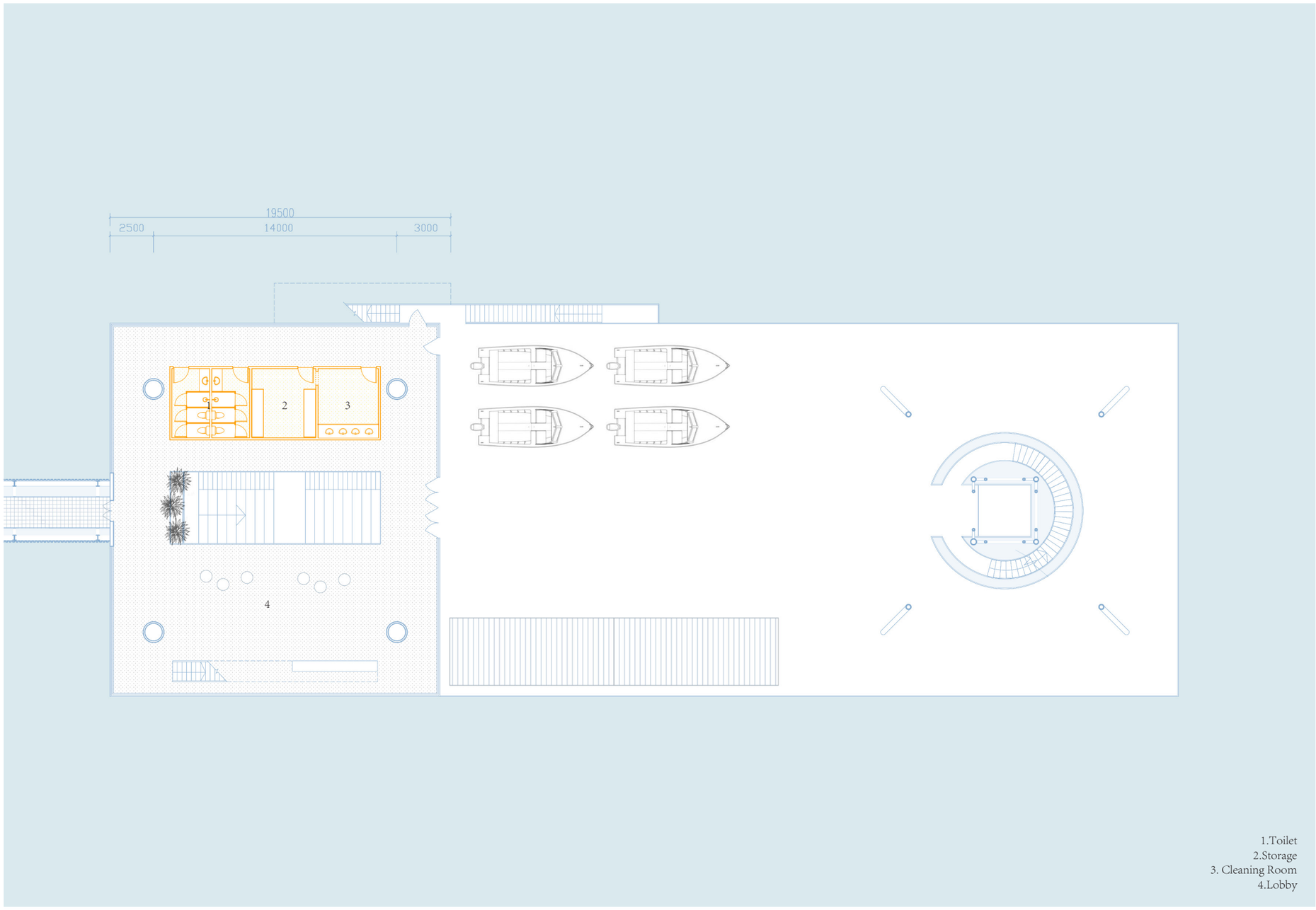






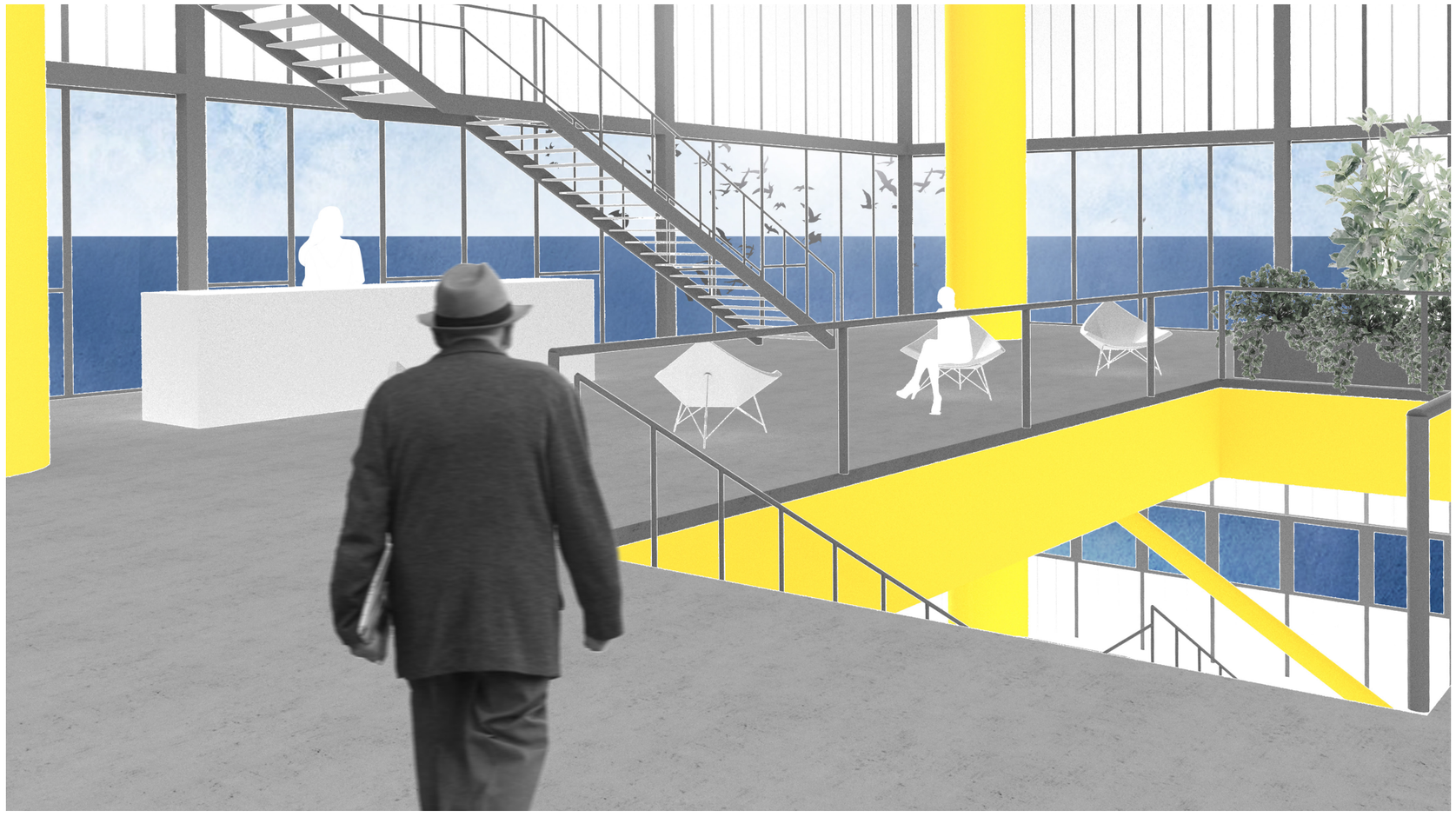
Lobby Volume(0m Plan 1:250)



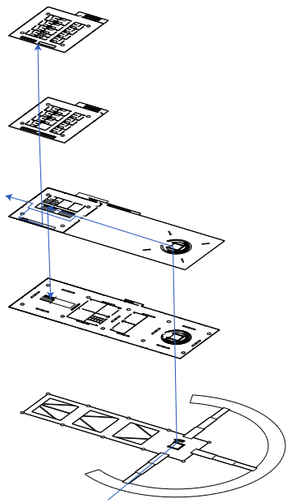


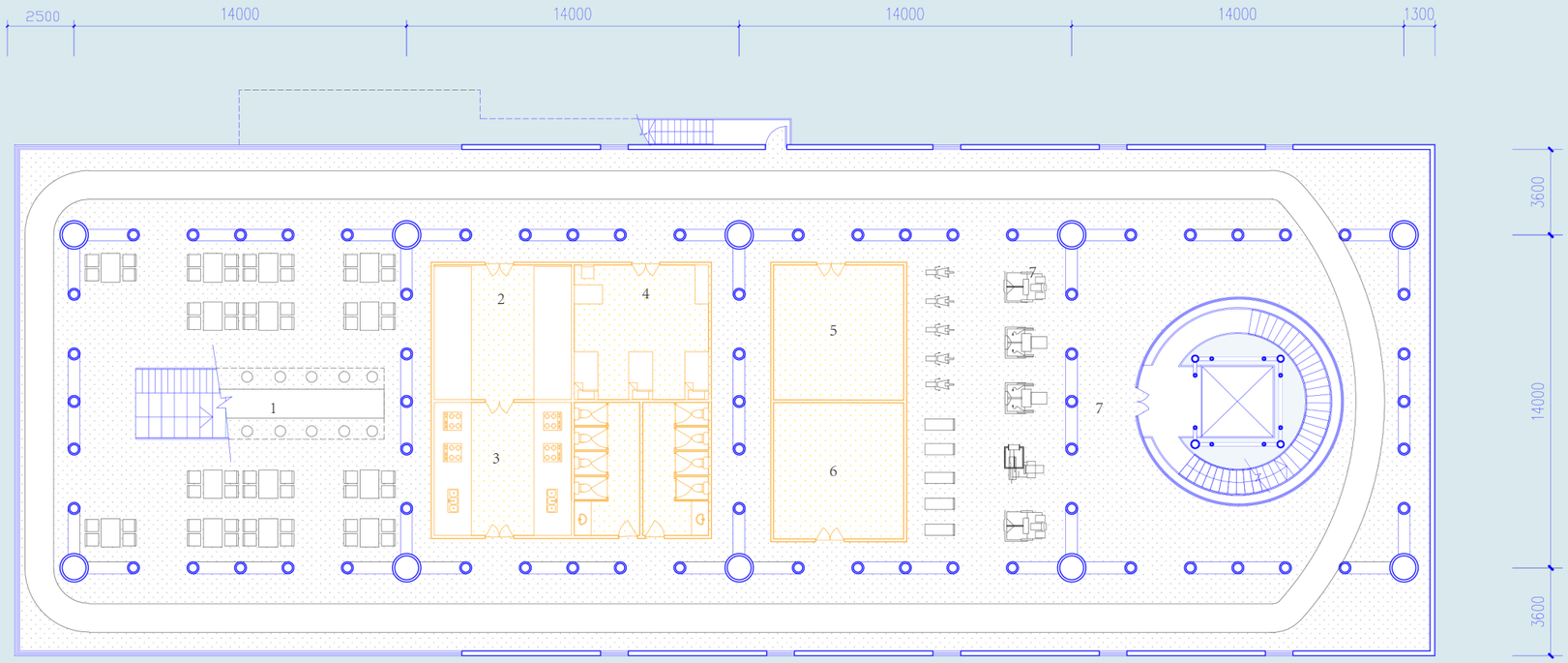
This level is the main entrance of the whole platform. People have to pass an open deck with piling containers and boats, having a typical offshore experience. In the lobby, there are cleaning rooms and storage rooms for researchers who need to go out and conduct in-situ experimentation and observation.

1.Toilet
2.Storage
3. Cleaning Room
4.Lobby



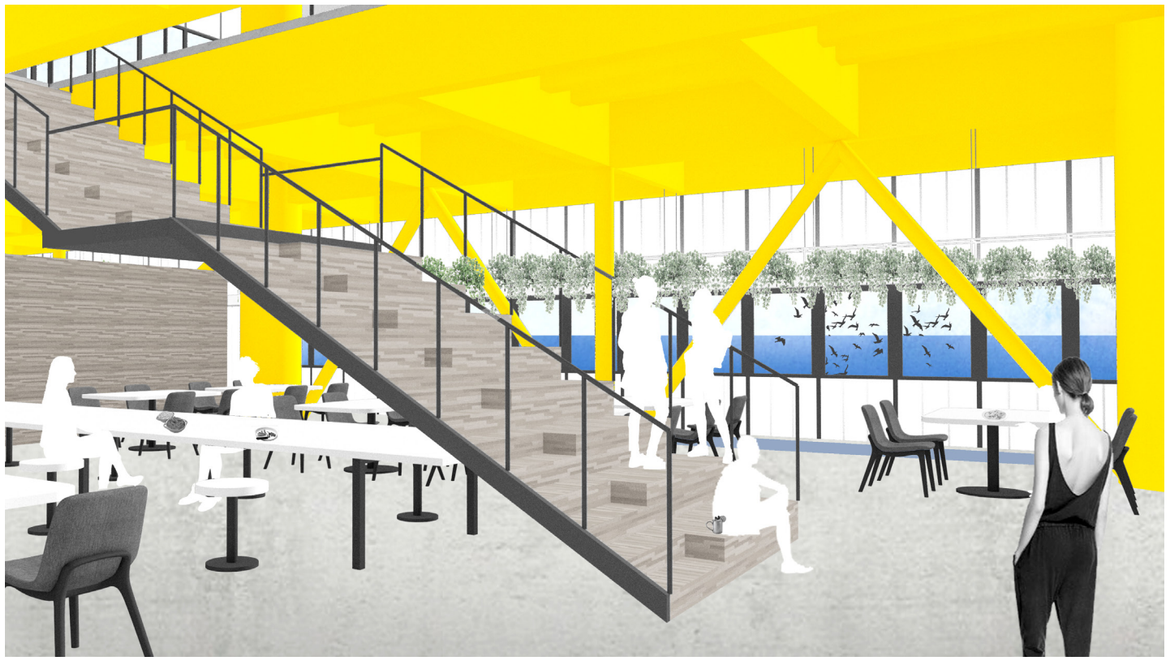
Lobby Volume(-5.4m Plan 1:250)

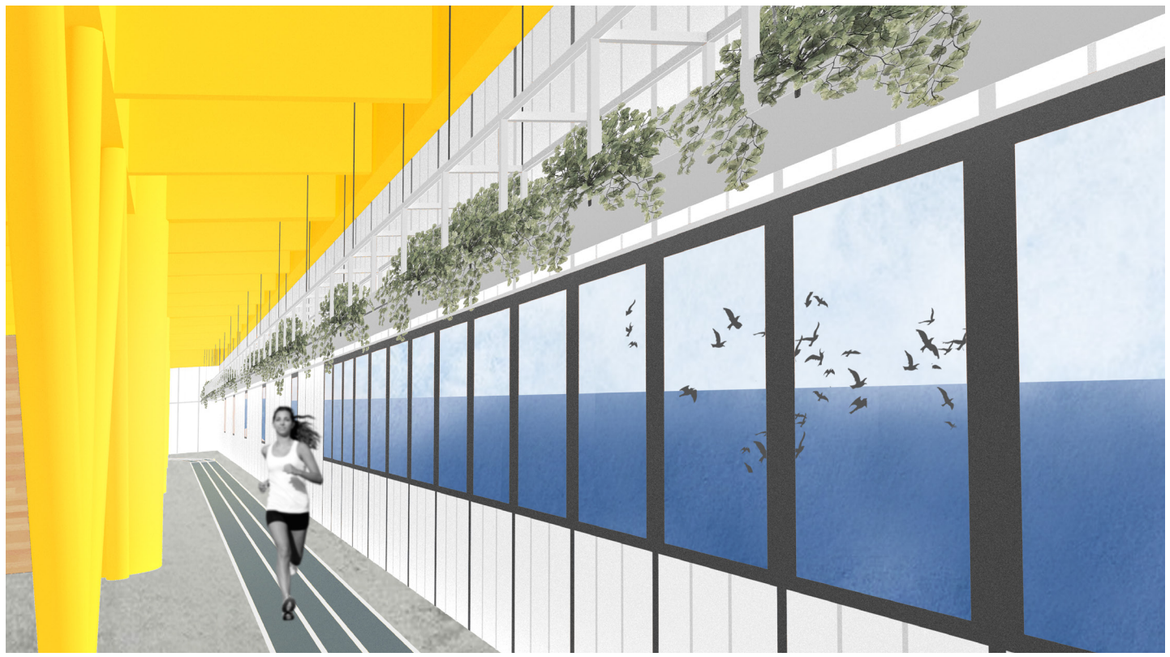




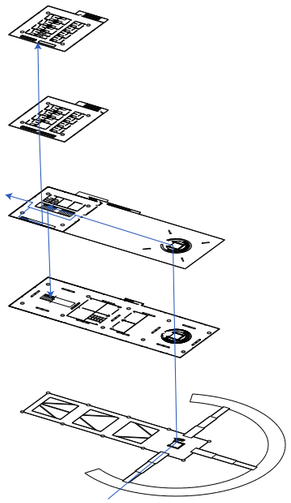
This floor contains a restaurant with 60 seats, when there's more people, the big stair can be used. There are also medical treatment room, mechanical room,toilet. The fitness area would allow 15 people to exercise together. A running path around all the space.

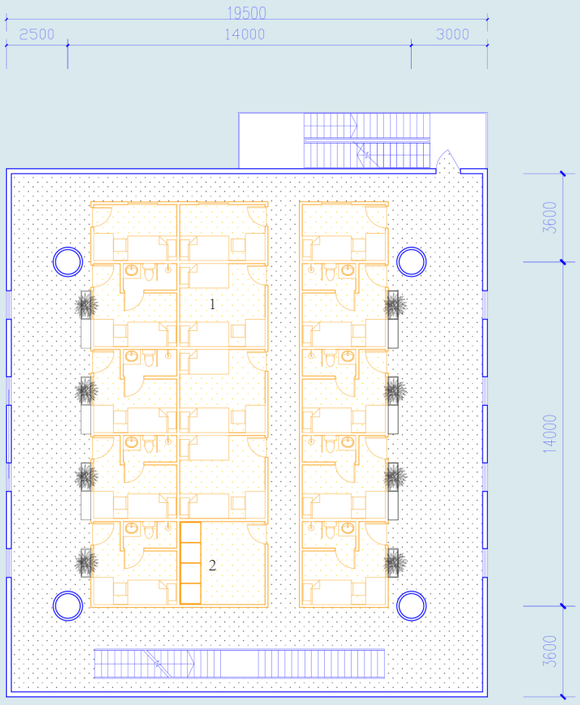
1. Restaurant
2.Kitchen
3.Kitchen Storage
4.Medical Treatment
5.Water related mechanical room
6.Other mechanical room
7.Fitness

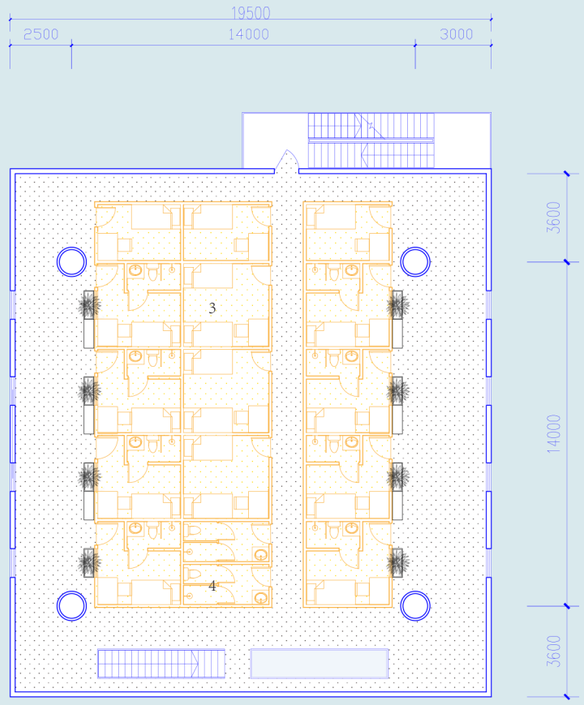




Lobby Volume(7.2m & 10.8m Plan 1:250)



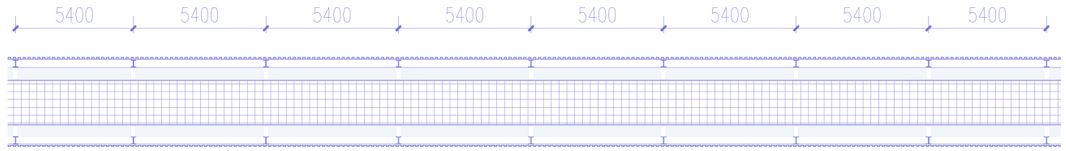


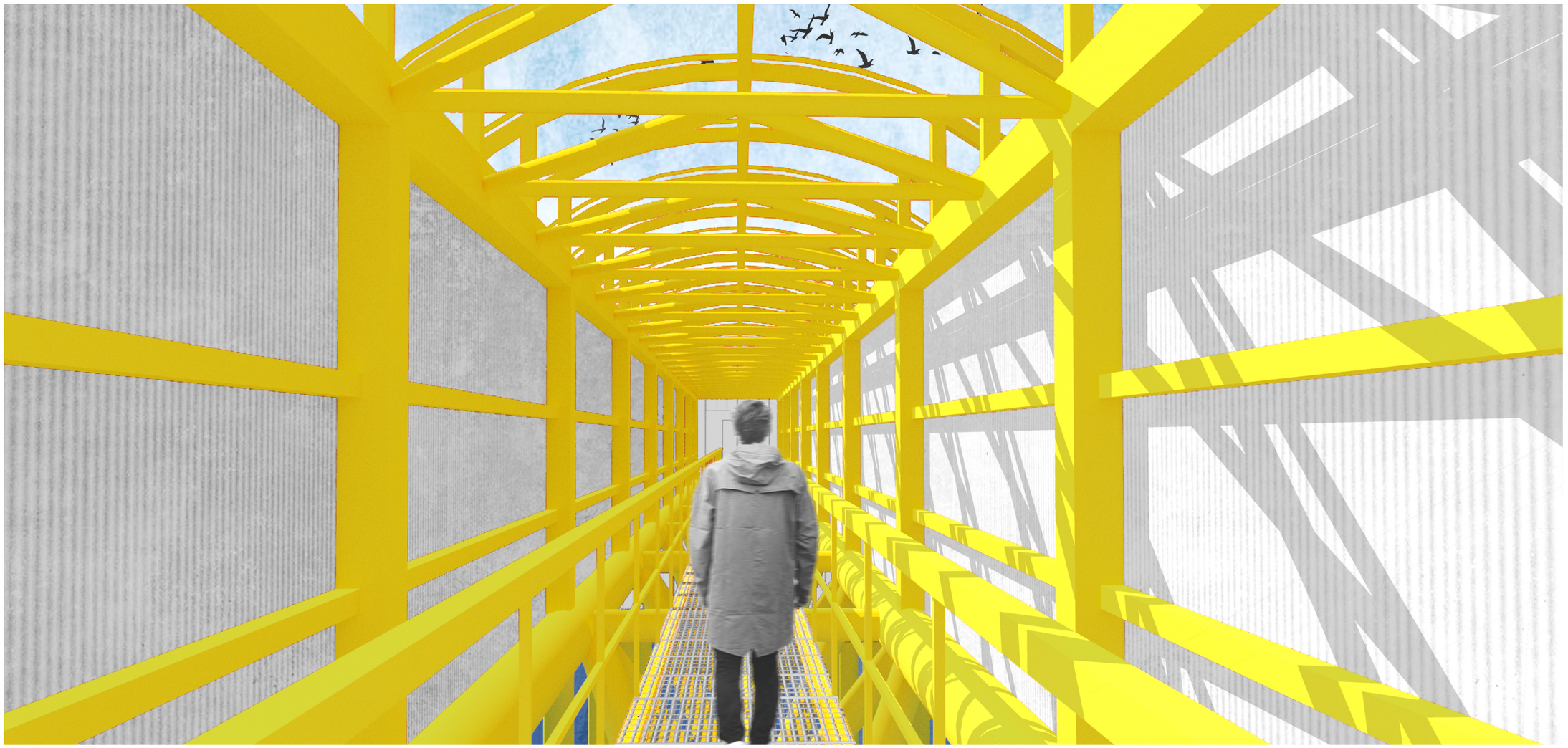


There are 16 single bed rooms for researchers who have to conduct long-term research，in case they live far away and are not able to commute daily. Apart from that , there are also 18 beds for people who conduct shor-term research. Chairs and plants are put in the corridors in order to create a more intimate atmosphere.

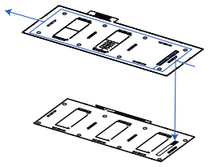
1. Single bed room
2.Laundry room
3.Double bed room
4.Toilet and shower

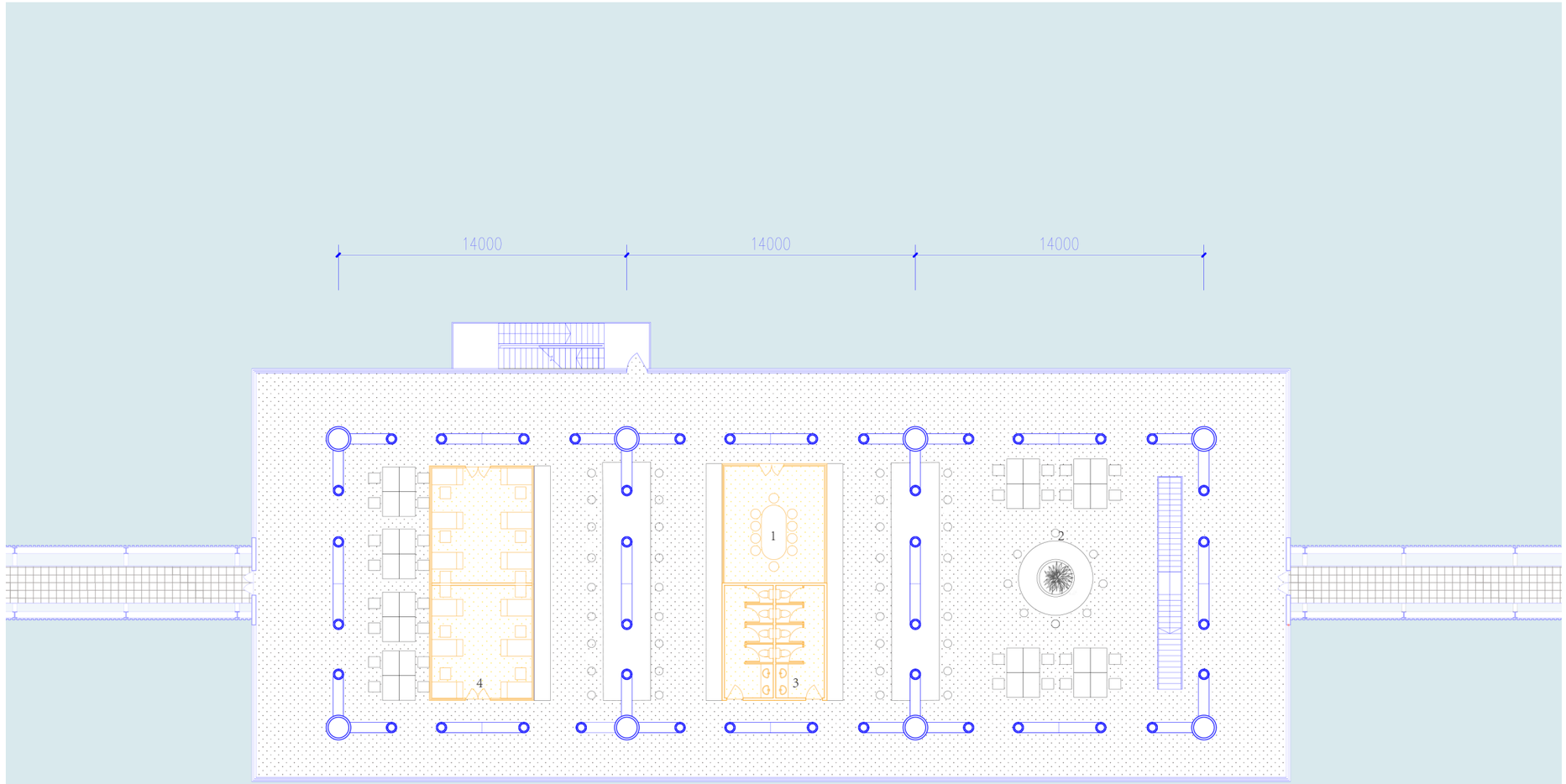
Bridge (0m Plan 1:250)





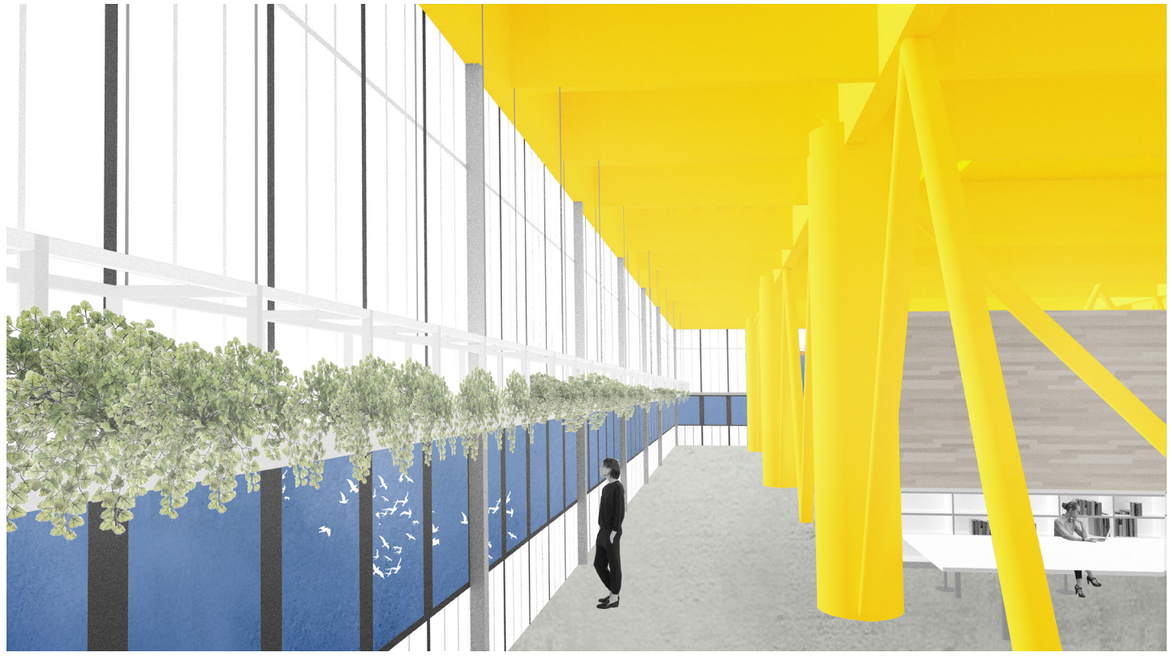
Office (0m Plan 1:250)



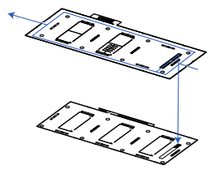


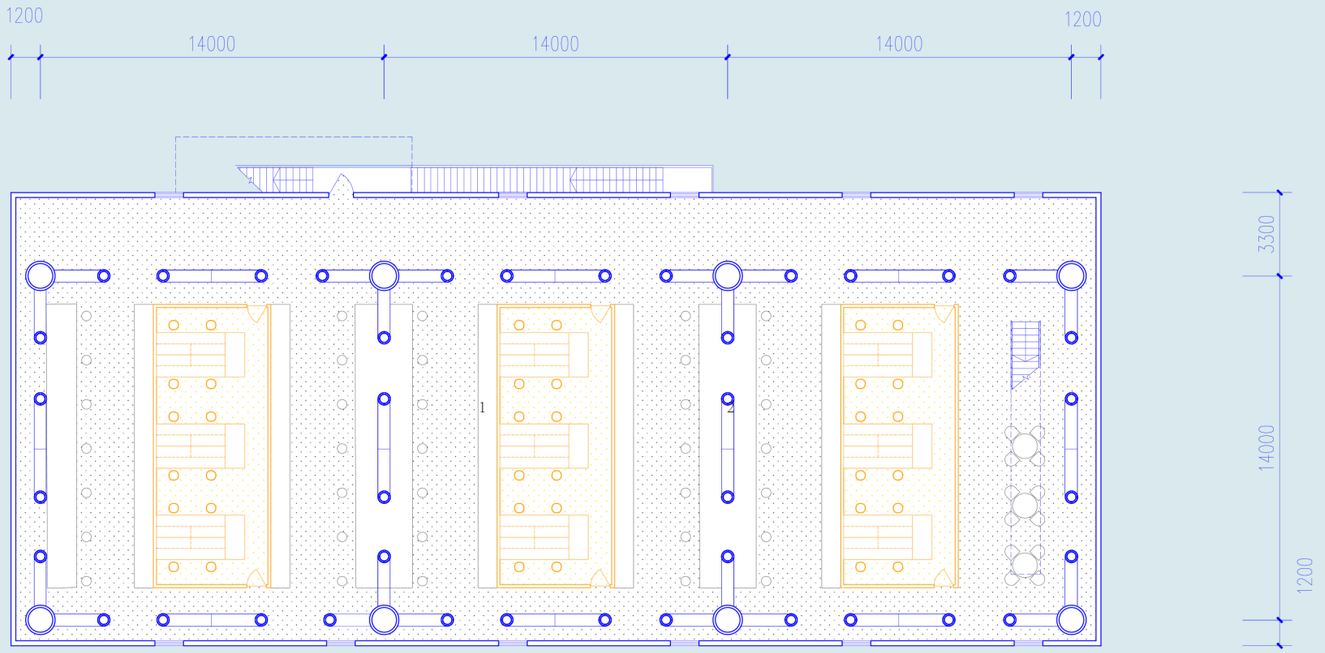
90 people can work in this area and there's also a small meeting room.

1.Meeting room
2.Open Office
3.Toilet
4.Closed Office



Office (-5.4m Plan 1:250)

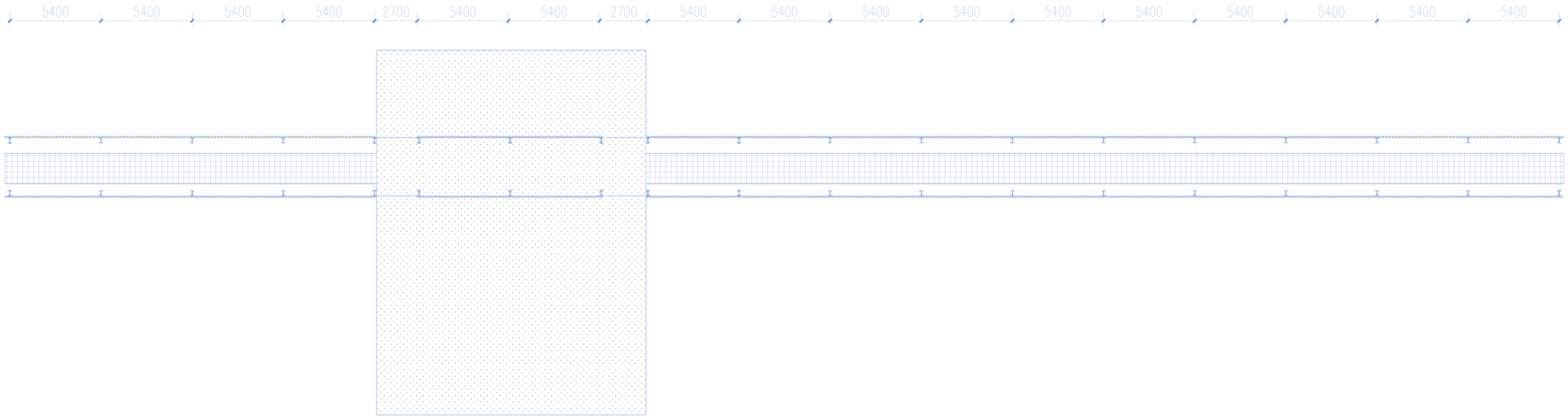


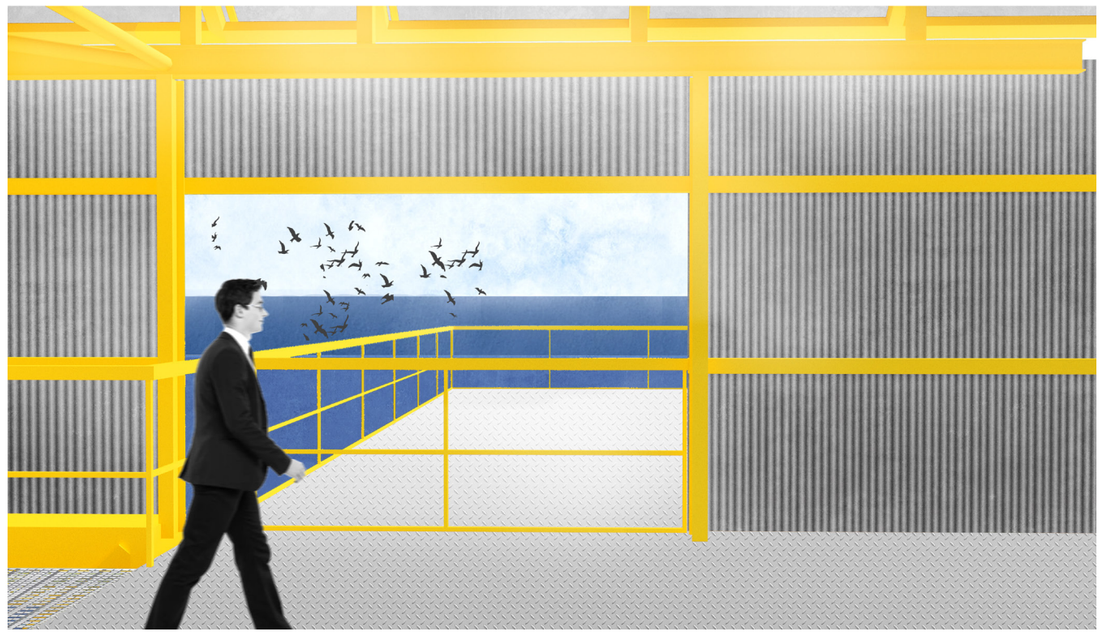


According to the floor plans of Carnegie Department of Global Ecology, the floor area of lab is around two thirds of the office and meeting area. And the area of closed lab is comparable to the open lab.

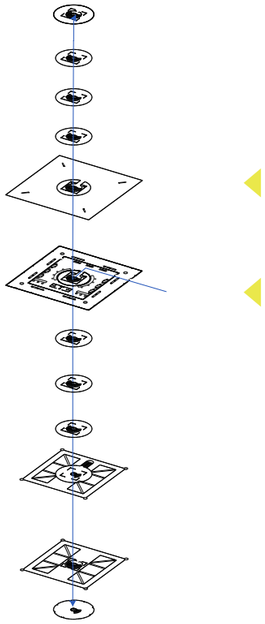
1.Closed Lab
2.Open Lab

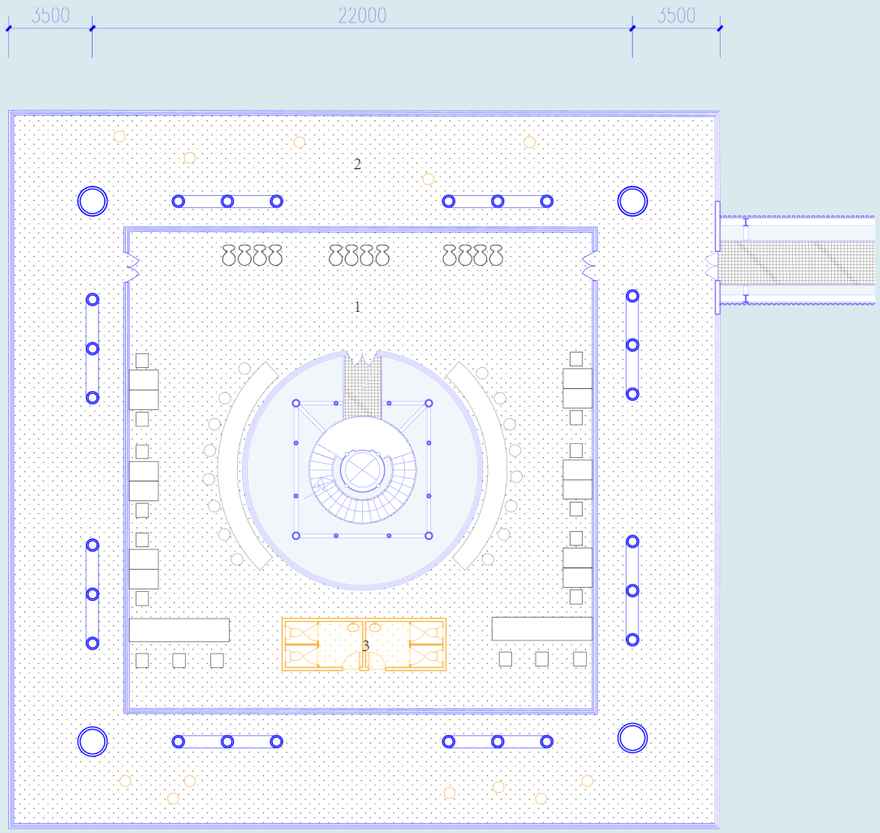
Bridge (0m Plan 1:250)



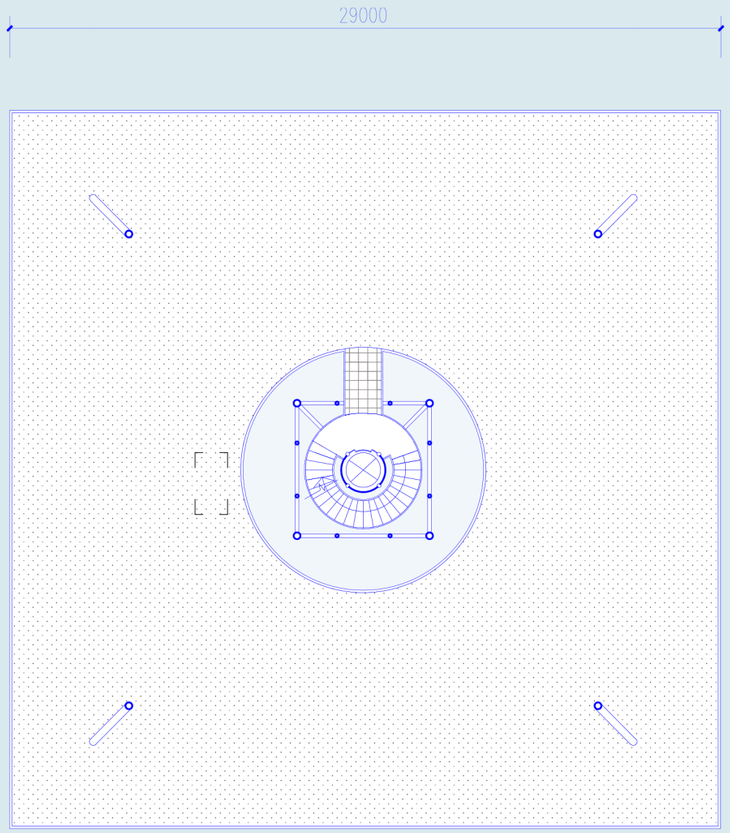


Observatory (0m&12.6m Plan 1:250)





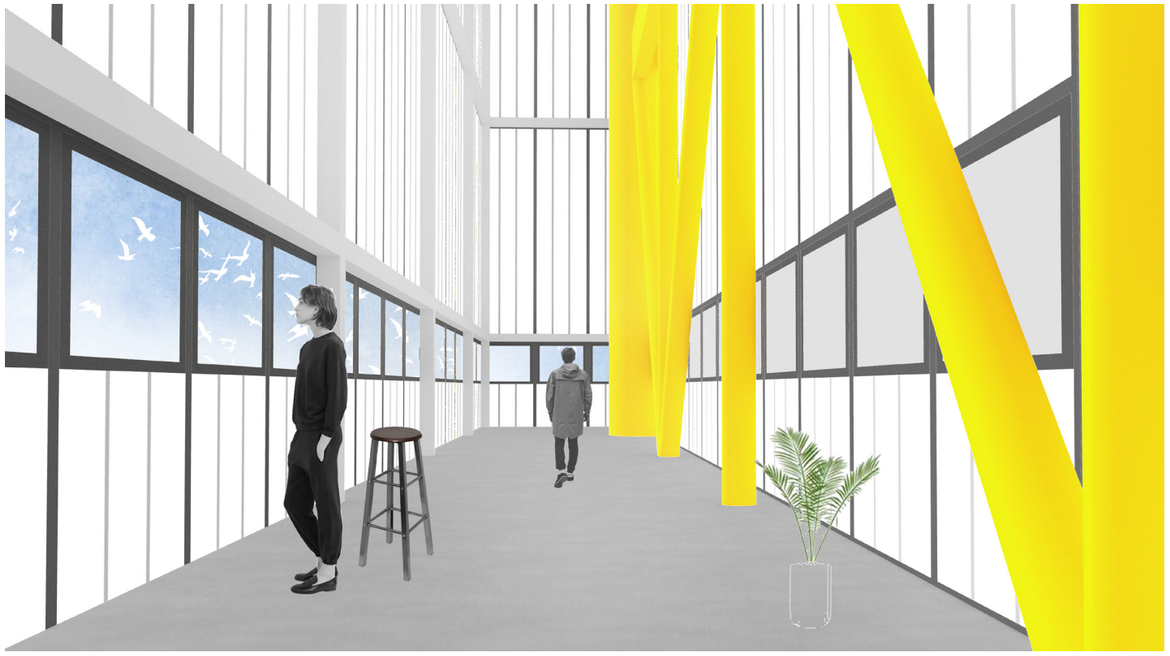
0m Plan



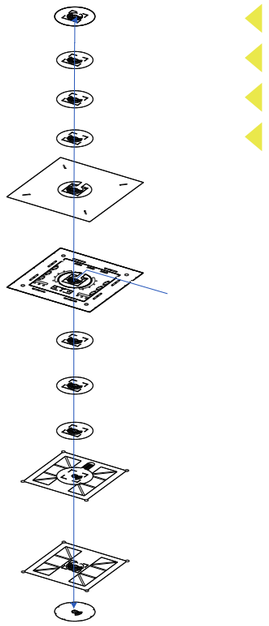
12.6m Plan

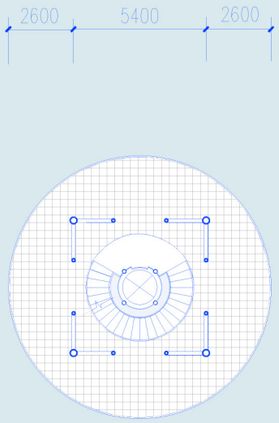
In the 0m plan, there are 3 layers of space from the outside to the inside. An observation corridor for people to watch the sea surface, an observation related office and a transportation core. There expected to be 5-10 people maximum to observe at the same time

1.Office
2.Observatory corridor
3.Toilet

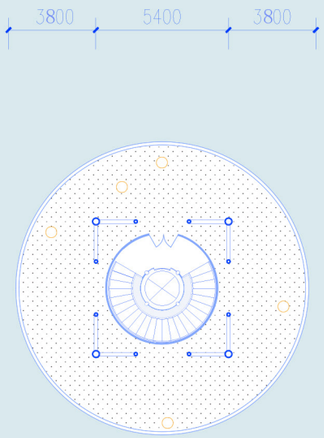


Observatory (12.6m, 16.8m, 21m,25.2m, 29.4m Plan 1:250)

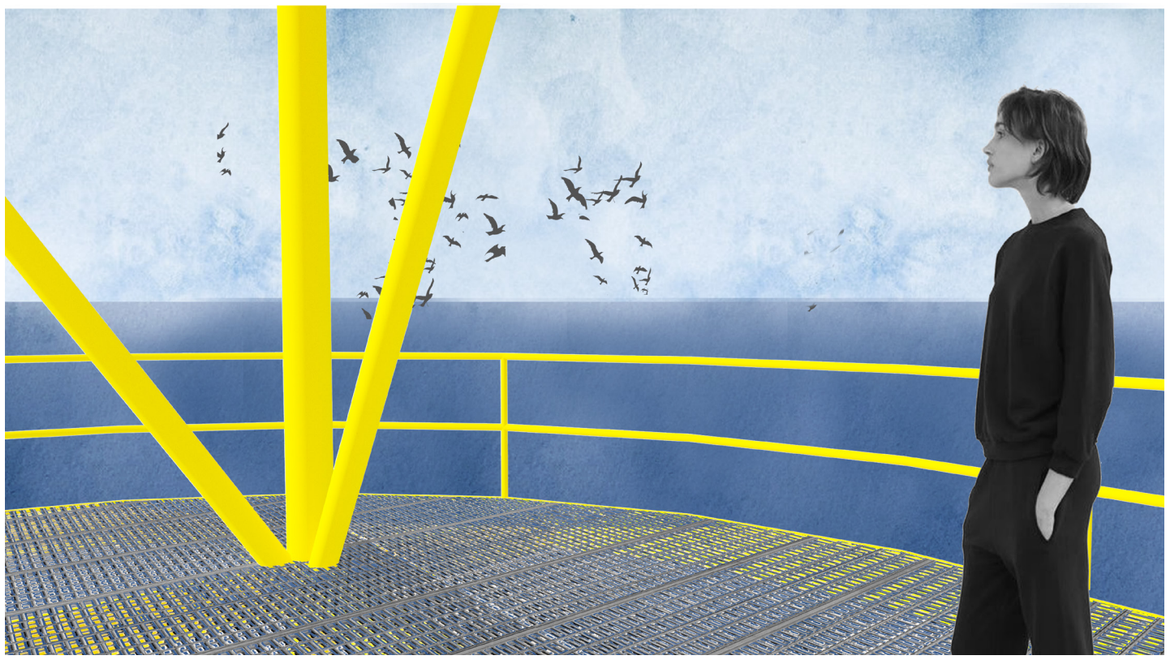




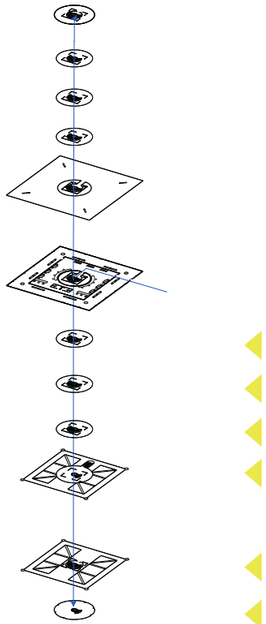
12.6m, 16.8m,21m,25.2m,Plan

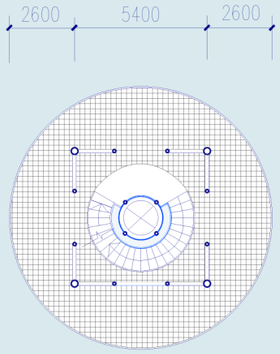


29.4m Plan

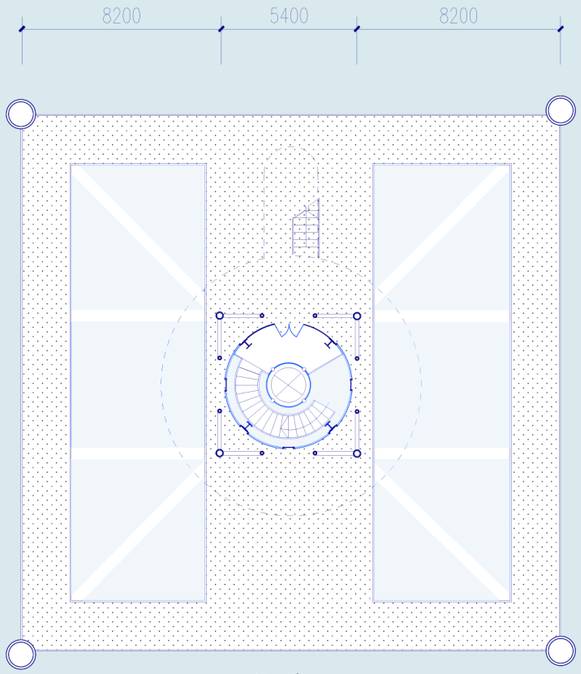


Observatory (12.6m, 16.8m, 21m,25.2m, 29.4m Plan 1:250)

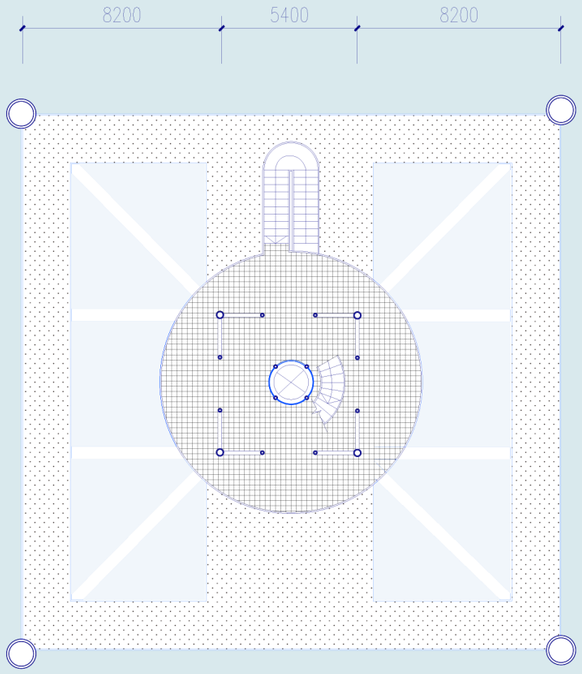




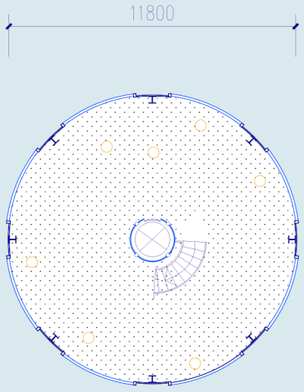
-4.2m,-8.4m,-12.6m Plan



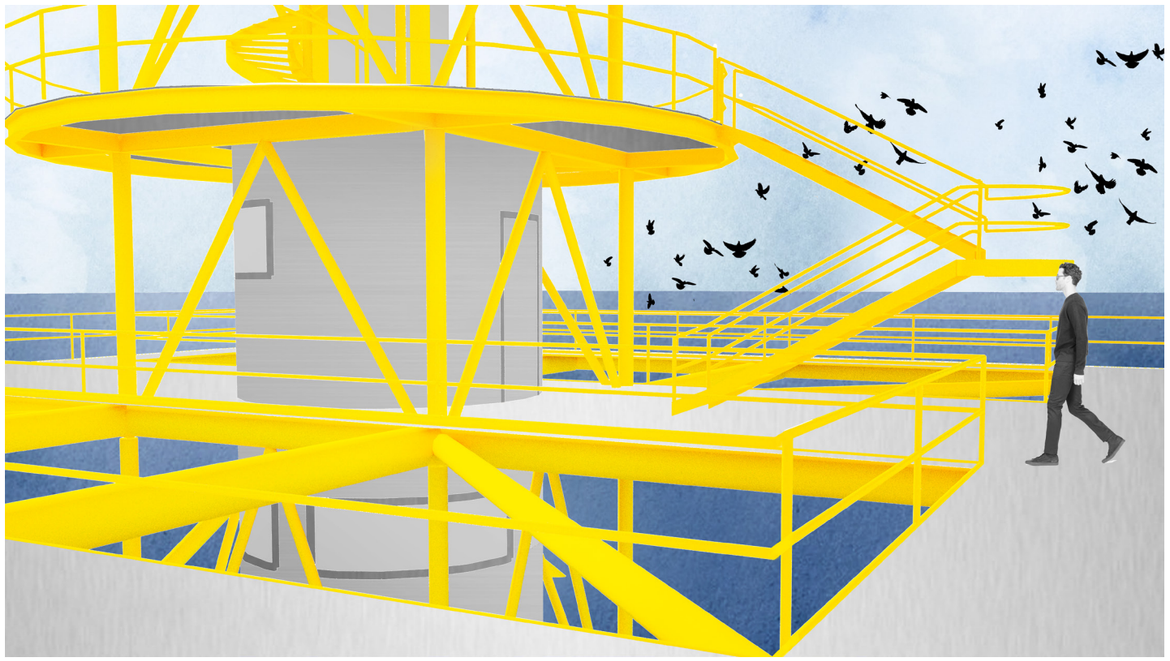
-21m Plan

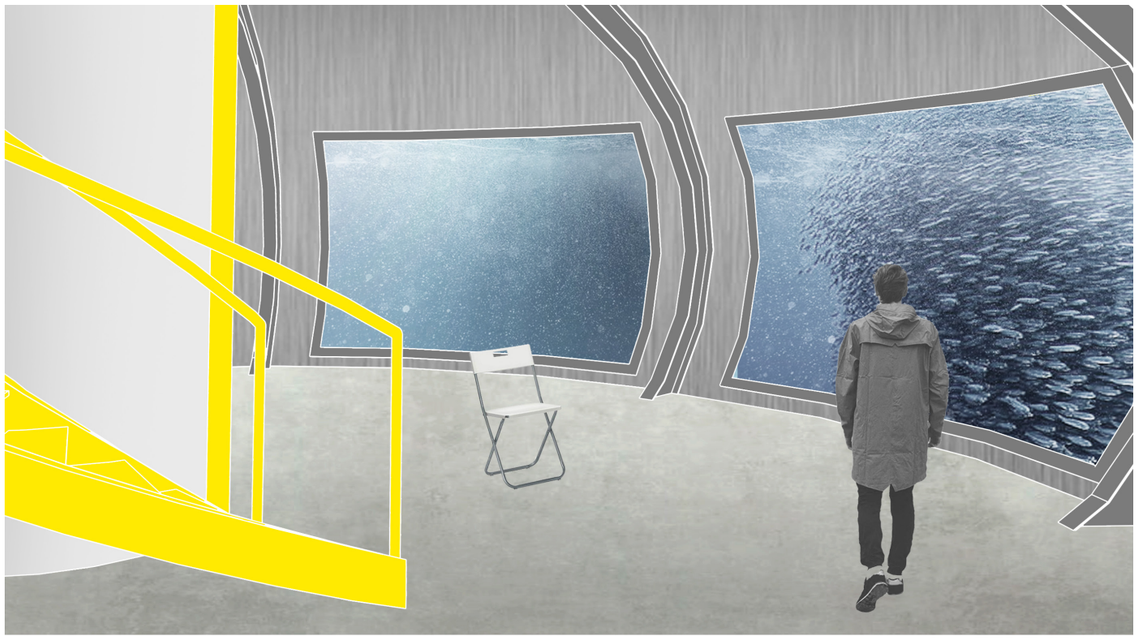


-16.8m Plan

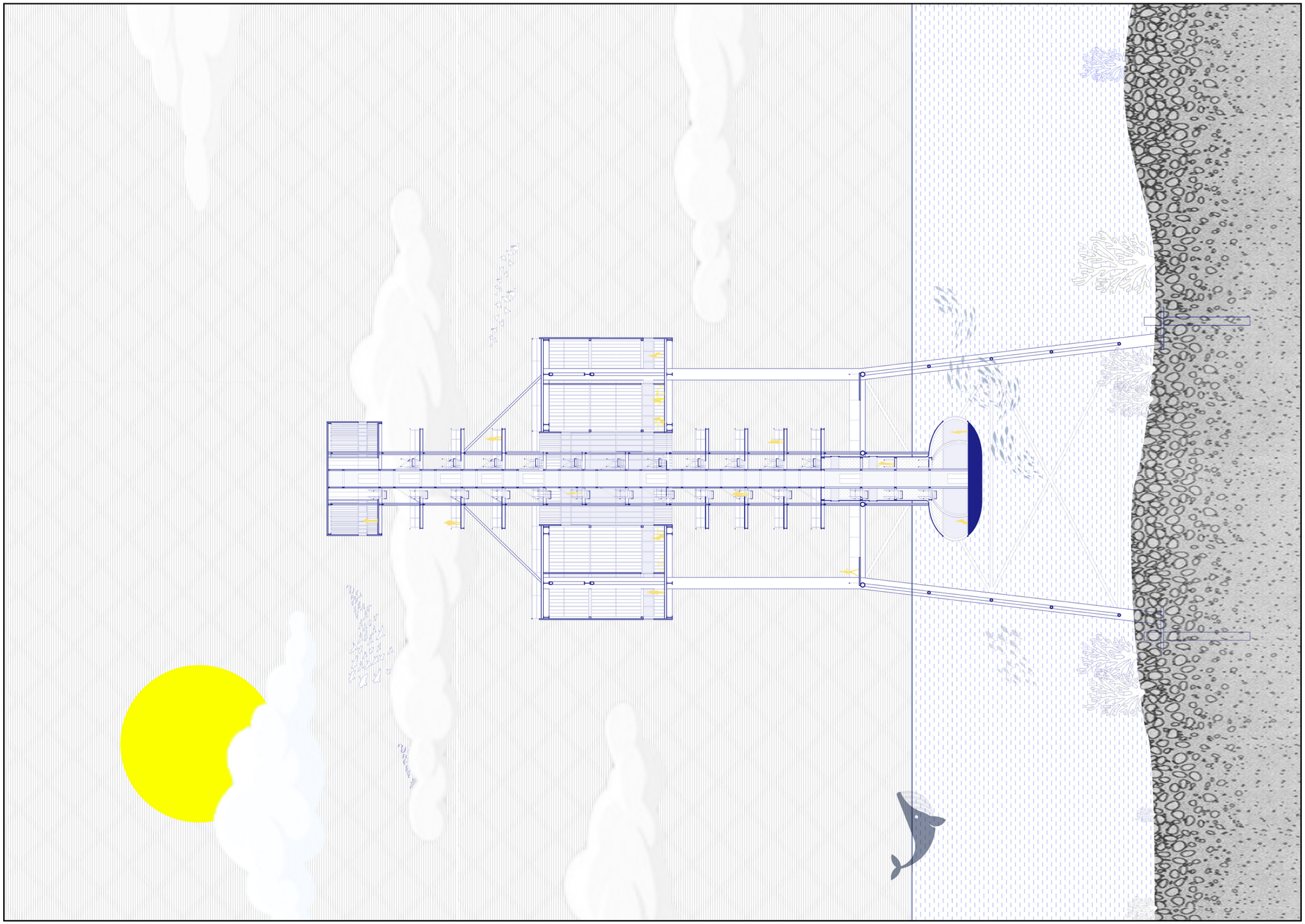


-31.9m Plan(Aquarium)



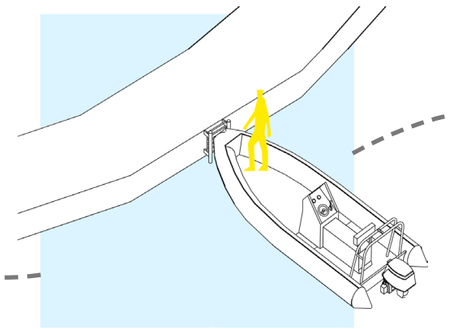


3.11 Observation Center Section

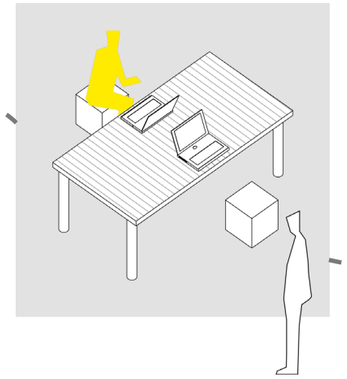


3.12 A Day in the Research Center

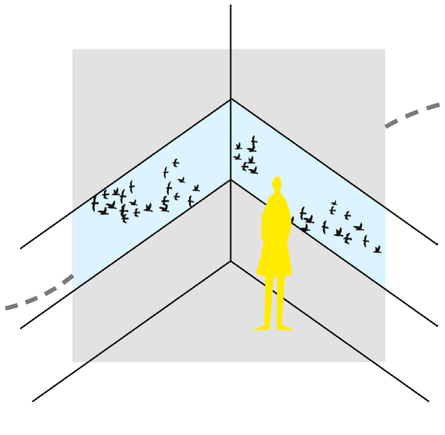
9 am
Arrival



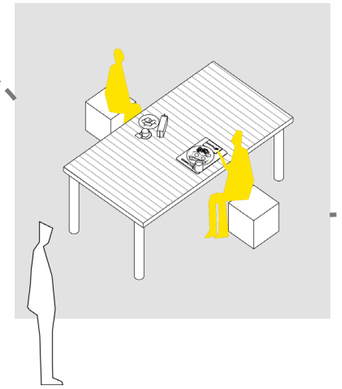
10 am
Work in Office



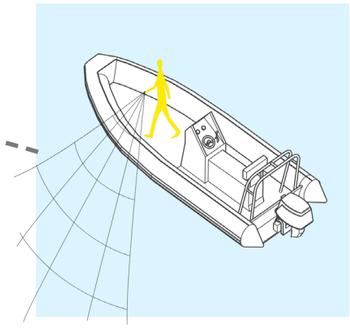
11 am
Observe



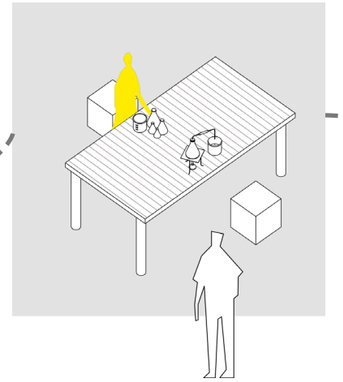
12 am
Have Lunch



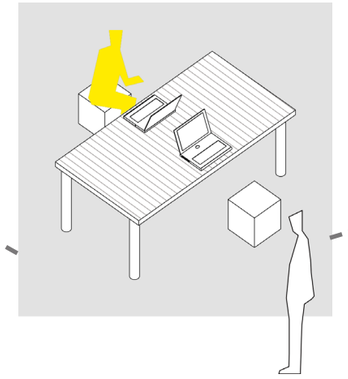
1pm
On Field Investigation



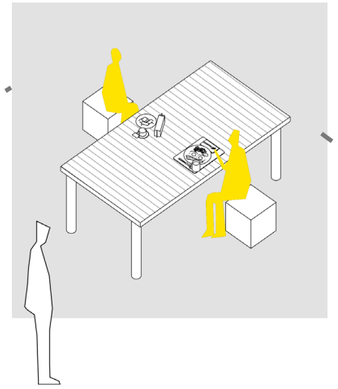
2pm
Experiment in Lab



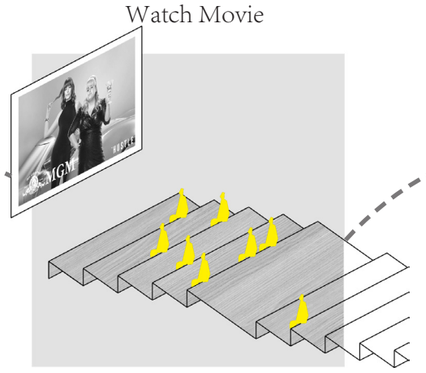
4 pm
Work in Ofiice



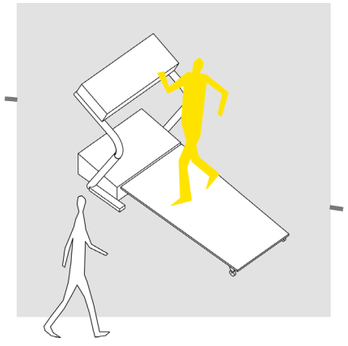
6 pm
Have Dinner



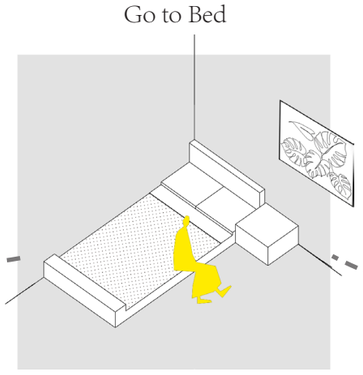
7 pm
Watch Movie



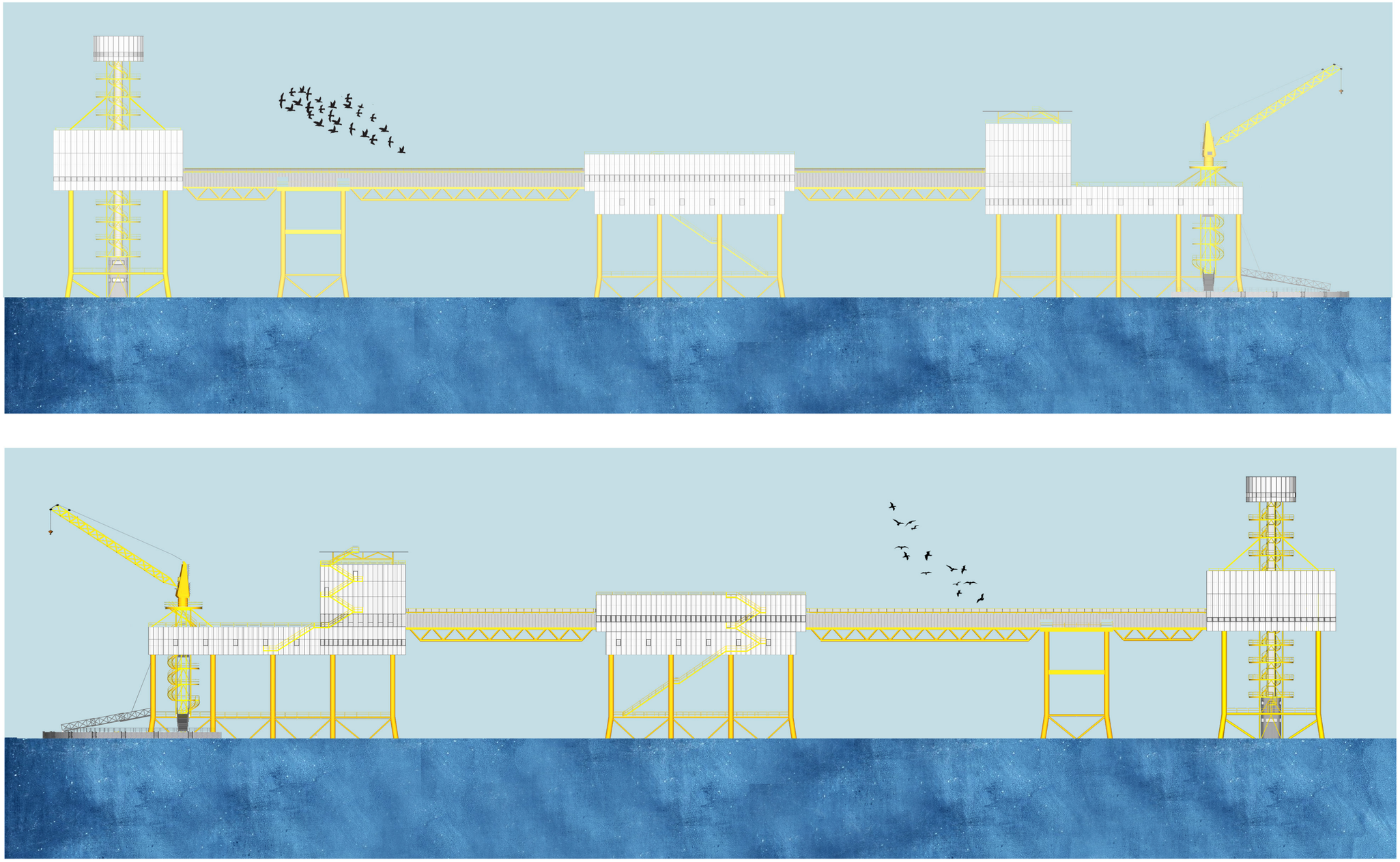
8 pm
Execise



10 pm
Go to Bed



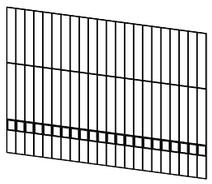
3.13 Facade 1:1000



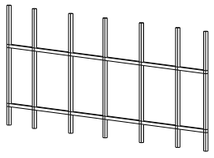
Technical Document

4.1 Facade and Detail

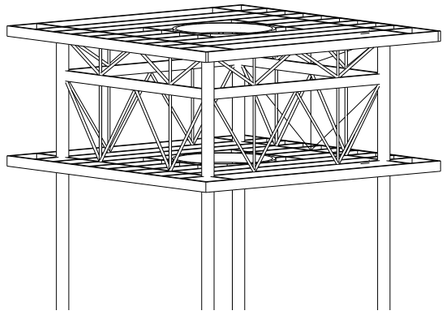
The Layer of Facades



Transluscent Wall Panel



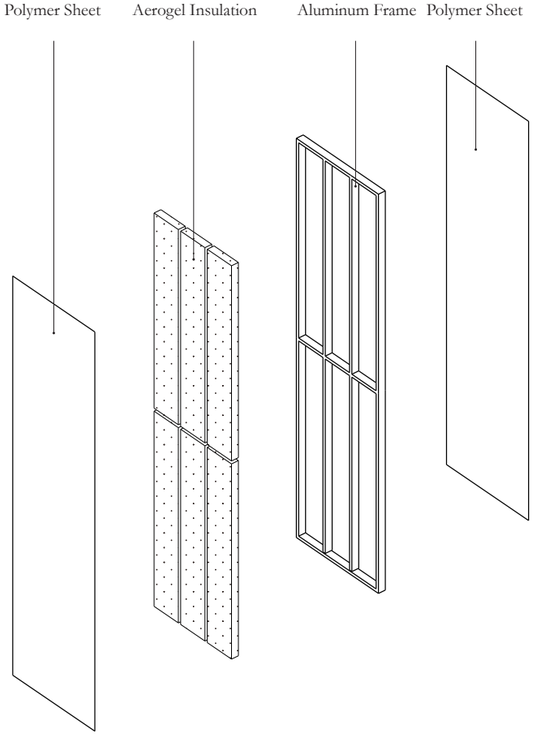
Steel Facade Substructure

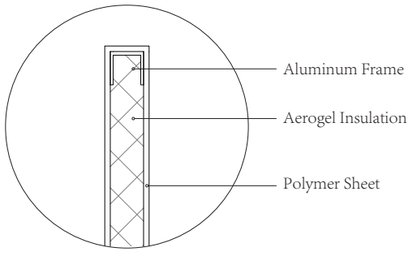


Main Structure

The facade system consists of facade panels, substructure in order to resist the wind load and main structure.

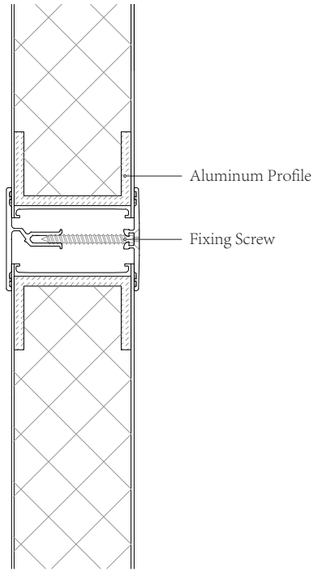
Facade Panel Illustration



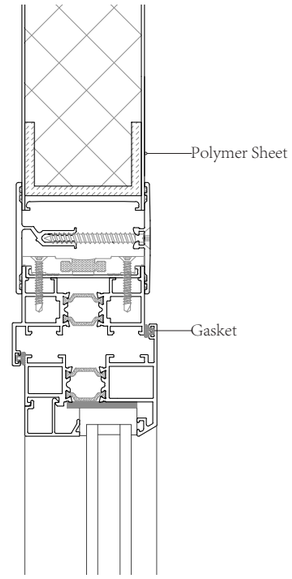


The facade panel consists of 2 polymer panels outside, an structural aluminum frame and transluscent insulation integrated with the aluminum frame. Polymer is salt resistant, which makes it very suitable in the marine environment. The panel in the observatory tower are 1.2 m wide. But their heights are 5m and 3.5 meter.

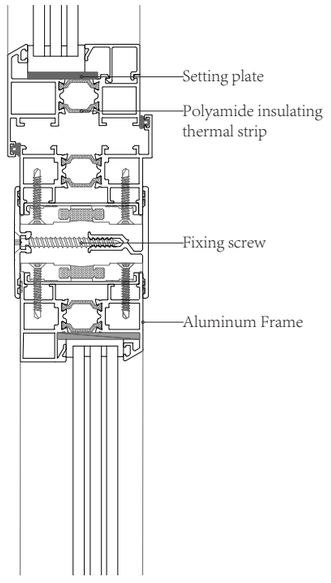
Detail of Facade Panel



Panel to panel connection

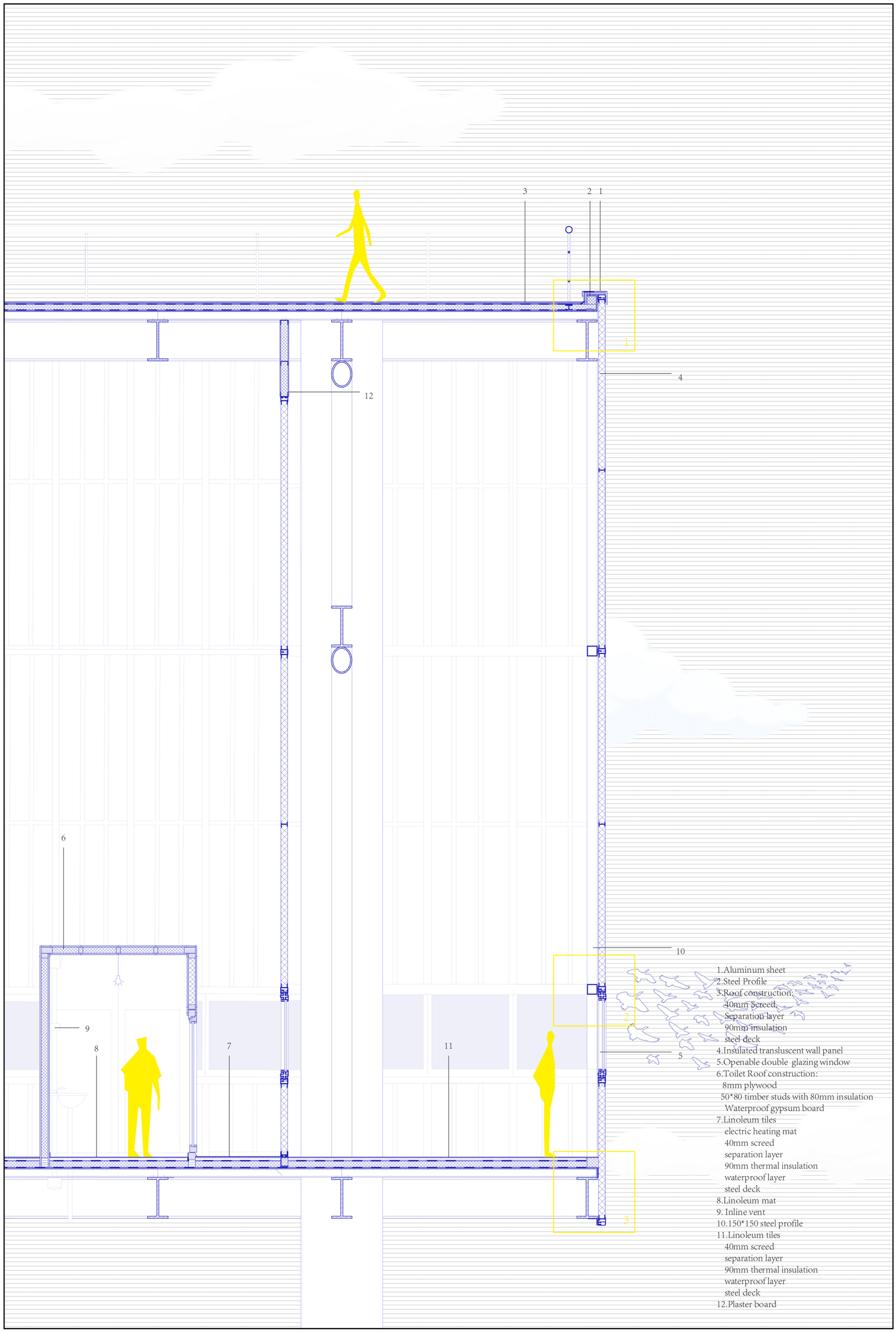


Panel to window connection



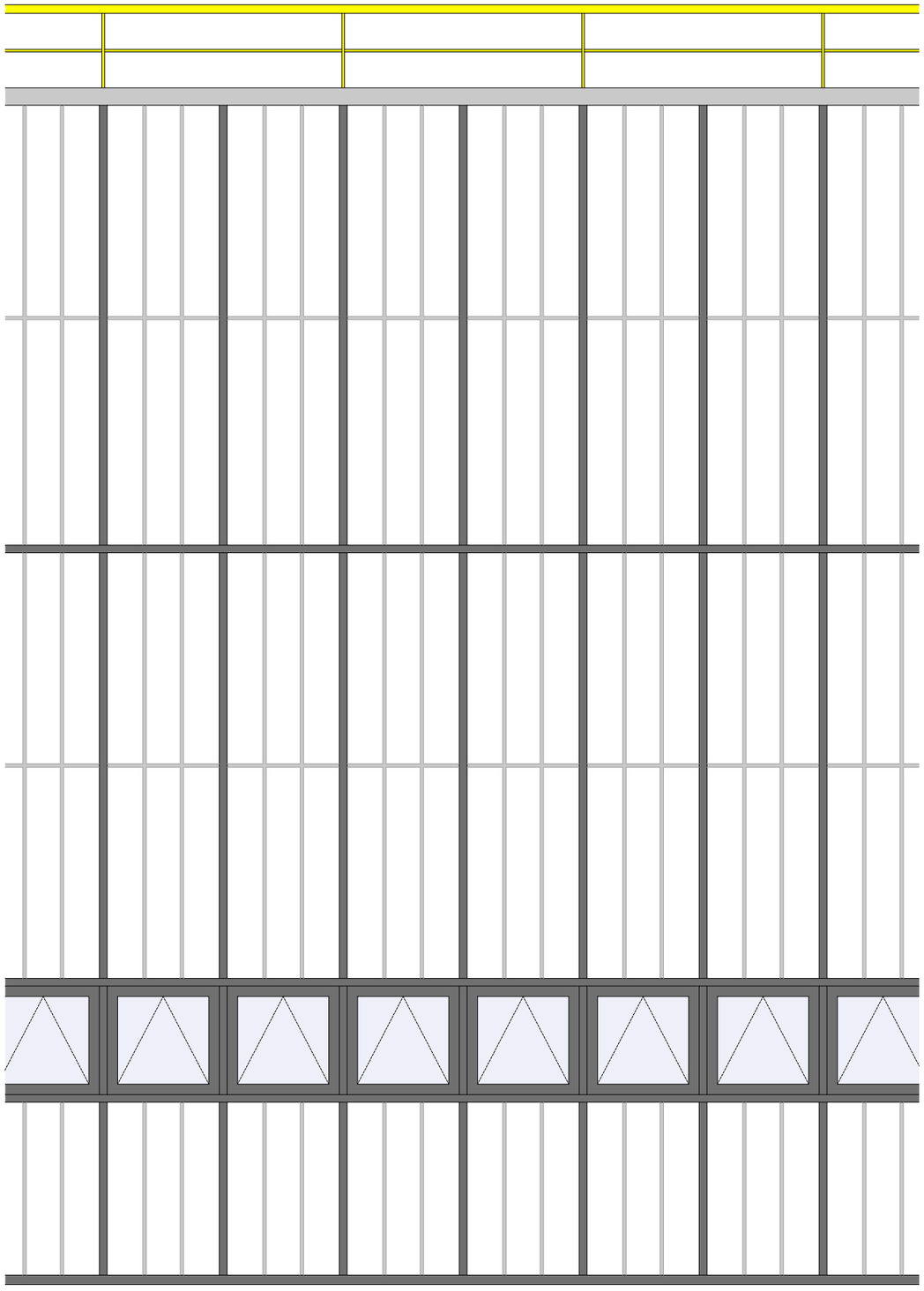
Windowto window connection

Detail of Observatory Tower 1:50

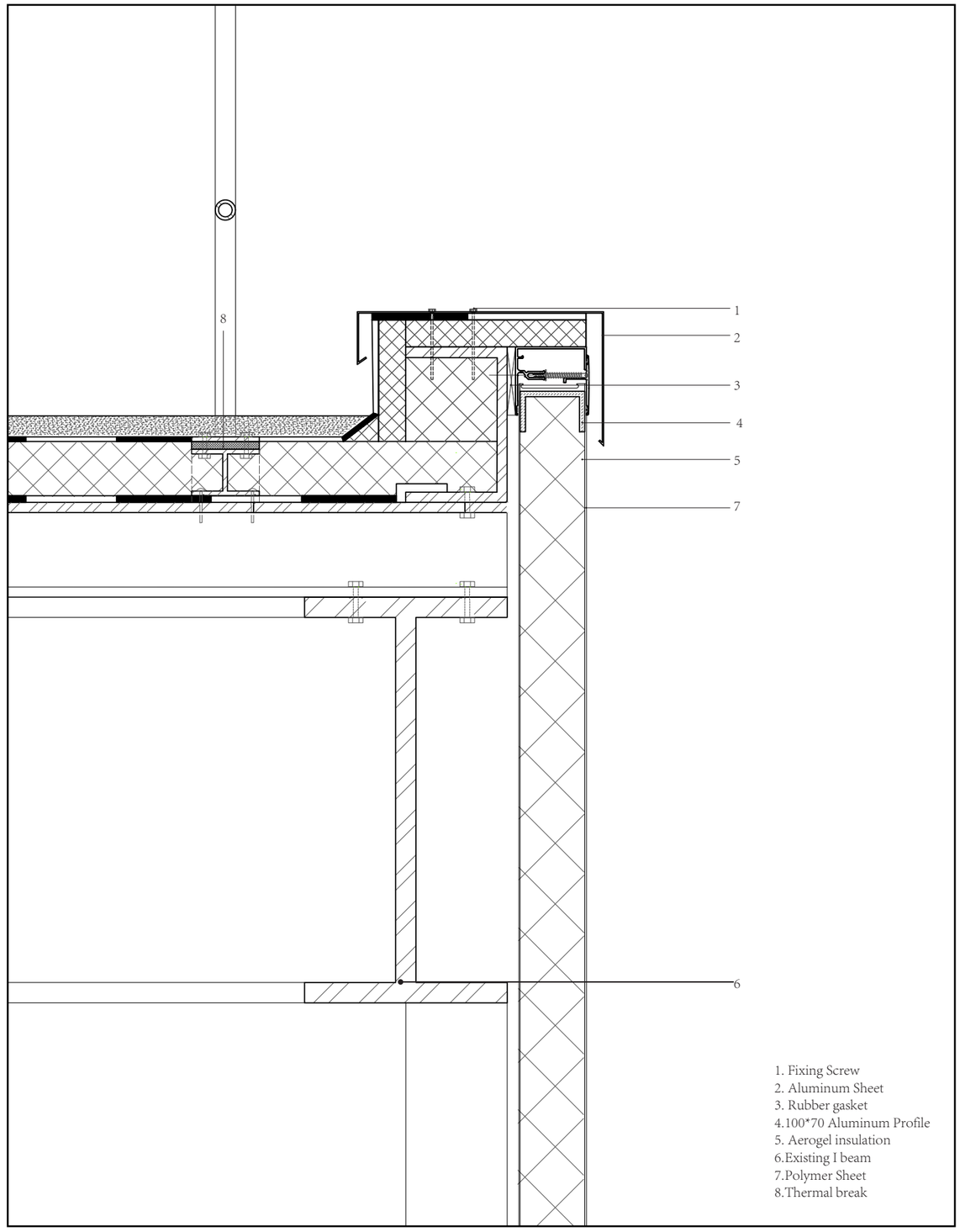


1.Aluminum sheet
2.Steel Profile
3.Roof construction:
40mm Screed
Separation layer
90mm insulation
steel deck
4.Insulated transluscent wall panel
5.Openable double glazing window
6.Toilet Roof construction:
8mm plywood
50*80 timber studs with 80mm insulation
Waterproof gypsum board
7.Linoleum tiles
electric heating mat
40mm screed
separation layer
90mm thermal insulation
waterproof layer
steel deck
8.Linoleum mat
9. Inline vent
10.150*150 steel profile
11.Linoleum tiles
40mm screed
separation layer
90mm thermal insulation
waterproof layer
steel deck
12.Plaster board

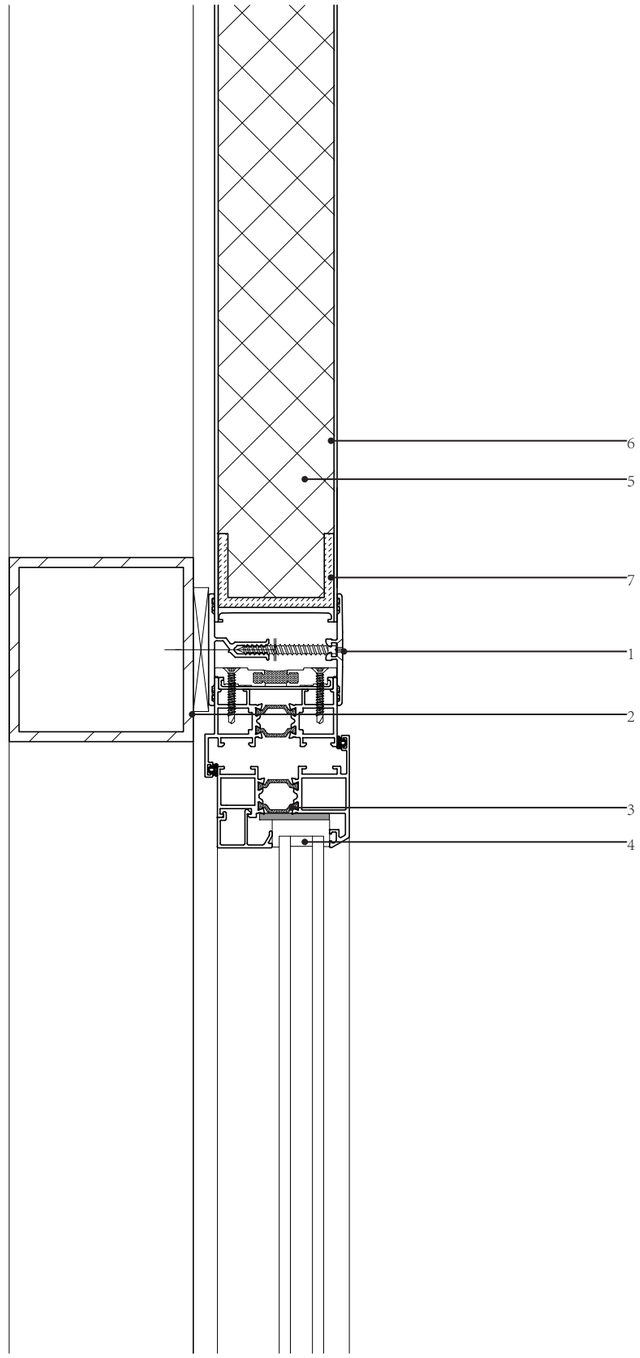
Detail of Observatory Tower （Facade）1:75



Detail 1 1:5

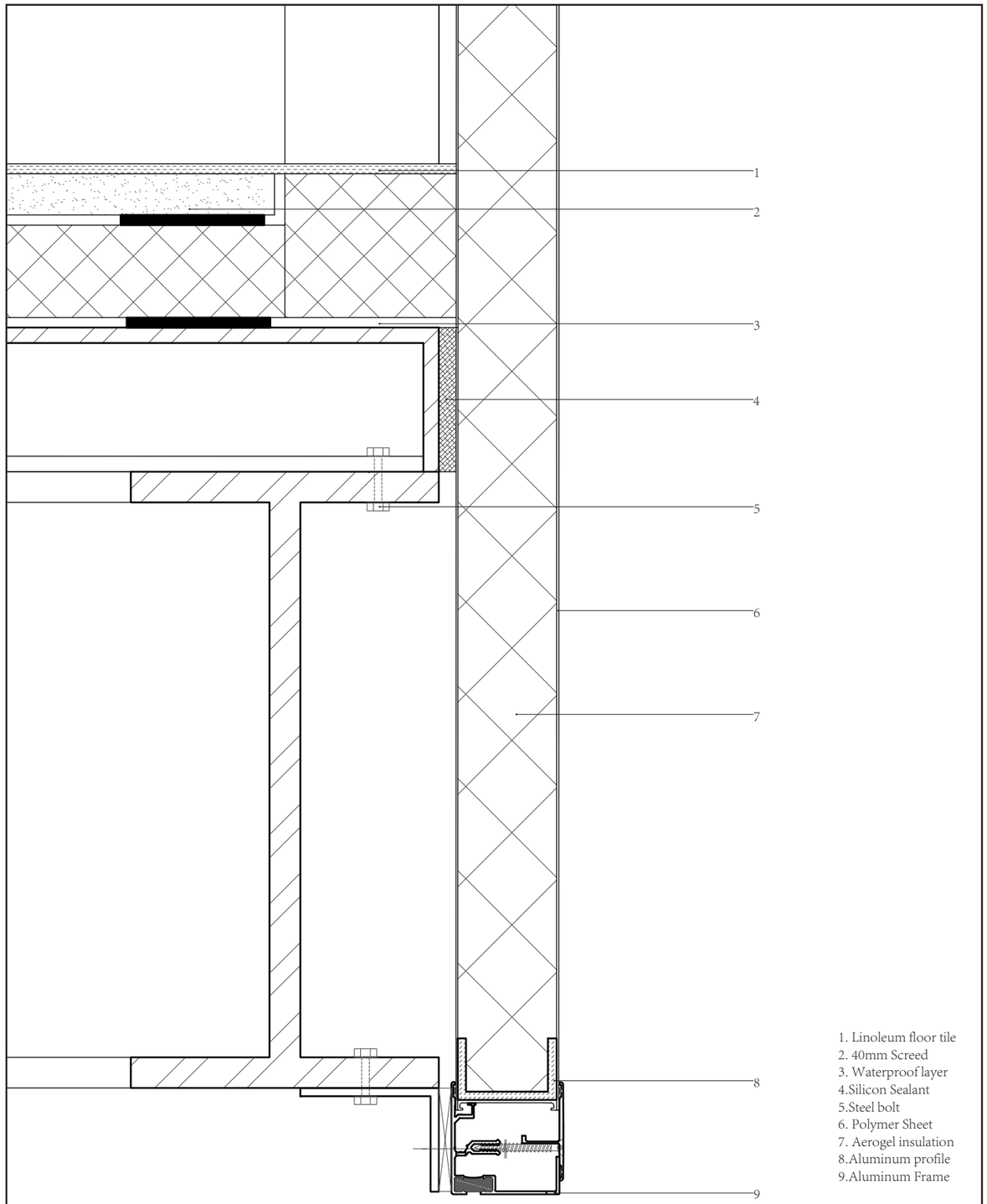


Detail 2 1:5



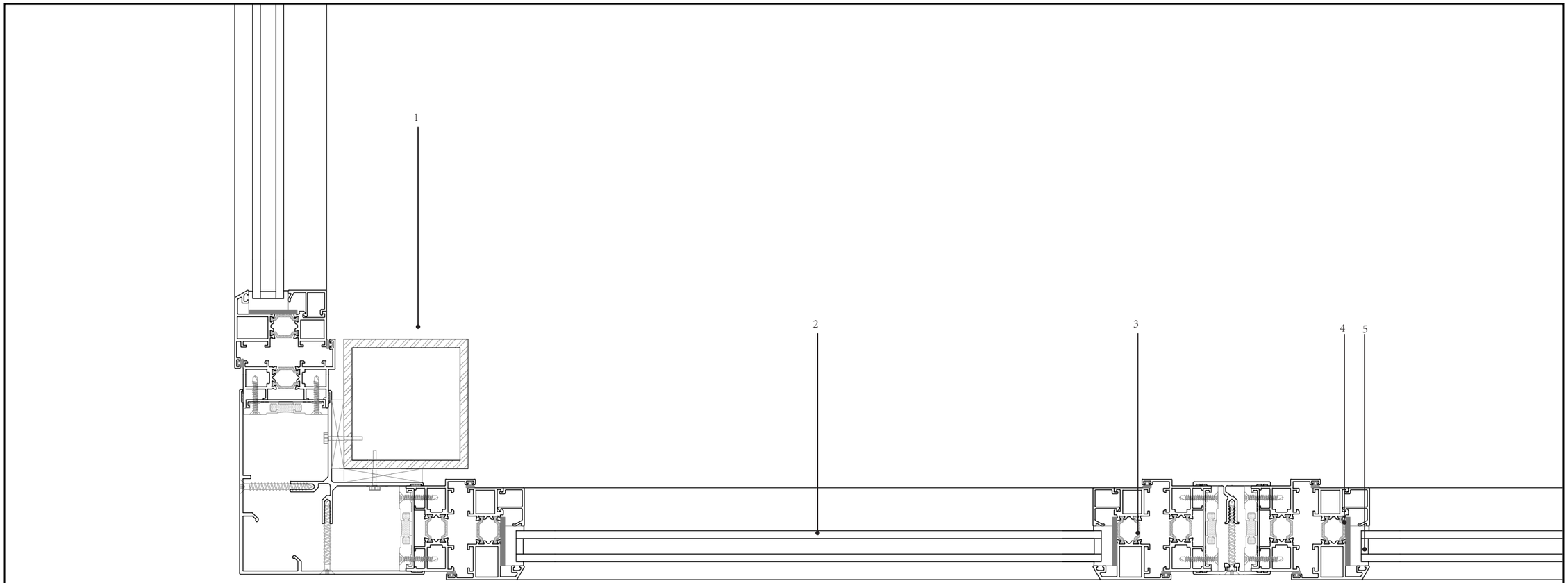
1. Fixing Screw
2. 150*150 steel profile
3. Polyamide insulating thermal strip
4.Glass Spacer
5Aerogel Insulation
6.Polymer Sheet
7.100*70 Aluminum Profile

Detail 3 1:5



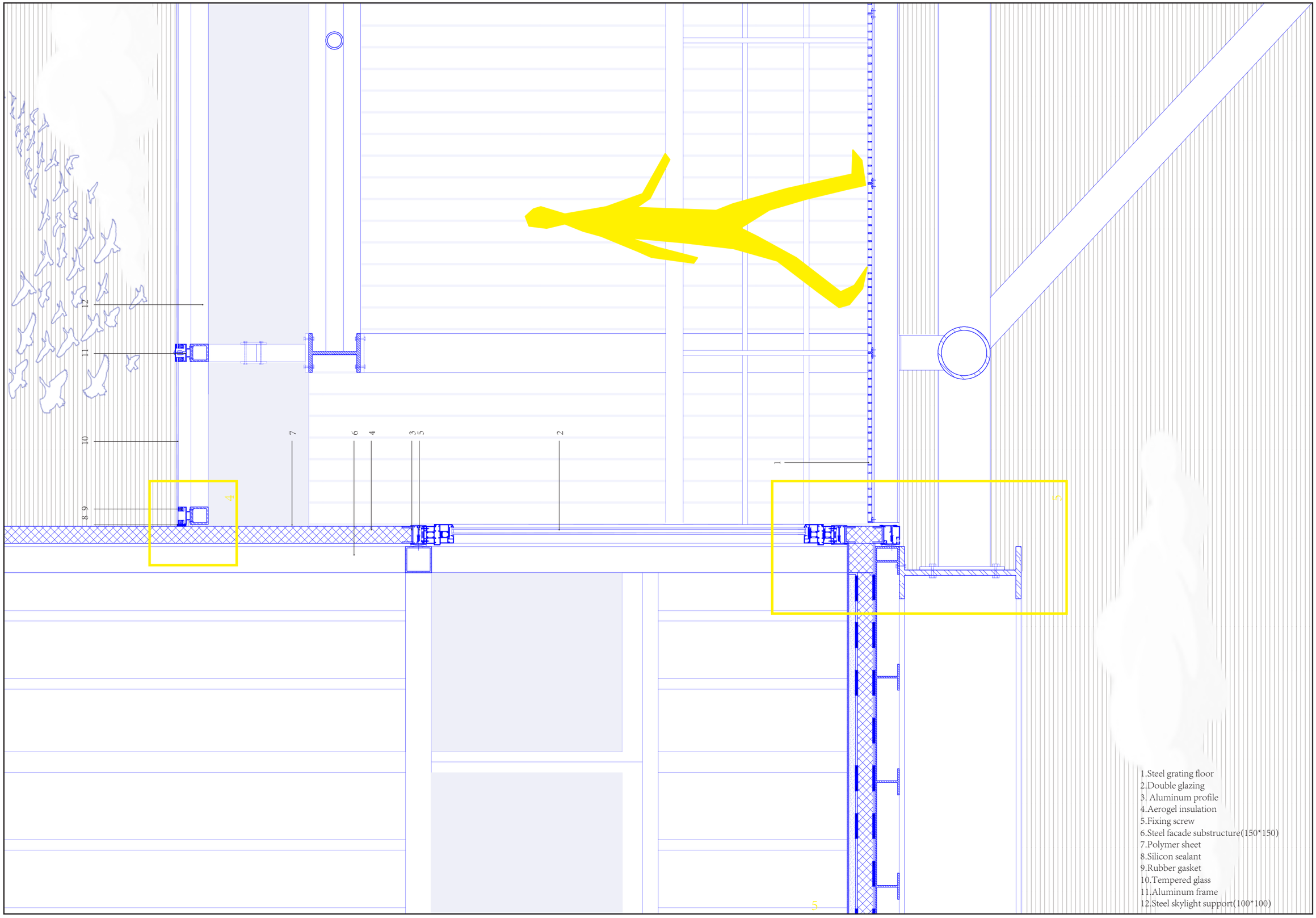
1. Linoleum floor tile
2. 40mm Screed
3. Waterproof layer
4.Silicon Sealant
5.Steel bolt
6. Polymer Sheet
7. Aerogel insulation
8.Aluminum profile
9.Aluminum Frame

Horizontal Detail 1:5

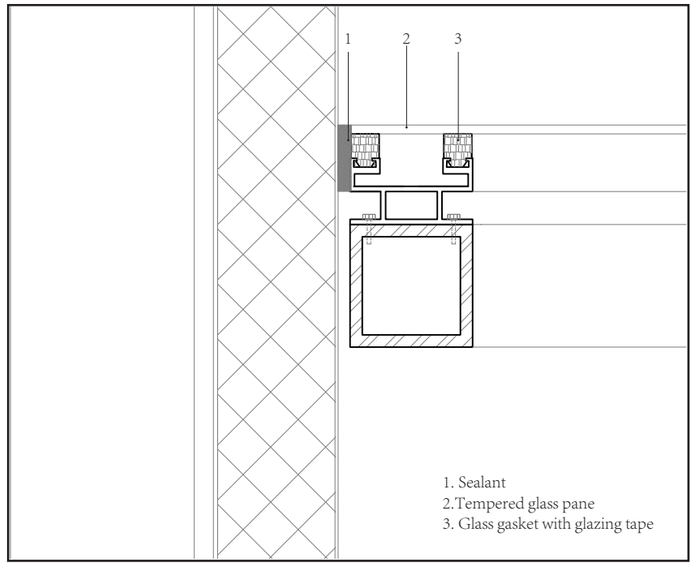


1. Steel facade substructure (150*150)
2. Double Glazing
3. Insulation strip
4.Setting plate
5.Glass spacer

Detail of Observatory Tower 1:20

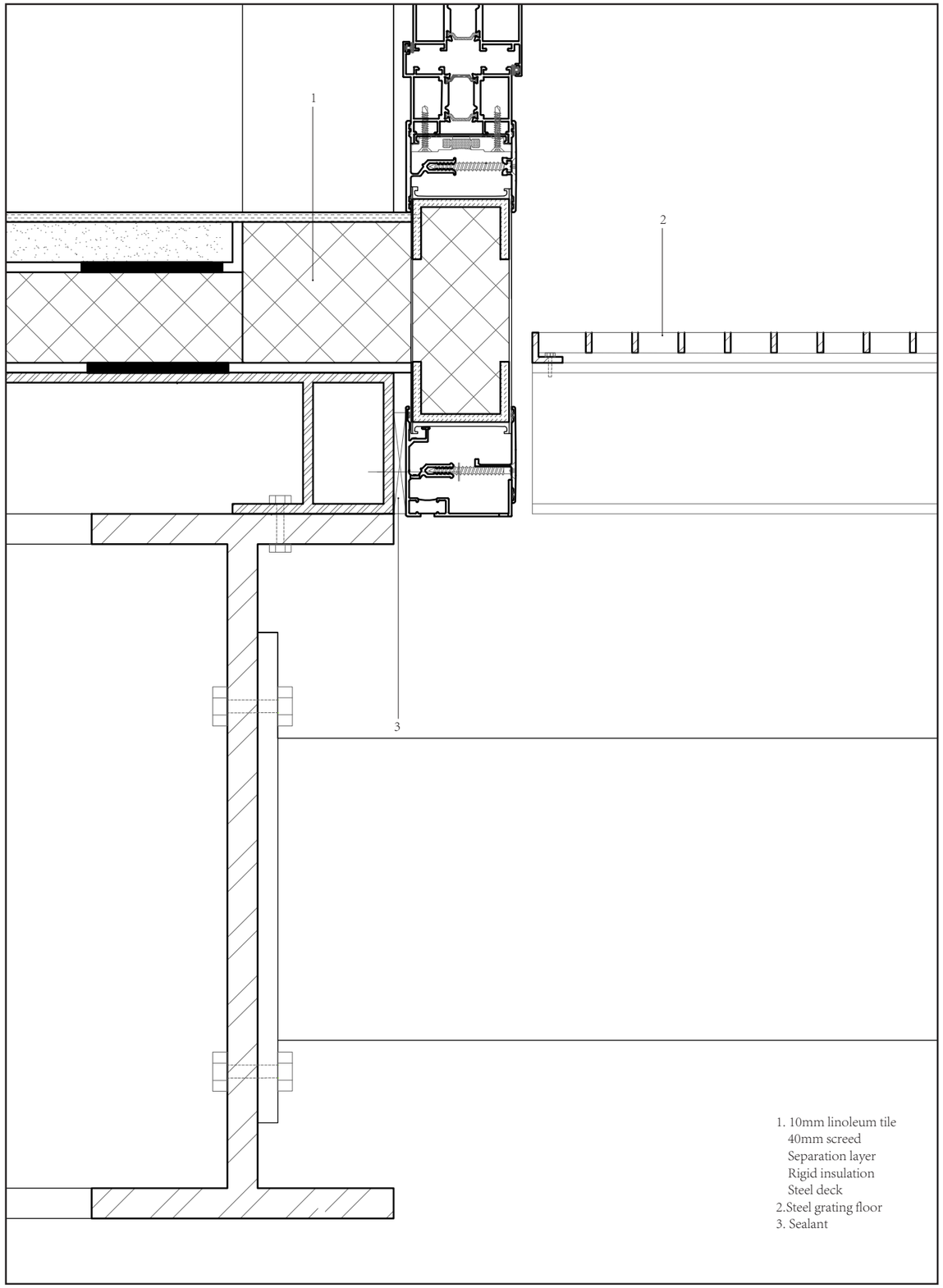


Detail 4 1:5



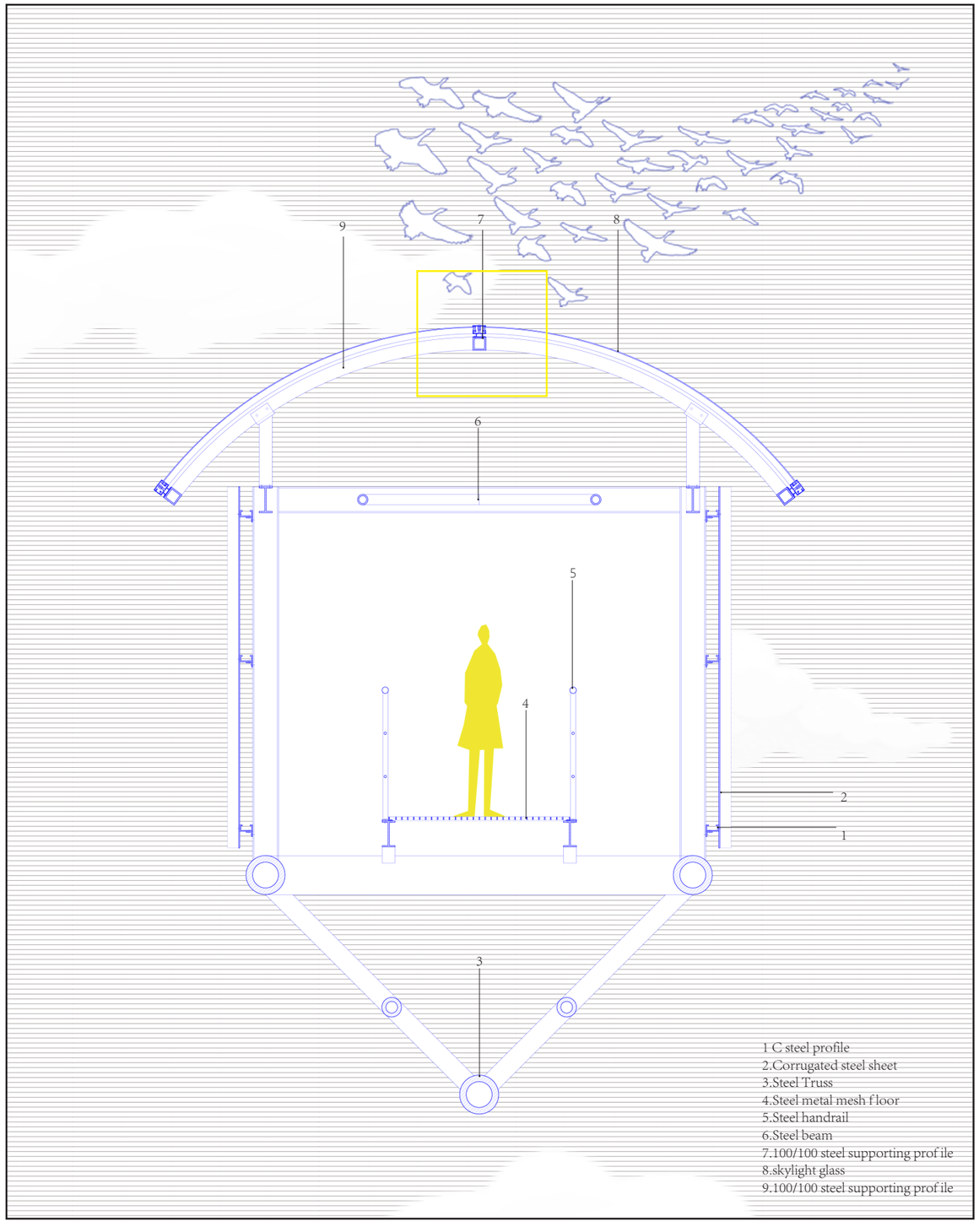
1. Sealant
2.Tempered glass pane
3. Glass gasket with glazing tape

Detail 5 1:5



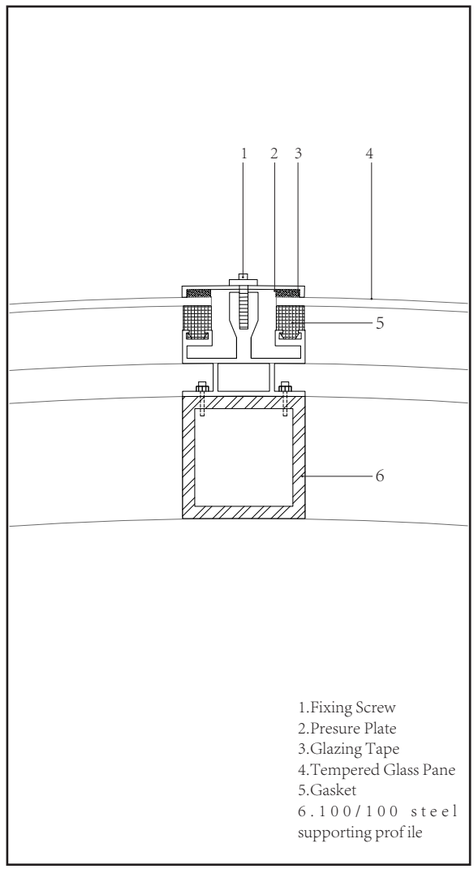
1. 10mm linoleum tile
   40mm screed
   Separation layer
   Rigid insulation
   Steel deck
2.Steel grating floor
3. Sealant

Detail of Corridor 1:40



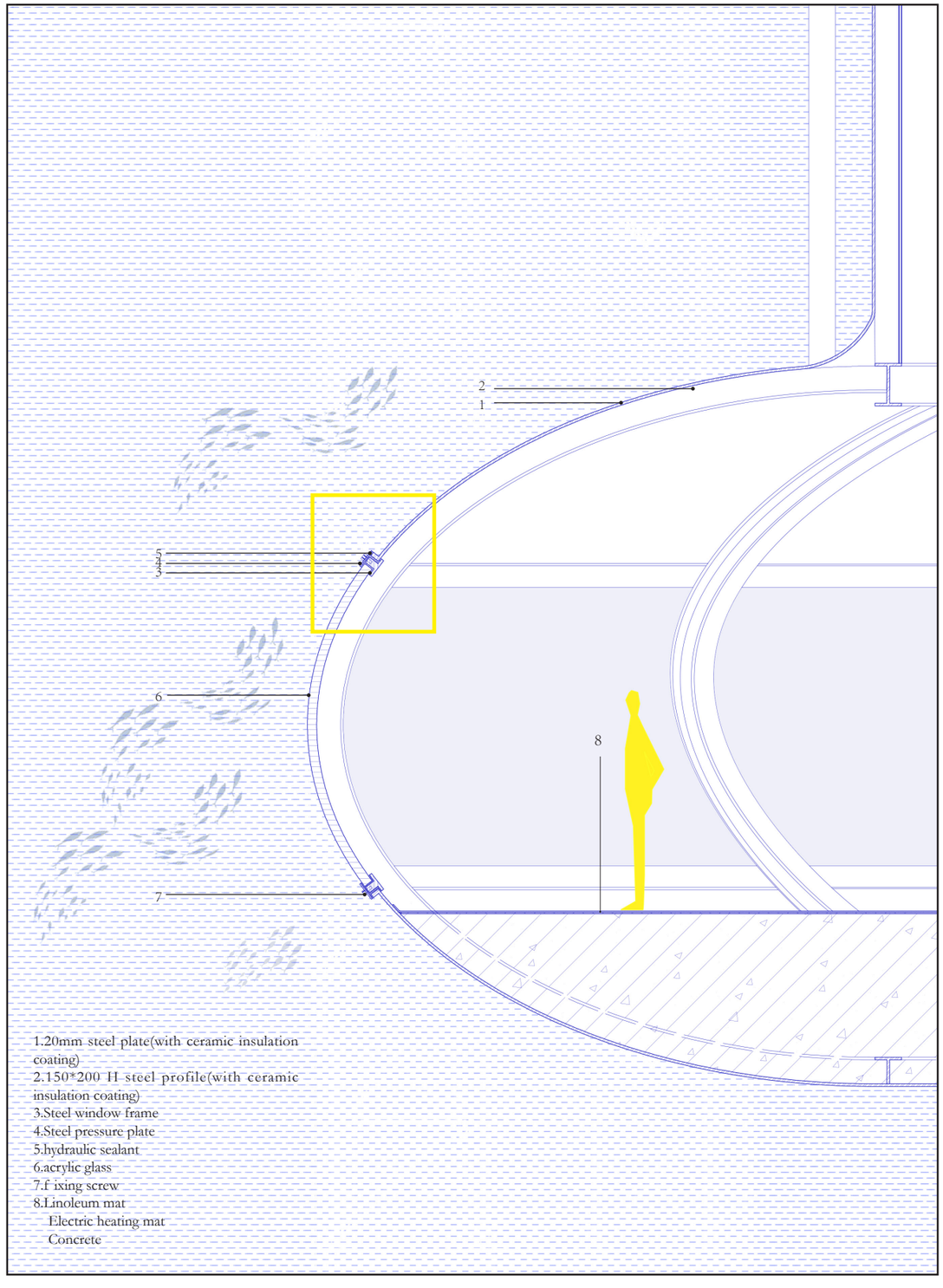
1 C steel profile
2.Corrugated steel sheet
3.Steel Truss
4.Steel metal mesh floor
5.Steel handrail
6.Steel beam
7.100/100 steel supporting profile
8.skylight glass
9.100/100 steel supporting profile

Detail of Corridor 1:5



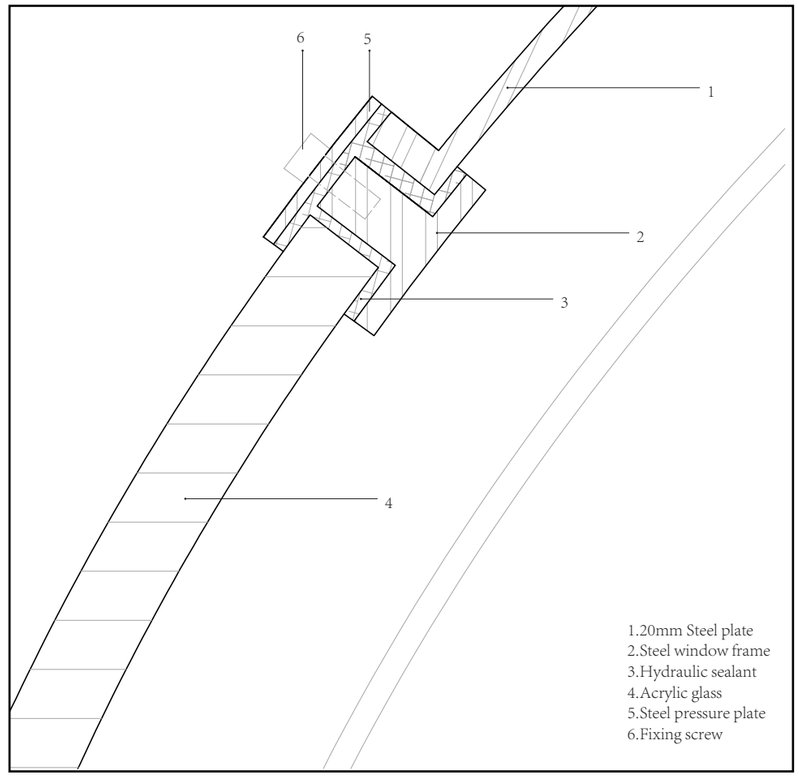
1.Fixing Screw
2.Presure Plate
3.Glazing Tape
4.Tempered Glass Pane
5.Gasket
6.100/100 steel supporting profile

Detail of Aquarium 1:30



1.20mm steel plate(with ceramic insulation coating)
2.150*200 H steel profile(with ceramic insulation coating)
3.Steel window frame
4.Steel pressure plate
5.hydraulic sealant
6.acrylic glass
7.f ixing screw
8.Linoleum mat
Electric heating mat
Concrete

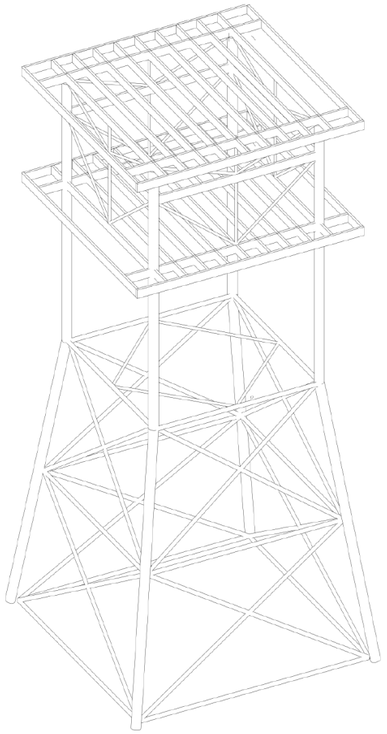
Detail of Aquarium 1:5



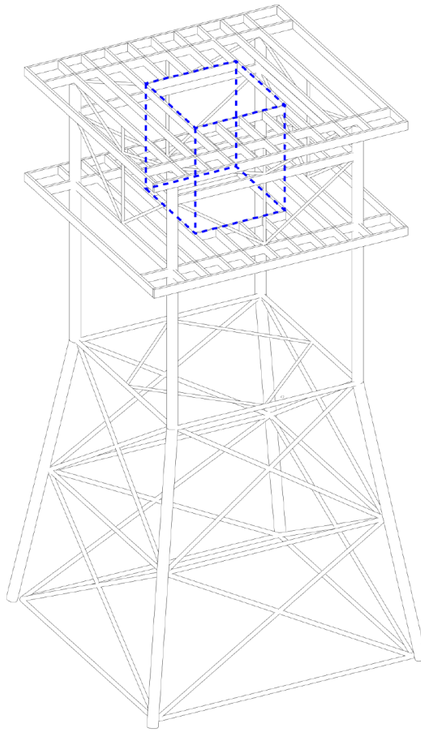
1.20mm Steel plate
2.Steel window frame
3.Hydraulic sealant
4.Acrylic glass
5.Steel pressure plate
6.Fixing screw

4.2 Structure

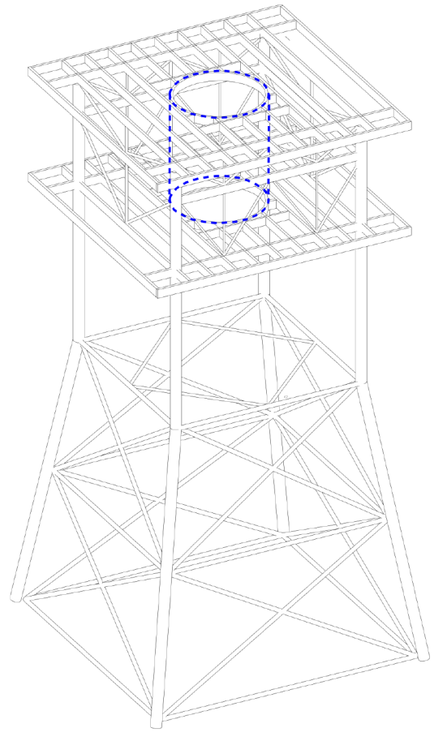
Intervention on the main structure



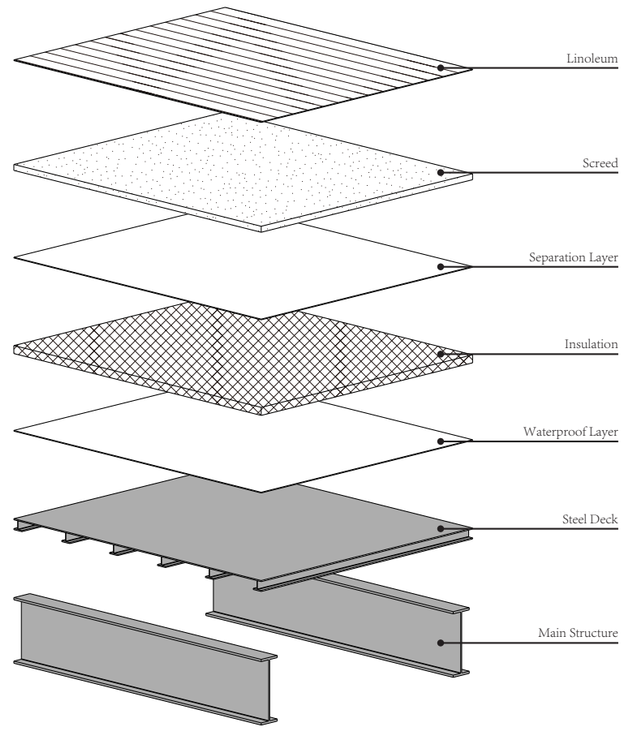
Remove the unnecessary beams to form a double height skeleton



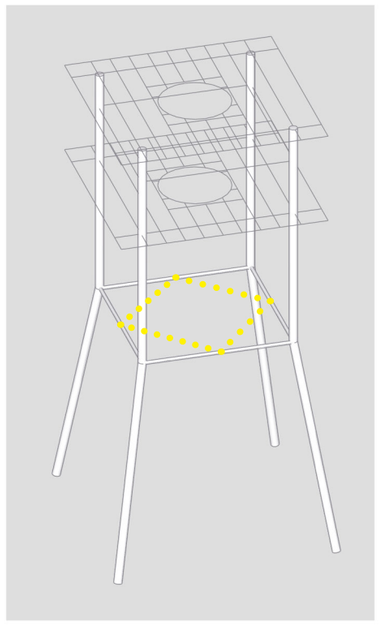
Cut beams to form a hollow space in the center

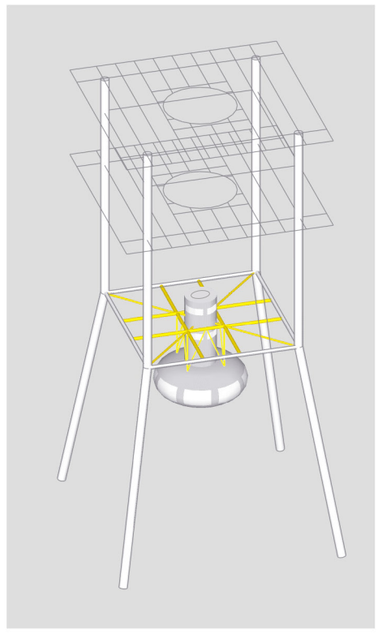


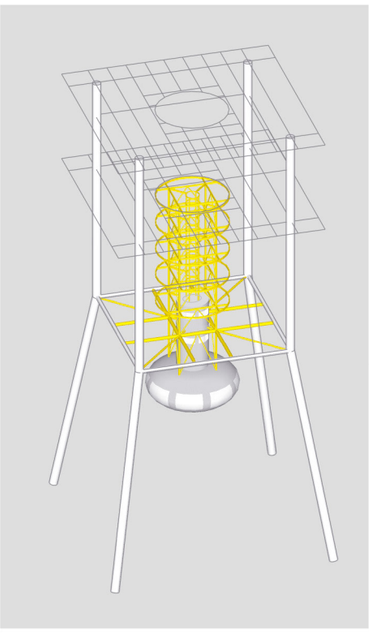
Add circular beams to support walls that would construct later

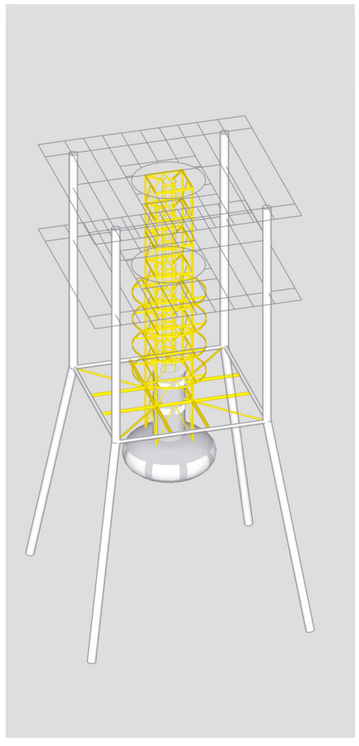


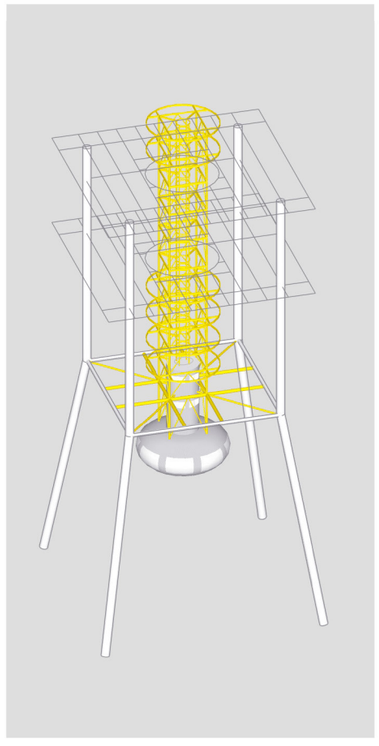
Floor Construction

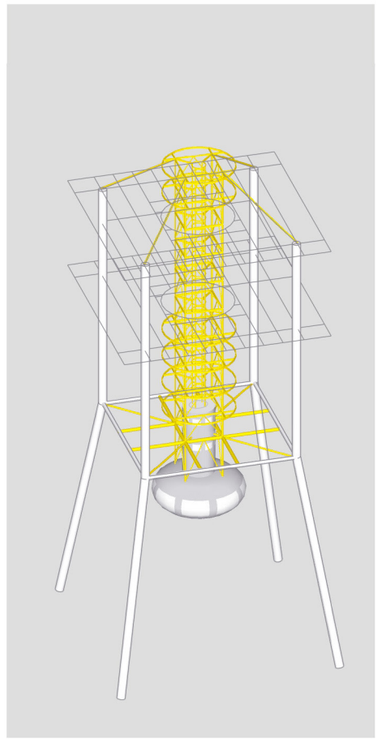


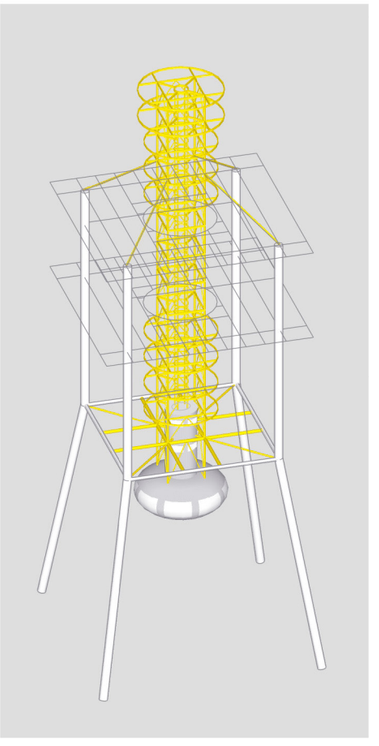




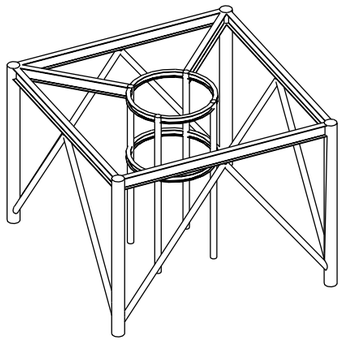




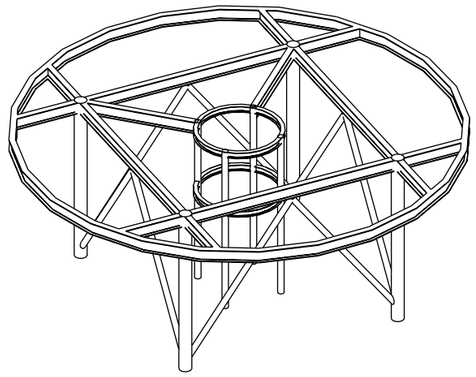




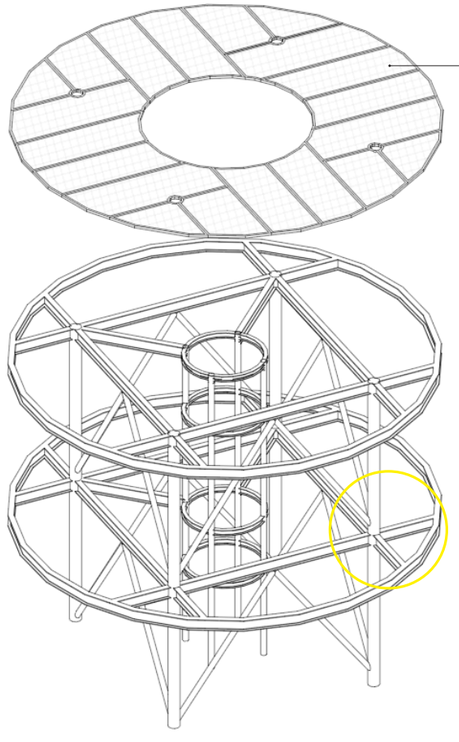
Construction of the Tower



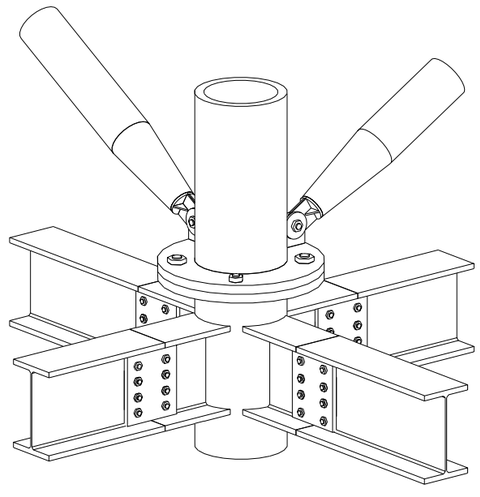
The structural unit of the tower



The structural unit of the tower

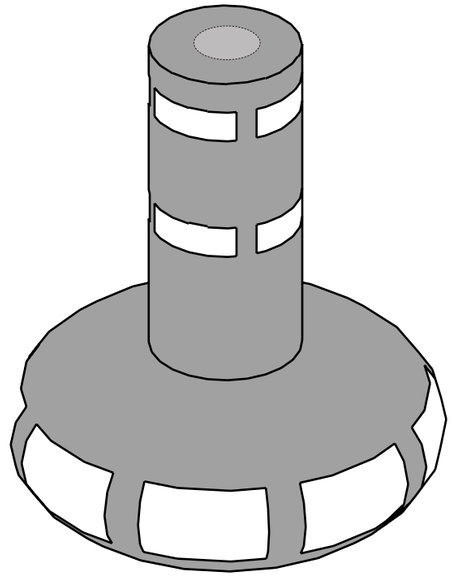


Composition of the tower

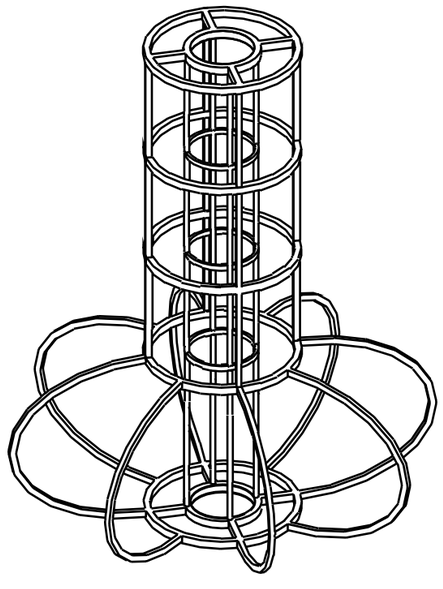


Steel Structure connection

Construction of the Aquarium



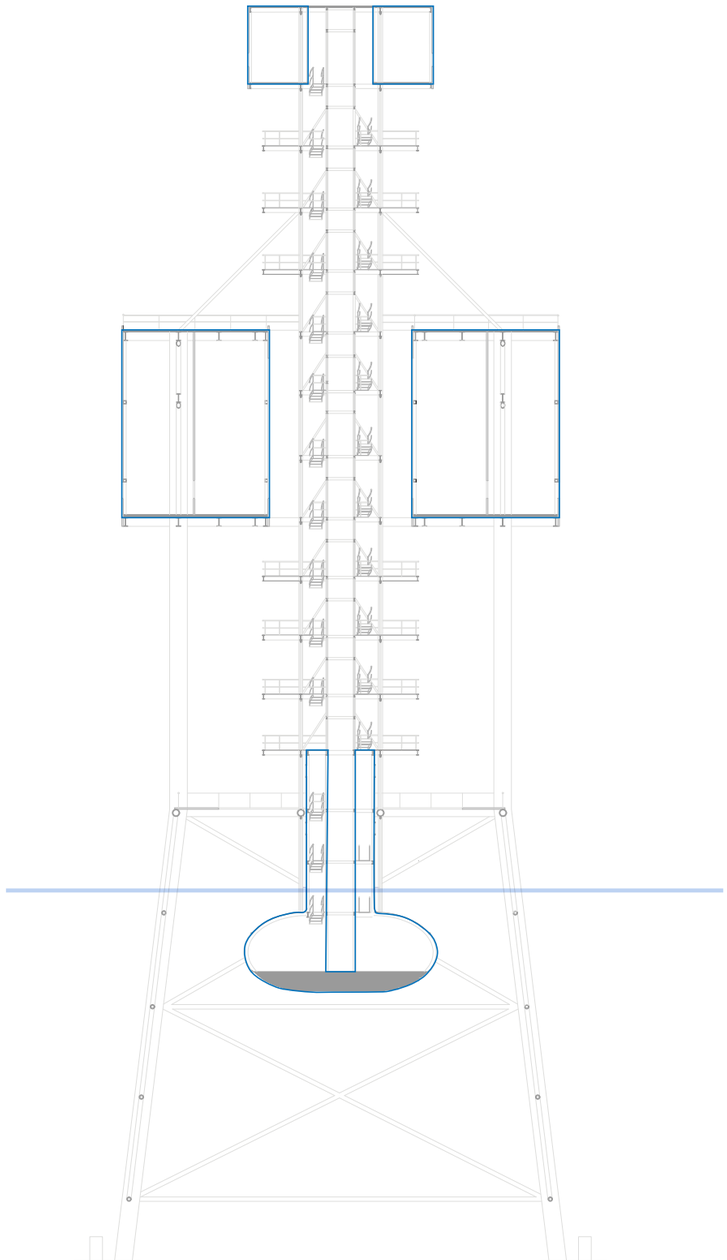
Steel Cladding of aquatium (welded to steel skeleton inside)



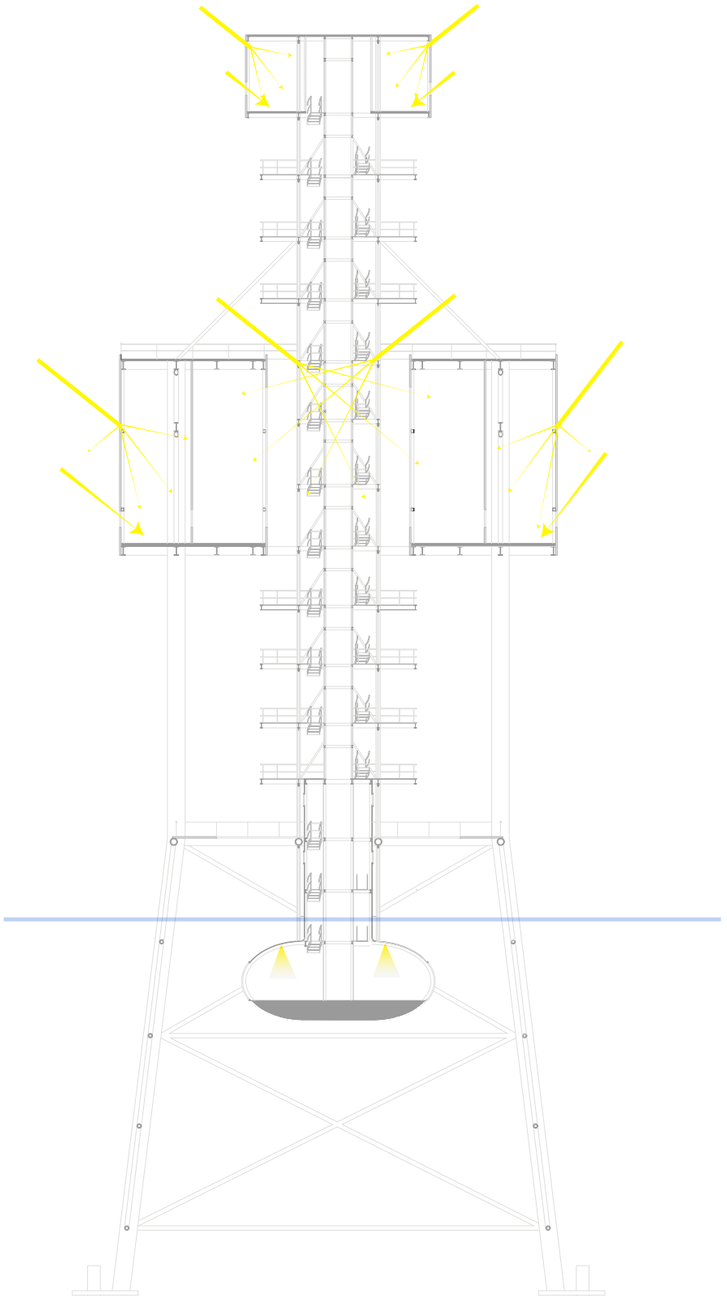
Steel Skeleton of Aquarium

4.3 Climate

Insulation Line

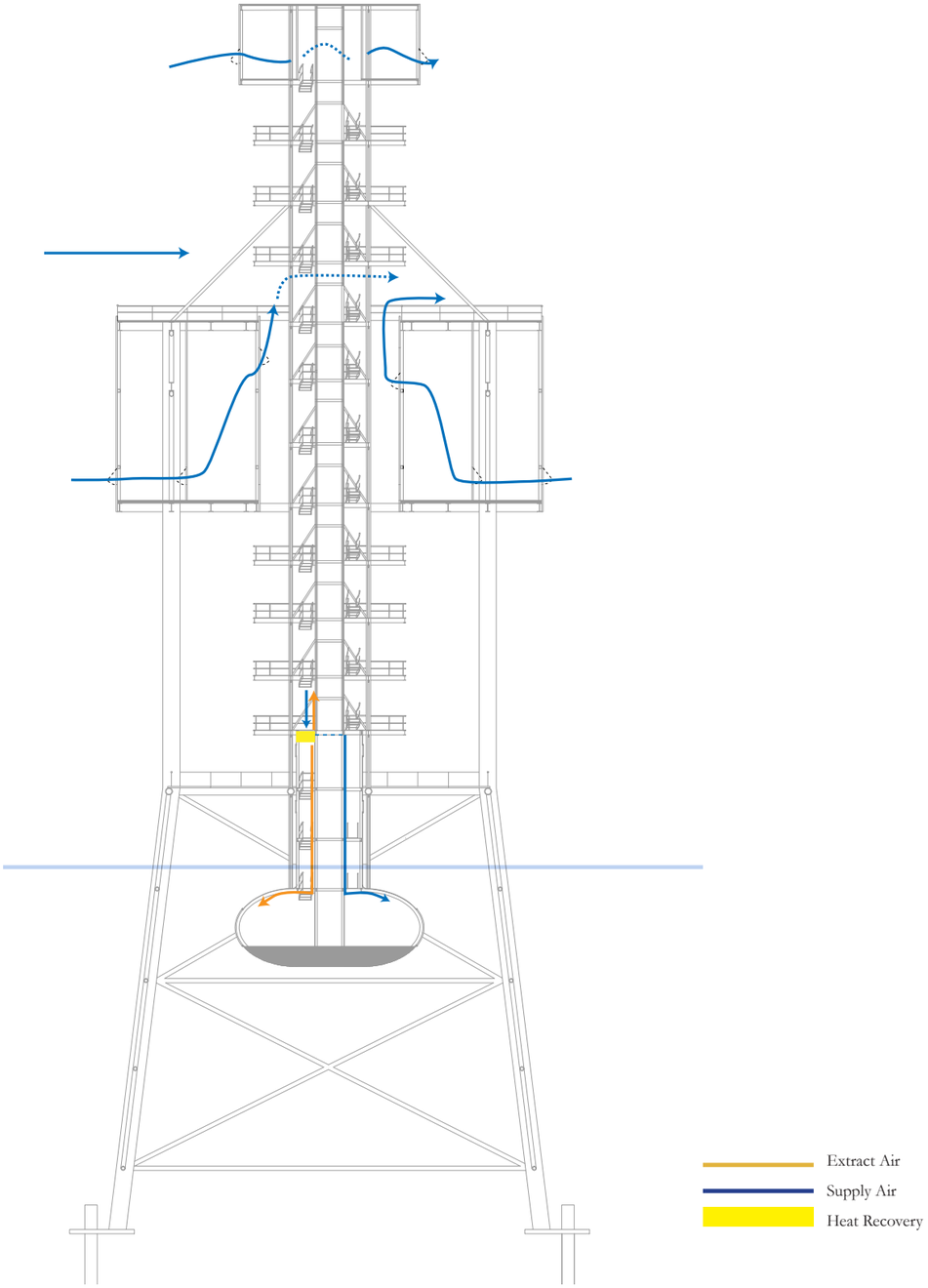


Lighting

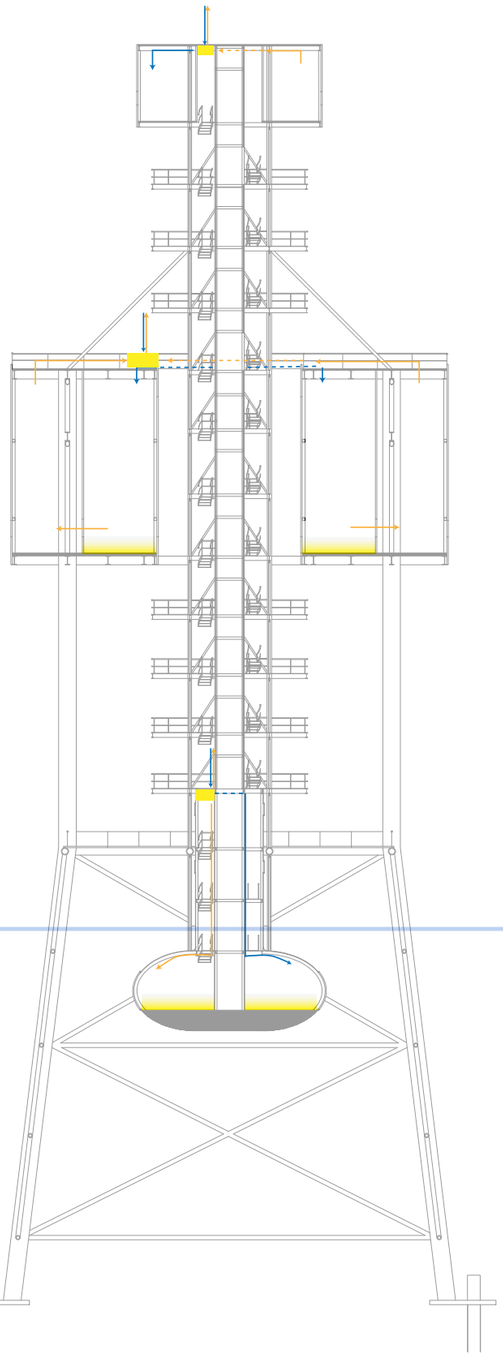


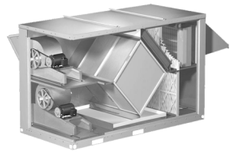
The facade is a combination of transluscent material and transparent glass. So the direct sunlight is limited, but the diffused light is enough. For the underwater aquarium, artificial lighting is necessary.

Ventilation in Summer

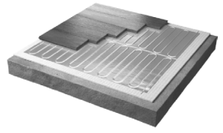


Ventilation and heating in winter

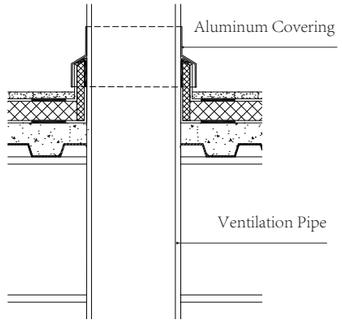




Rooftop Heat Recovery



Floor heating mat

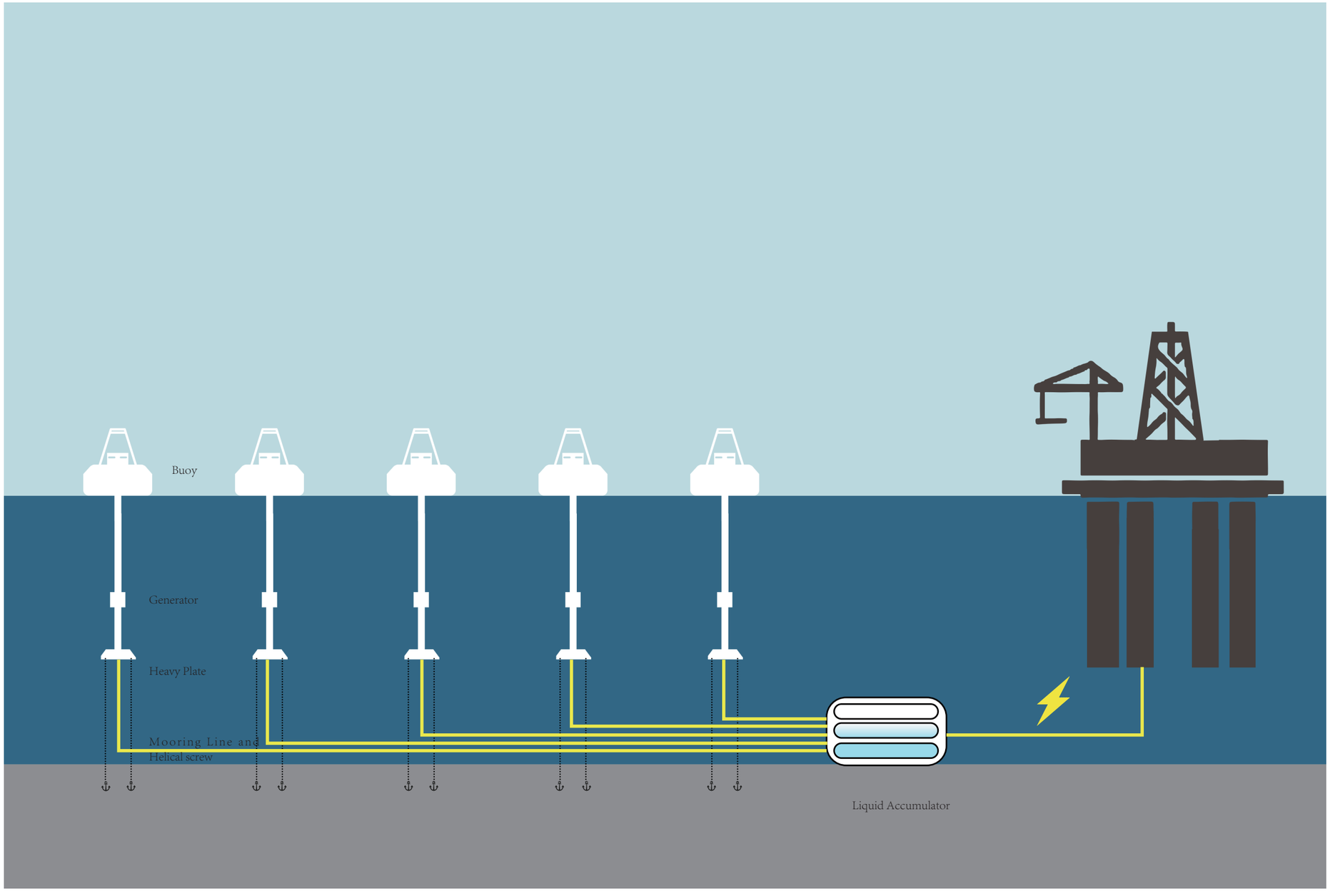


Ventilation pipe penetrating roof

The office part is able to use stack ventilation, the bird watching can have cross ventilation. However, the underwater aquarium has to use mechanical ventilation.

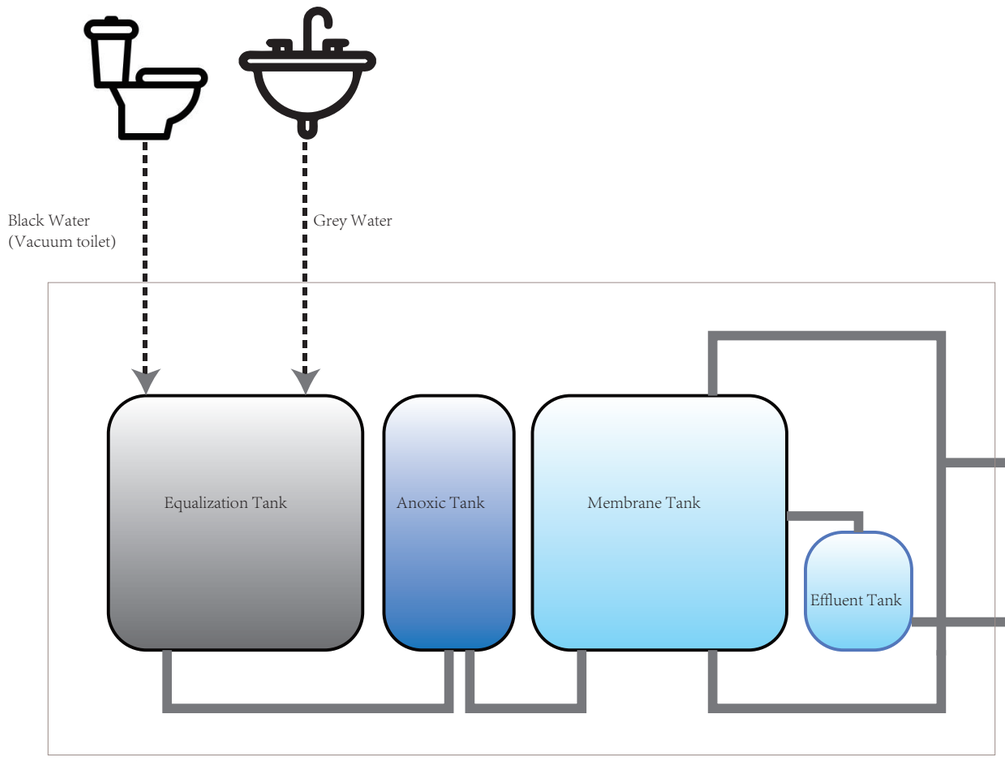
4.4 Other Technical Issues

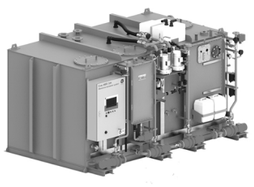
Energy Use



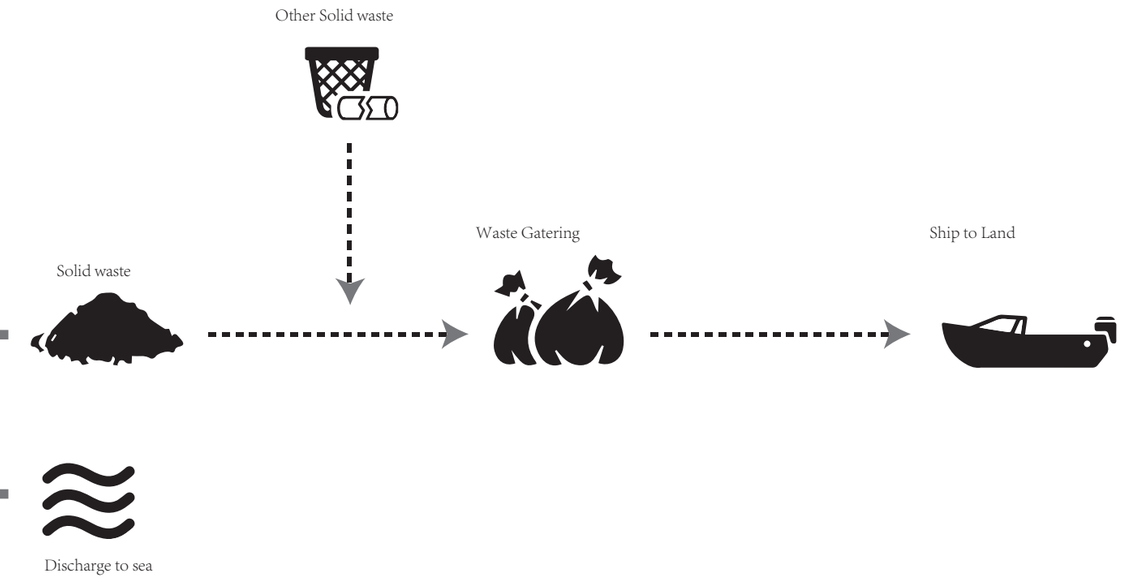
The energy of this ecology center would be provided by power buoy. This kind of equipment is able to produce energy through the vertical movement of the wave. It won't kill fish, create less noise. The mean wave height in this area is between 1m and 1.5 meter (Source: *Measurements of Wind Wave and Currents*, Energy Research Center of the Netherlands). The diameter of the wave power buoy I use is 4m. The efficiency of energy converse of this equipment is around 30&-45%,which means a single power buoy would be able to produce 160 kwh/day at least. The energy consumption of office building is 0.65 kwh/m2, and this building may create an energy demand of 3000kwh/day. Therefore, around 18 wave turbines are needed. In order to avoid unexpected accidents, I used 20 power buoys in my design. The residue electricity can be stored in an underwater liquid accumulator.

Waste Management



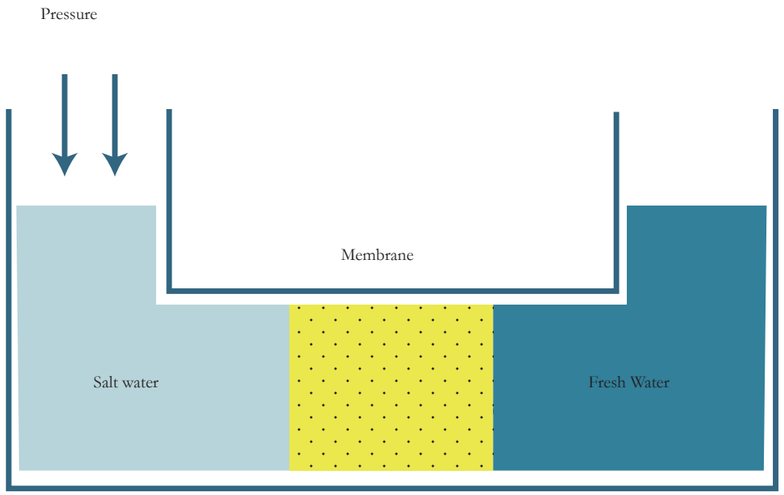


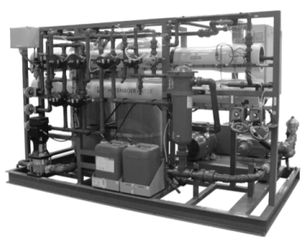
The waste purification system could dispose grey water and black water and then safely discharge into the sea. The size is 5600*2400*2600mm. The photo is from a manufacturer named Evac,



Dirty water would be disposed before charging to the sea. All other solid waste would be collected and then finally shipped to land.

Water Desalination

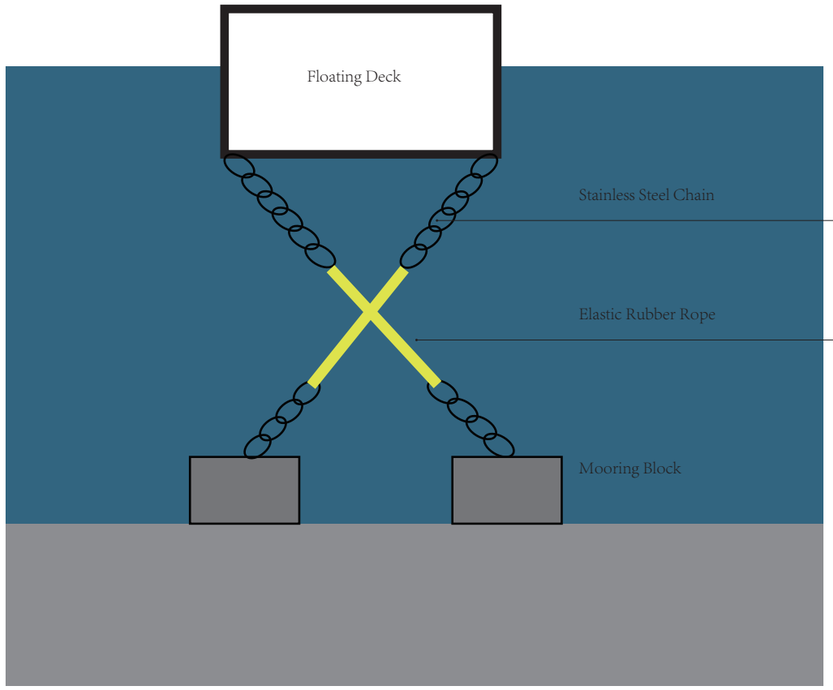


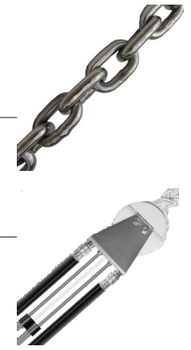


(Source: Manufacturer OVIVO)

The average water use in an office building is around 0.04cubic meter per person per day. For the residential units, the consumption would be 0.1 cubic meter per day. (Source: *Water Consumption* , TU Delft OCW).This building is meant to be used by 90 up to 150 people. Then the water consumption would be 9 cubic meter per day. This kind of water desalination equipment is able to produce 24 cubic meters potable water per day, and the dimension is 1800*1500*1800)

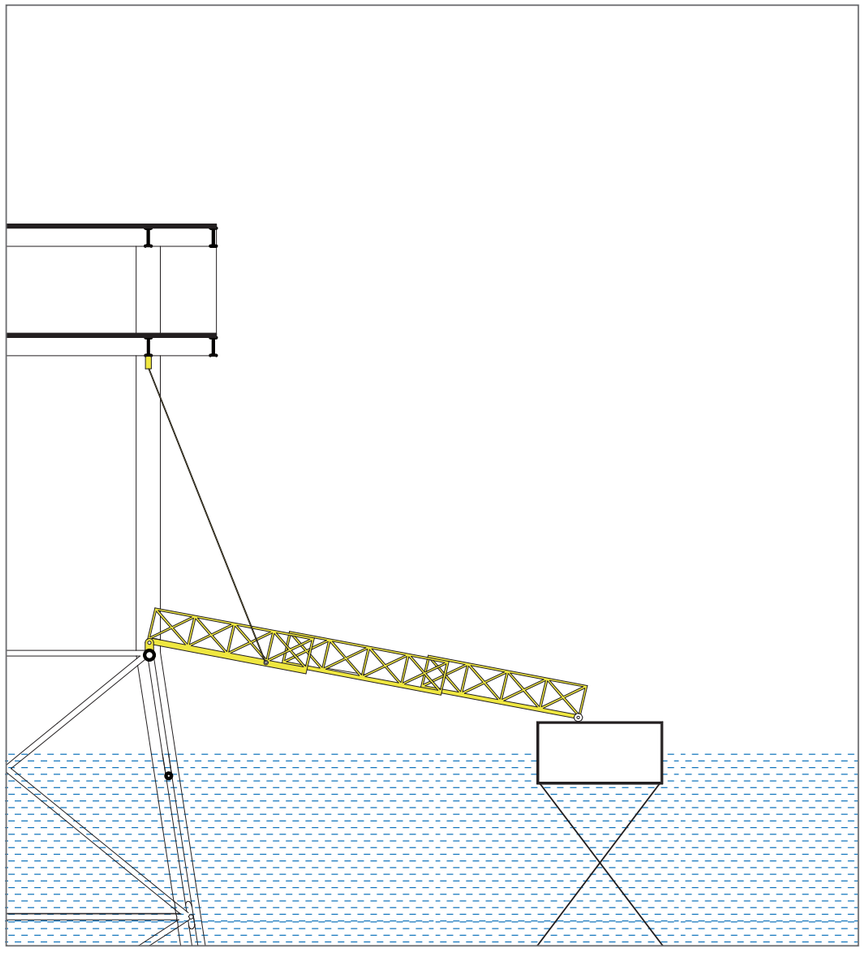
Construction of the Harbour

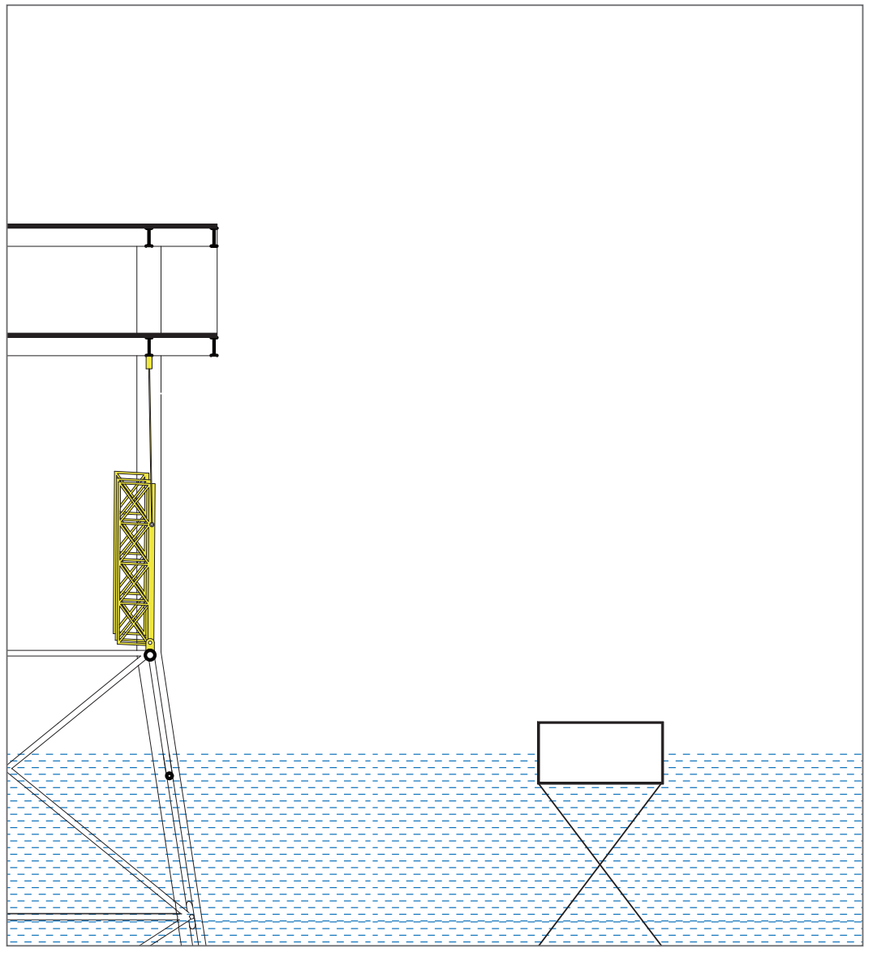




The mooring lines of the floating harbour are the combination of steel chain and elastic rubber rope. So during the high tide, the ropes will extend. This also help to resist sea-level rise to some extent.

Ship Gangway of the Harbour





The floating harbour would be connected to the gas platform by ship gangways. The angle of these ship gangways can be adjusted. During the flood event, the ship gangway can be folded. They can also adapt to the sea level rise.

Anti Corrosion

Aluminum Frame: Fluoropolymer coating: a highly durable protective coating for architecture, it works well in salty environment. (Source:*Fluoropolymer Coatings for Architectural Applications*, American Coating Association)

Steel Elements: 1.Tie active metal to the structural joints (like zinc)
2. Epoxy mixture coating is common in the offshore industry

(Source:*Corrosion in Oil Platforms*, Brianne Christopher)

Insulation Coating

Insulative coating for Steel Structure: Acrylic insulation coating is able to provide very good insulation even with the thickness of 2mm . This coating has been adopted in One Canal apartment in Boston and many other projects. It saves material and constructing time.(Source: *Insulating Coating Represents a Thermal Breakthrough*,TNEMEC)

Insulative coating for Aquarium:Ceramic based coating has been on ships operating around the world for over 15 years. Good insulation performance can be achieved with a coating thickness of 0.5mm. (Source: *Marine Thermal Coating*, Mascot)

Bird Protective Glass

Many birds died of window collision every year. In my project, a product of a German company Arnold Glass is adopted. With the understanding that birds are able to see ultraviolate light, this kind of glass used a patterned UV reflective coating making it visible to birds while remaining transparent for people. This is rather suitable when designing an observation center. Because it provides people with good views while keeping the birds safe.

What we see

What birds see

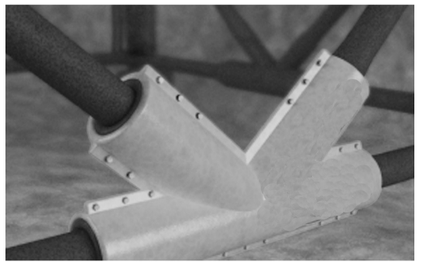
How color affect birds

Birds have a very highly developed sense of vision. It is hard for human beings to imagine birds' view.
Birds tend to be attracted by colors that close to their plumage, because it means potential mate. Some times they are also attracted by the colors that represent potential food source. For example, yellow flowers always attract bees and some birds that eat bees might be attracted by yellow flowers. Different birds will be attracted by different colors. Color will not keep birds visiting, but food source, water and shelter will. (*source:Colors that attract birds,Melissa Mayntz*)

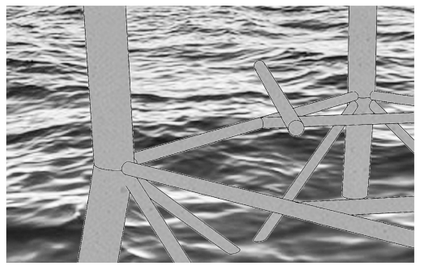
No specific color scare bird. But moving things do.(*Source: What Colors Are Birds Attracted to?, JACOB OLESEN*)

How to repair corroded elements

Fill the structure with concrete or grout



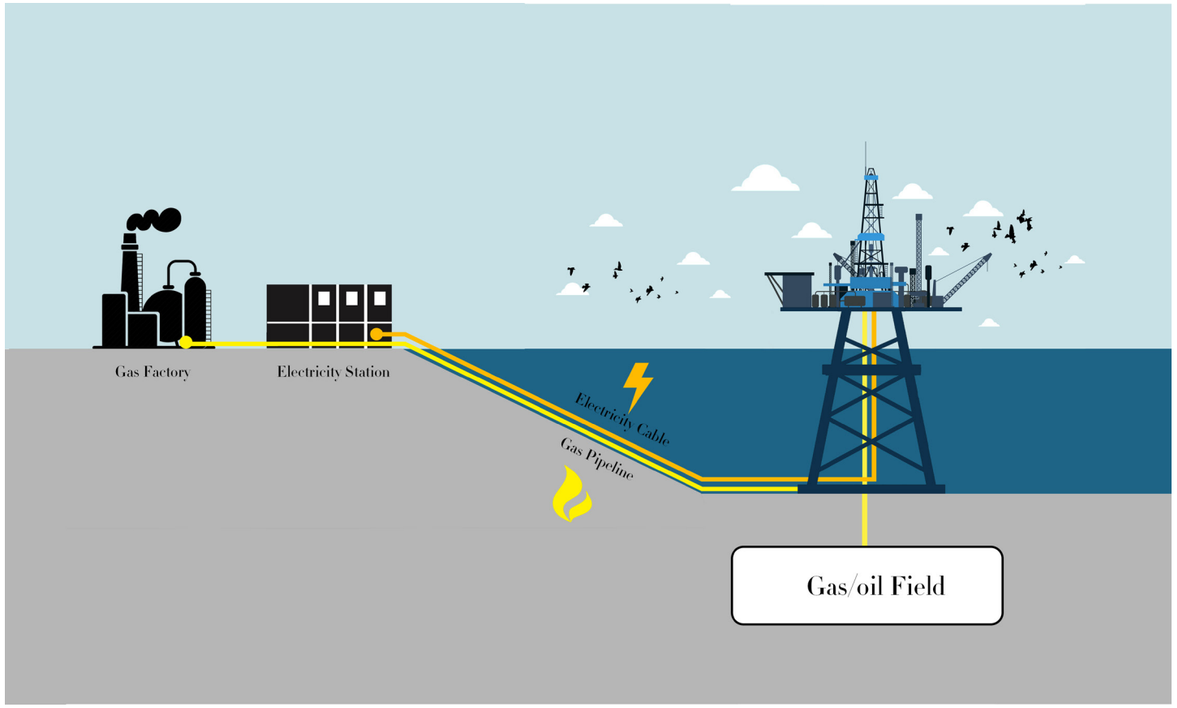
Reinforce the joints



Replace the structural elements

Appendix

5.1Opportunities created by offshore platform



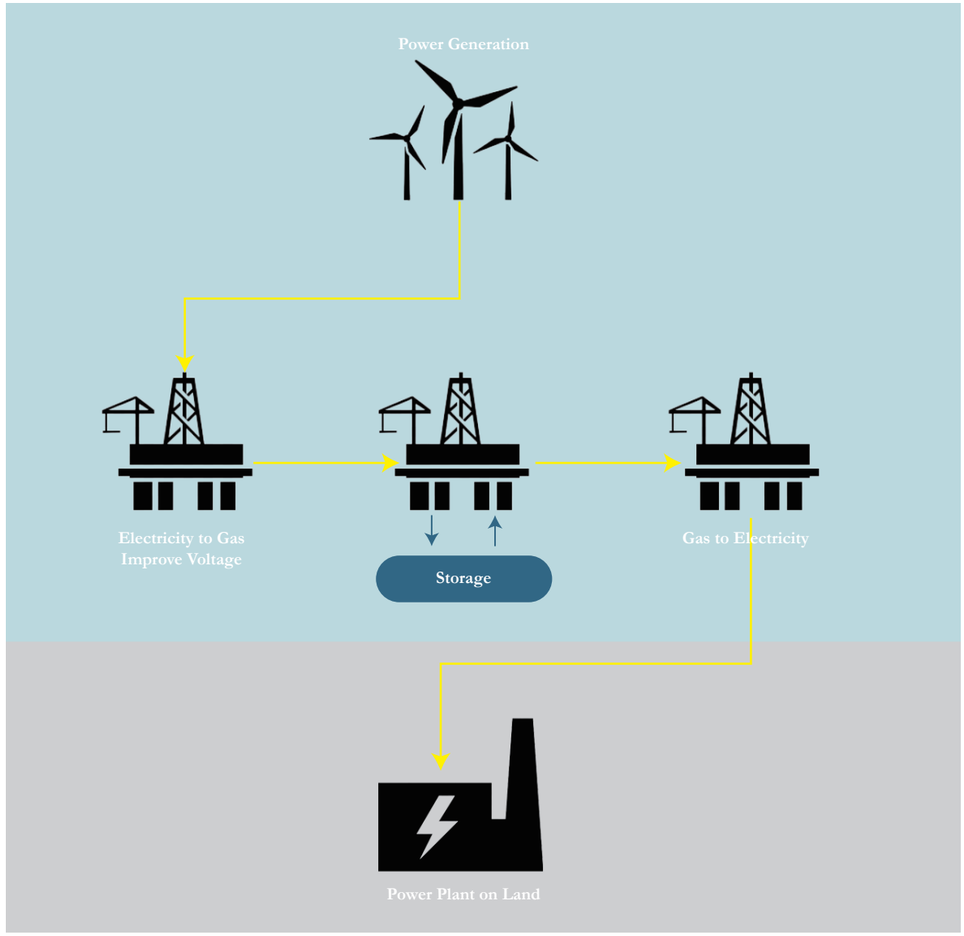
Offshore platforms has many other opportunites which make the reuse of them very sustainable and economic efficient.Some of the offshore platforms are equipped with electricity cables and are connected to the land with oil and gas pipelines. In this way, making use of these equipments could help to save money and reduce CO2 emission.They are also able to produce fresh water themselves. Moreover, the spacious space and a durable lifespan(100-300 years) allow a very flexible reuse.The empty gas or oil field could also be reused.

However, nearly none of the adaptive reuse ideas have been put into practice now. (Norman, Andy. "ENGINEERING INSIGHTS BLOG." Recommendations That the Oil and Gas Industry Should Look to Achieve in Order for 2017 Success, insights.claxtonengineering.com/remove-or-reuse-making-a-decision-on-decommissioning-offshore-oil-platforms.) Some options will be illustrated.

Gas to Wire Project

Introduction

Due to the energy transformation, there will be more and more wind farms on the North Sea. The electricity from the wind farms cannot be stored directly, normally there should be some sub-stations to transform the electricity into Hydrogen, storage them and then transport the electricity to the land. The obsolete oil and gas platforms are perfect place to do this job. In this way, the new construction are not necessary, cables and storage fields are already there.



Advantages: No new cable and no new construction is necessary

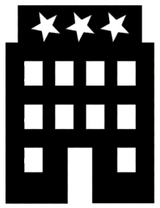
What needed:

1.Connectors between wind parks and platforms
2.Brown field modifications on platform
3.Regulatory frameworks

Entertainment and Tourism

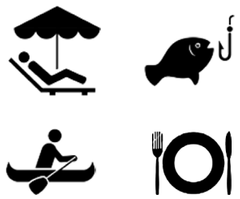
Introduction

Many ideas are now proposed, like hotels, diving center, other recreation like swimming and so on. However, the only idea that was put into practice is the diving center in the Celebes Sea. This is a way to create commercial income and look at the heritage.



Hotel

Diving



Other Enertainment

1. Hotel and Research Center (Concept)

2. Hotel and Diving Center

3. Hotel and other entertainment (Concept)

Advantages: The special spatial quality will become attractive, commercial income would be created

Disadvantages: A lot of renovating engineering would be necessary, activities would disturb the ecosystem.

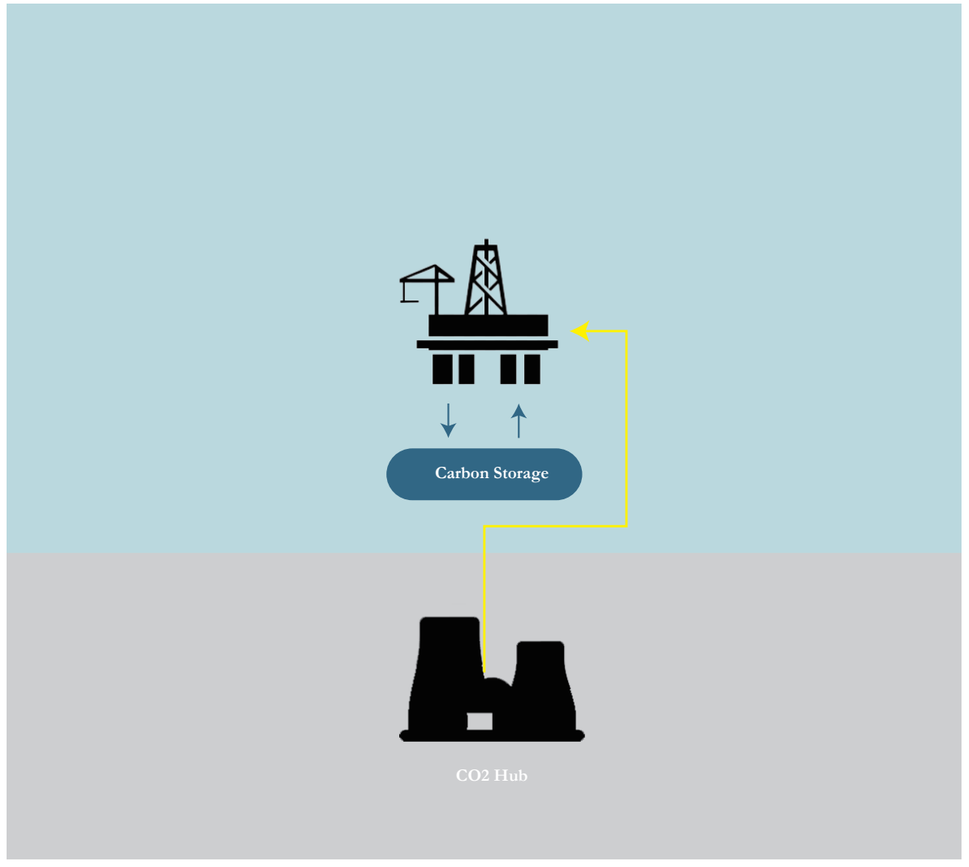
What needed:

1.New transportation methods are necessary
2.Brown field modifications on platform
3.Regulatory frameworks
4.Insulation system

Carbon Capture and Storage(CCS)

Introduction

CCS is a process of capturing waste carbon dioxide from large point sources, such as biomass or fossil fuel power plants, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation. The aim is to prevent the release of large quantities of CO2 into the atmosphere and metigate the global warming and ocean acidification. Although CO2 has been injected into geological formations for several decades for various purposes,

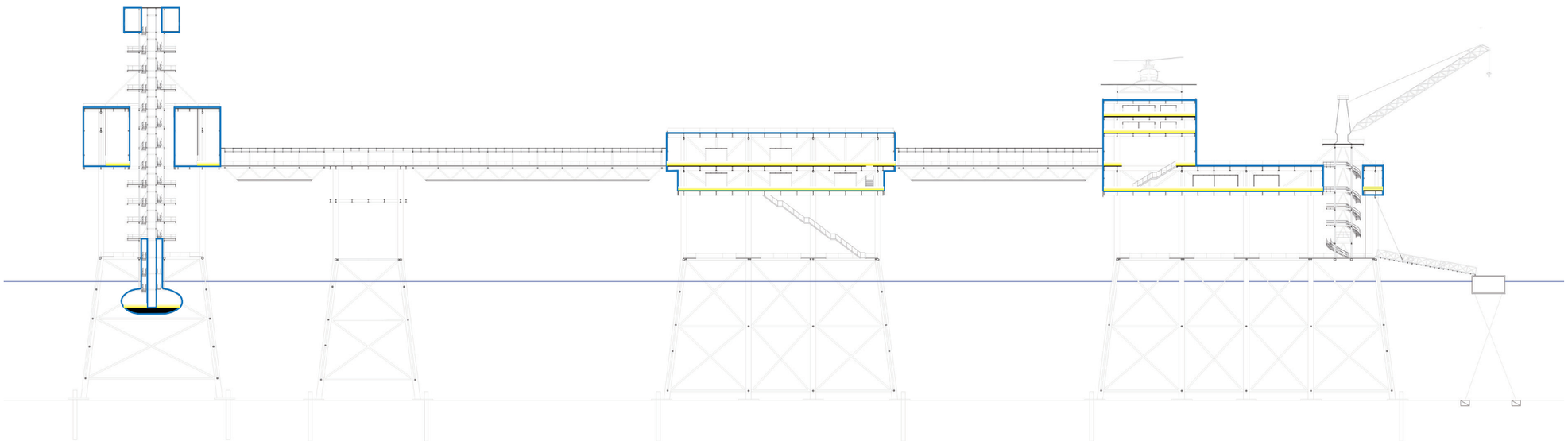


Advantages: No new cable and no new construction is necessary

What needed:

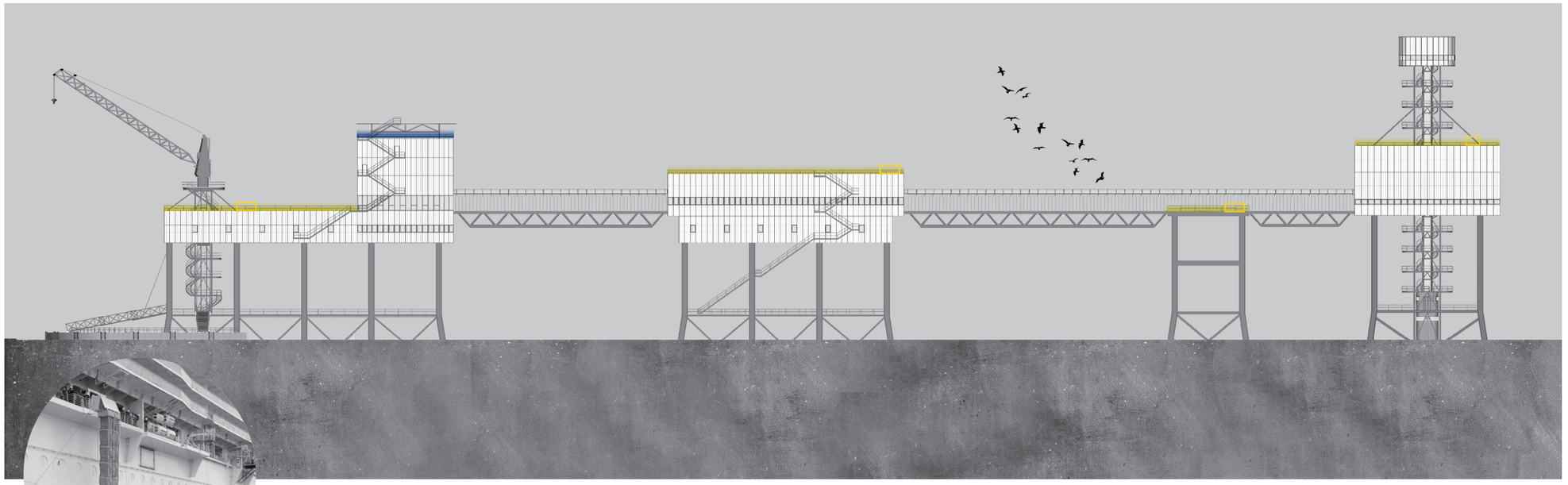
1.Connectors between CO2 hub and platforms
2.Brown field modifications on platform
3.Regulatory frameworks

5.2 Overall climat diagram and evacuation scheme



Insulation Line

Floor Heating



Chute evacuation system

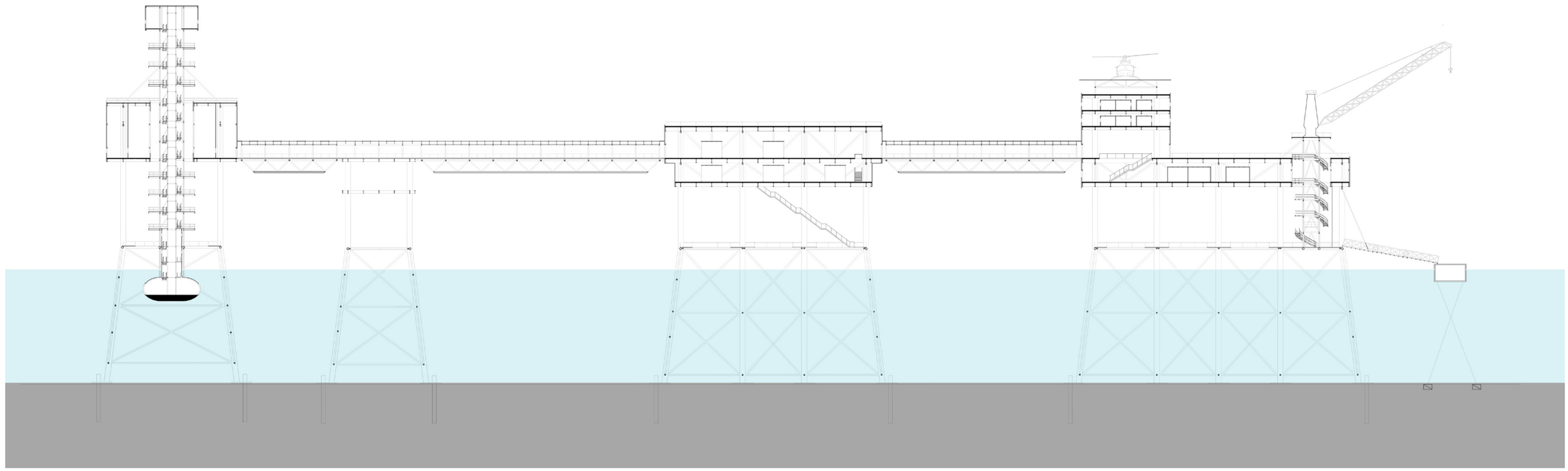
Life boat evacuation deck

Helicopter evacuation deck

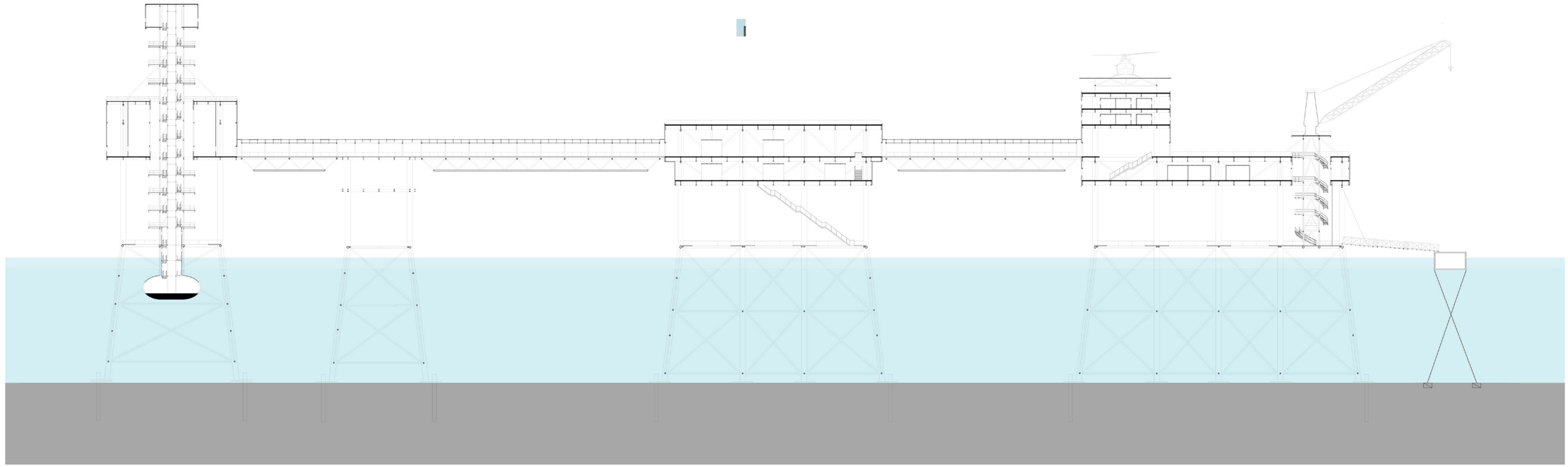
The roof tops are equipped with chute system. In which people get quick vertical transportation and life boats. Those life boats will be inflated automatically. A helicopter deck would be also used in some emergency events.

5.3 Adapt to sea level rise

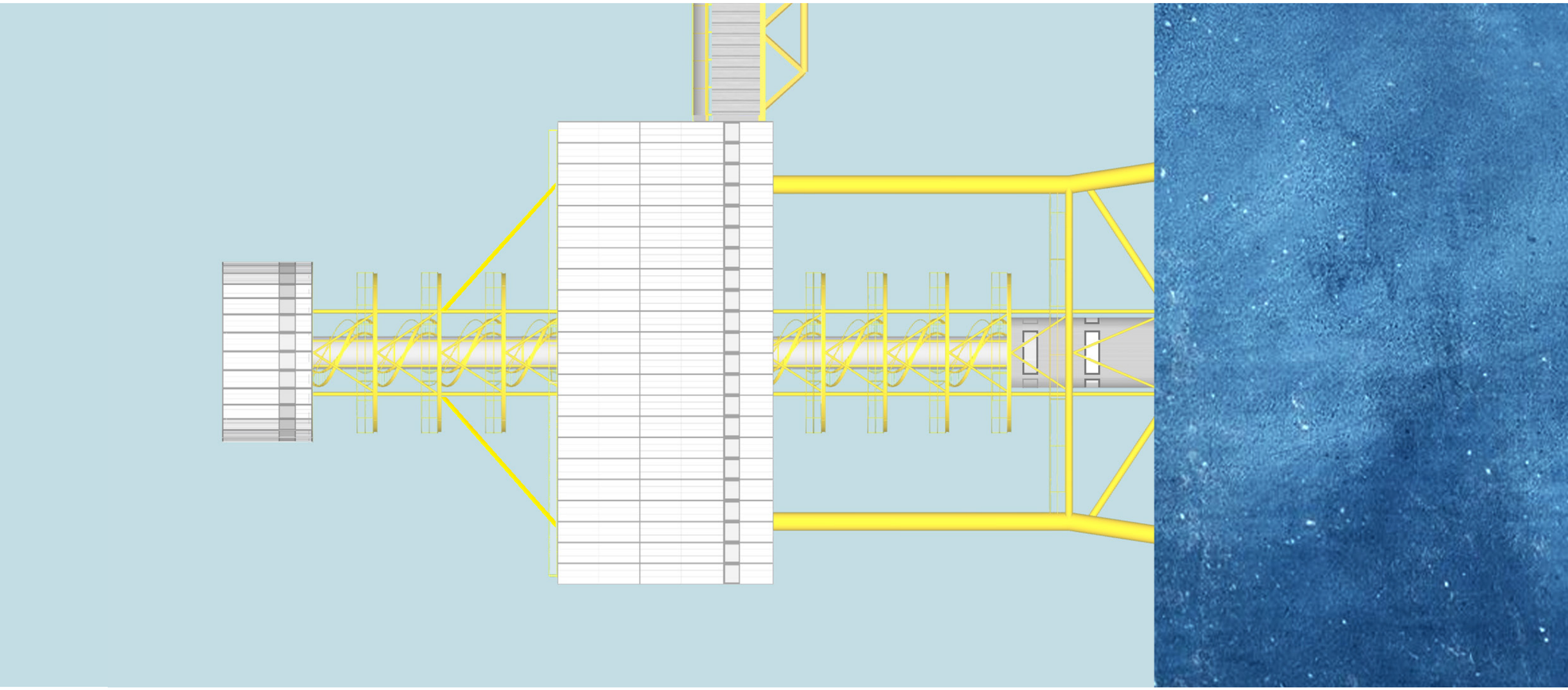
Current situation

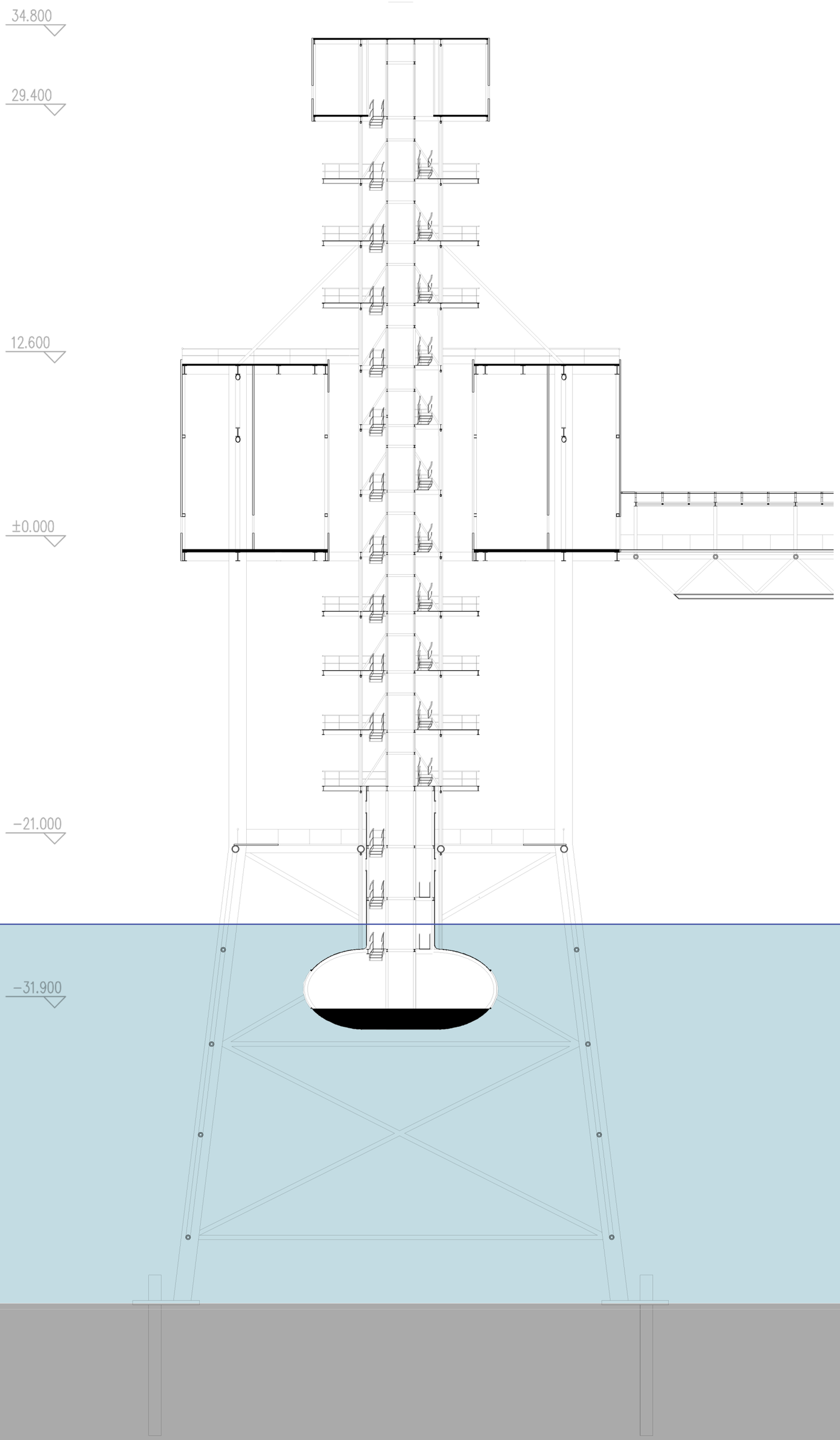


3 meter sea level rise



5.4 Facade and Section 1:250




34.800
29.400
12.600
±0.000
−21.000
−31.900

34.800

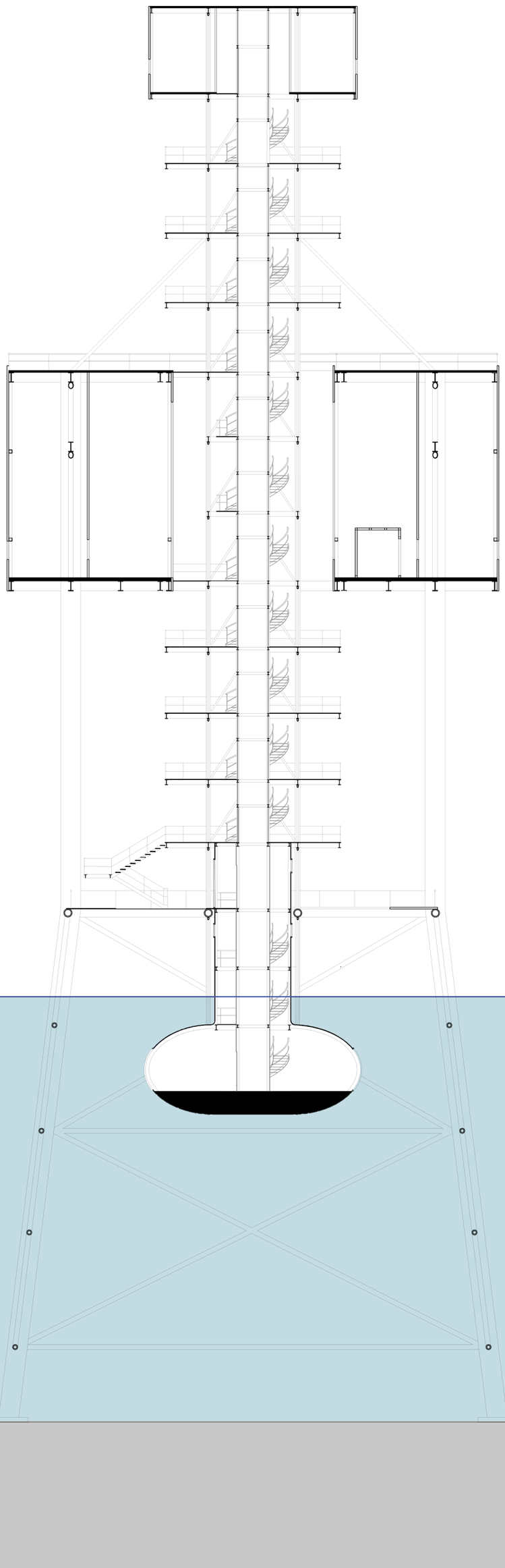
29.400

12.600

±0.000

−21.000

−31.900



Reference

Literature:

Corner,J.(1999).The agency of mapping:speculation,critique and invention(pp.213-252).na.

Leichenko,R.(2011).Climate change and urban resilience. Current opinion in environmental sustainability,3(3),164-168

Bhatia, N.(2013).The petropolis of tomorrow(pp.530-553), New York: Actar Publisher

Terragni, E.(2018).Living on Water, London: Phaidon Press

Schaap, P.(2015).The Dutch Offshore, Den Burg:Flying Focus

Toyo Ito.(2014). The Great Transformation of Architecture, Beijing: Guangming Press

Capuzzo, E., Lynam, C. P., Barry, J., Stephens, D., Forster, R. M., Greenwood, N., . . . Engelhard, G. H. (2017, October 24). A decline in primary production in the North Sea over 25 years, associated with reductions in zooplankton abundance and fish stock recruitment. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.13916

Ford, E. (2000). Scientific method for ecological research. Cambridge: Cambridge University Press. (2000). Retrieved 03, 2019

Precedents:

Noah Oasis Skyscraper, by Ma Yidong, Zhu Zhonghui, Qin Zhengyu, Jiang Zhe

Prinos Offshore Platform Complex Re-use: An Ocean Awareness Destination, by Katerina