ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 13, Issue, 12 (A), pp. 2708-2713, December, 2022

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

FLOATING ECO-HOTEL WITH WATER SPORTS FACILITY

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DOI: http://dx.doi.org/10.24327/ijrsr.2021.1211.0557

ARTICLE INFO

Article History:

Received 28th October, 2022
Received in revised form 25th November, 2022
Accepted 14th December, 2022
Published online 28th December, 2022

Keywords:

Float, Floating, Buoyancy, Floating structure, Water, River,

ABSTRACT

Earth is 70% covered by water and 30% by land. And there are people living everywhere, including along riverbanks. We frequently experience natural disasters like floods since we live close to water. Sea level has risen above mean sea level by 91.0 mm as a result of global warming. In the following years, it will cover the majority of the land as a reflection. In addition, individuals are turning to land reclamation because there is no more land available for development due to factors such as land price, geological conditions, and others as a result of the metropolitan regions' rapid growth and development. People seek to demolish mountains, sand dunes, and other ecosystems in order to reclaim the land, which causes more problems than what we are having now. Finding out whether floating architecture will be a solution for improving water resources is the primary goal of this project. And as has already been mentioned, floating architecture is already being used by individuals in Hamburg, Sweden, Portland, New Orleans, the Netherlands, and Kerala. Additionally, research into the effects of the environment, sociology, natural disasters, energy shortages, construction materials, and other projects with different economic ideas contributes to the resilience of floating structures. As a result, by using lightweight and eco-friendly materials, this sort of fashion will lessen its global carbon footprint. The surrounding ecology won't be harmed because we don't need to fill up on water, and the same is true for the sea ecosystem. Since we don't have to pay for land, the urban area around the coast will be different. Additionally, this project will serve as a baseline for the all-floating structure, enabling advancement.

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INTRODUCTION

Approximately 40% of people on earth today, according to NASA estimates, reside within 100 kilometers of the shore. In the meantime, as economic income levels rise, more people desire to live near or on the sea and engage in recreational activities there. This means that in the future, water-friendly construction will be a strong alternative form of architecture.

1. Since 1880, the sea level has risen by 21 to 24 cm.
2. The worldwide mean sea level was 2.75mm in 2000, 38.09mm in 2010, 68.81mm in 2020, and 91.3mm as of today.

Floods

There are not many locations on Earth where flooding is not a problem. Despite the fact that rain is not the main cause of flooding, any location where it rains is at risk. When water overflows or covers normally dry terrain, a flood ensues. Rivers or a stream overflowing their banks is the third most frequent cause of flooding. Excessive rainfall, a breached dam or levee, quick alpine ice melt, or even a poorly designed beaver dam can overrun a river and cause it to flood the nearby area known as a floodplain. When a powerful storm or tsunami pushes the sea inland, coastal flooding happens.

Land Reclamation

The process of converting oceans, seas, riverbeds, or lake beds into new land is known as land reclamation, commonly referred to as land fill. Extending land by elevating low-lying or water-bed areas or by pumping water out of puddle bogs.

Impact on Groundwater

As more water bodies disappeared over the years, a study calculated the diminishing volume of water extracted and the loss of ground water recharge. "Lakes and ponds were 2 meters deep, and surface water storage fell from 1,335 million cubic feet in 1893 to 339 million cubic feet in 2017.

According to water experts, the coastal belt has experienced significant saltwater intrusion and localized floods as a result of the quick depletion of natural resources. They remembered an IIT-Madras search study that indicated there were 650 water bodies in the Chennai area up to the late 1970s. The floods in Chennai in 2015 were an obvious sign of poor lake management and inadequate canal protection. And it continues,

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with a significant flood occurring in November 2021 during the downpour. Every year, flooding in the city is brought on by the water bodies that have been swallowed up by real estate and other development, including the long tank, Velachery lake, Adambakkam lake, Katteri lake, Konnur tank, and Kodungaiyur lake. And unequivocally demonstrates that water has a powerful memory.

AIM AND OBJECTIVE

The goal of this project is to create a floating, five-star hotel with a water sports facility that doesn't harm the Marian ecosystem.

The proposal's goals are as follows:

1. Learn about the numerous theories and principles that are applied to ships or floating structures.
2. Investigate the form and shape to see how it responds to the environment.
3. Learn about alternative building materials with regard to floating structures.
4. Investigation of floating construction technologies.

METHODOLOGY

The proposal has been derived on five levels. The four levels are 1.Core factors of floating, 2.Case study, 3.Site selection and analysis, 4.Design of modular unit.

Core Factors of Floating

Literature

Several aspects must be taken into account for an object to float. In addition to buoyancy, hydrostatic pressure, water density, static equilibrium, and stability effects of loading on stability, the meta-center, board estimation for nothing, breakwater system and mooring system.

Buoyancy

According to Archimedes' principle, a submerged item experiences an upward force proportional to the weight of the displaced fluid. This is the first requirement for equilibrium. Let's think about the buoyancy force mentioned above. We refer to it as the centre of buoyancy, and it is situated in the middle of the submerged portion or hull.

Furthermore, Stevin's law explains why the centre of buoyancy and the centre of gravity of a floating body must be vertically aligned. The centre of buoyancy follows a curve whose centre of curvature is known as the meta-center for various inclinations. If the meta-center is located above the centre of gravity of a floating body, the equilibrium is stable.

Hydrostatic Presssure

It can be anything, and pressure affects it from all sides since fluids exert pressure on the object, P. Prior to the presence of an item, the pressure scalar quantity is directionless. The buoyancy force was heavily influenced by the volume of water present. The triangle is the object with submerged volume in this sentence. The total buoyant force is equal to the mass of the object times its total underwater volume, times the gravitational acceleration, and times the density of the water it is submerged in.

Density of Water

Since salt water and fresh water have different densities, being in the ocean indicates that you are in salt water, and being in a river or lake indicates that you are in fresh water. Even if these variables have significantly changed, they nevertheless result in change. Because salt water has a larger density and more buoyancy force, you will lose some drought as a result of the change in water's density. Therefore, the density of the water should be taken into account when building the pontoon floater.

Static Equilibrium

The first is that the total force is equal to zero, which is one of two criteria for static equilibrium. The entire buoyancy force of the ship equals its whole weight in most cases. Some of the movements in condition 2 are zero.

Stability

Transverse stability and longitudinal stability are two separate types of stability. When we have an object, it has a centre of buoyancy and gravity. The centre of buoyancy, which moves to the centre of the underwater volume of a ship or item, changes when you apply force to one part of the transverse side of an object, but the centre of gravity stays the same. If we now apply weight and the buoyancy force, the movement will be caused since the centre of buoyancy has been moved. And the static equilibrium has been lost. The movement entails making an attempt to push the object upright so that it is stable.

The shape of the buoyancy changes as force is applied to one side of the longitudinal side, just like transverse stability. The meta-center, meta-centric radius, vertical centre of gravity, and vertical centre of buoyancy are all also reflected. The longitudinal movement of inertia is going to be marked by a significant number of distances from the trim axis, therefore the BM here is greater than the transversely. There is a genuine risk of capsizing with the BM in the transverse. The longitudinal stability of (BM) makes it practically difficult to capsize in this manner. So, we must concentrate on the trim.

The Meta-Center

The meta-centric height GM must be stable and positive. Since stability rises as GM increases and is defined by the centre of buoyancy of a floating body, which depends on the shape of the item and the position in which it is floating, stability rises as GM increases. The centre of buoyancy will vary if the object is disturbed by a slight heel angle because the shape of the submerged volume is altered.

In order to understand the meta-center, consider how the centre of buoyancy, B here, moves toward the B' prime here when the object is tilted. And at small angles, it moves in a circle, with (M) transverse meta-center at its centre. It's like an imaginary point way up in the sky; it's not a point we build on the ship or floater.

K- Keel of the ship or object
M-Meta-center
G- Center of gravity (Comes from the loading)
B- Center of buoyancy (come from the underwater volume)

Free Board

The depth, which is the overall height of the deck, is one of the two main vertical metrics in this context. Draft is the term used to describe the portion that is submerged. Both of them are calculated from the keel line, which is at the base of the deck. And the free board is what separates these two.

Mooring System

The process of mooring involves anchoring the ship to a permanent or floating object and maintaining that connection during loading and unloading activities. Several forces, including the wind, the current, the tide, and the waves, must be withstood by a safe mooring.

CASE STUDY

The case studies were carried out at both site and building level as discussed earlier. The projects were selected on the basis of their site areas and construction technologies. The selected case studies were:

1. Hotel Haegumgang- Korea
2. Good Hotel- London
3. Urban Rigger- Denmark
4. Poovar island resort- Kerala
5. Polo Floatel- Kolkata

Inference from case study

1. Site location, Geological surroundings, Climate condition, Depth of the water body, Usage of the water body and Surrounding ecology these are main factors need to be consider.
2. Deck & super structure need not be homogenous material. The Super structure may or may not be PEB structure and need not to be single structure.
3. Deck foot print and building need not to be same. Shape of the deck can take any form but it should not be 90 degree on the wall (it should be tapper, maid of curves).
4. Should carry sustainable features of Electricity- solar panel, wind turbine, Water desalination, STP, and etc
5. Floating break water system needs to use.
6. Anchor can be used on both sides for mooring system. For making the stand at one place.
7. While designing the floating deck the Meta-center should be calculated and result should be sable or higher.
8. Window can be aluminum and door can be wooden. And rubber gas cut should be used on joints for preventing water leakage.
9. Light weight material should be used on super structure for reducing the loading capacity.

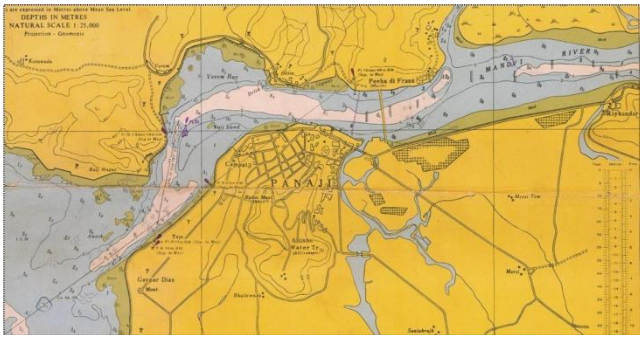
Site selection & analysis

The information was taken from India Tourism Statistics at a Glance 2018–2020. According to the data, Goa has 5% of all international tourists visiting the country from 2017 to 2020, according to the Share of States for Foreign Tourist Visits. A city development plan was created in 2007 by the Corporation of Panaji City for an area of 8.12 km2 and a population of around 59 066. The municipality of Panaji is included in the North Goa district's Tiswadi taluk. It serves as both North Goa district's administrative centre and the state capital of Goa. It was incorporated into India together with the rest of Goa and the former Portuguese territories in the invasion of 1961, and it has served as the administrative hub from Portuguese rule until Goa was elevated to the status of a state in 1987.

The population of Panaji makes up 16% of the urban population of the North Goa district and 2% of the state as a whole. Over the past fifty years, the city's population has fluctuated primarily because of changes in the territory under CCP's control. According to Census 2011, there are 40,017 people living in Panaji as compared to 59,066 people in that year.

Depth map of mandovi river

The estuary region of Panaji is where the River Mandovi meets the Arabian Sea. The region is home to ecologically delicate elements like mangroves, marshy regions, aquatic life, river fronts, lakes, and seafronts. The Coastal Regulation Zones (CRZ) I, II, and III include these areas. The River Mandovi and the River Zuari, which flow from the northern side of the city to the Arabian Sea in the south, are the two main water bodies in and around the city. The Mandovi River and the Zuari River have a silting issue. Since all storm drains are currently dumping storm water into the Mandovi River, in addition to the river becoming silted near the mouth of the Arabian Sea, the river needs rapid treatment. Out of the 2032 sq. km. total catchment area, 375 sq. km. are in the state of Karnataka and 77 sq. km. are in the state of Maharashtra. Goa is home to the remaining 1580 square kilometers of the Catchment area.



Map 1 Mandovi River

If the construction is a single gigantic structure, the buoyancy will be significant, preventing us from going any further than 23 to 25 meters. Additionally, the effective breadth of the maximum depth is 196 meters at the junction of the Mandovi River. So we can use many floating structures, connecting them with the appropriate support once they arrive at the place. With its very eco-sensitive mangroves, marshy lands, aquatic life, river front, lakes, and sea front, the River Mandovi joins with the Arabian Sea. A little over 33% of the 8.30 km2 that make up the city of Panaji are covered by natural features.

Surrounding topography

Panaji is located at 15.25 degrees North latitude and 73.5 degrees East longitude. The city occupies just 36 square kilometers of land. The city, which sits on the island of Tiswadi, is practically level with the water. It reaches to a height of 60 meters.

Design

Figure 1 Concept

These plants have leaves and blossoms that grow to the water's surface and float there, yet their roots are rooted to the pond's bottom. A plant with floating leaves include water lilies, lotuses, water shields, and spatterdock. The idea behind the floating deck is similar to that of the floating leaves. The size of the leaves varies from plant to plant. So, the size of the superstructure will vary depending on the activity taking place there. Even though the leaf has an anchoring mechanism, when there are floods, it will travel toward neighboring leaves. The edges are trimmed with reference to the six-sided polygon since the convex edges will overlap other leaves and have an impact on the structure in real life. The triangle is the second-strongest form, thus the polygon shape reflects this.

Master Plan

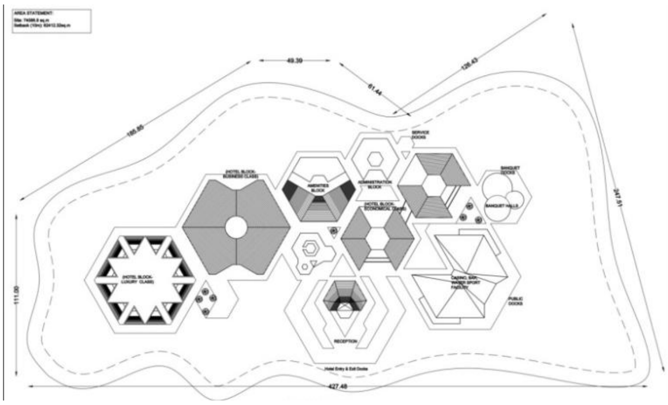


Figure 2 Site Plan

Modular Plan

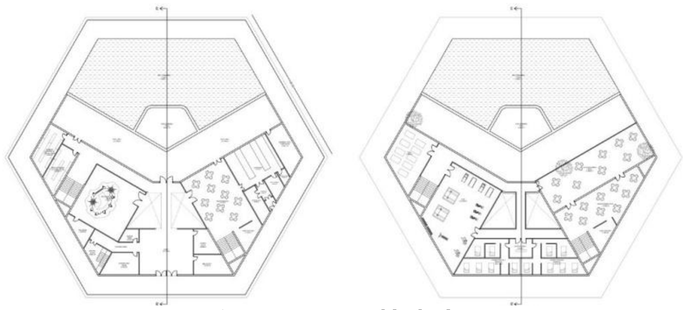


Figure 3 Amenities block Plan

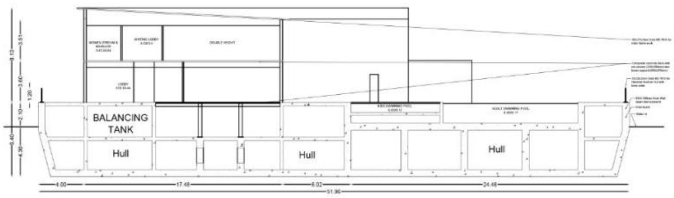


Figure 4 Amenities block Section

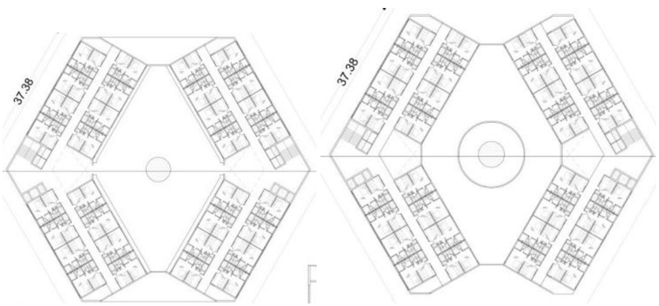


Figure 5 Business Class Block Plan

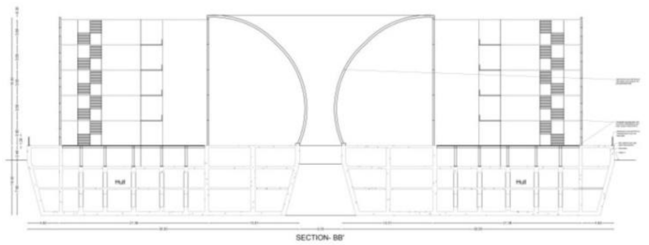


Figure 6 Business Class Block Section

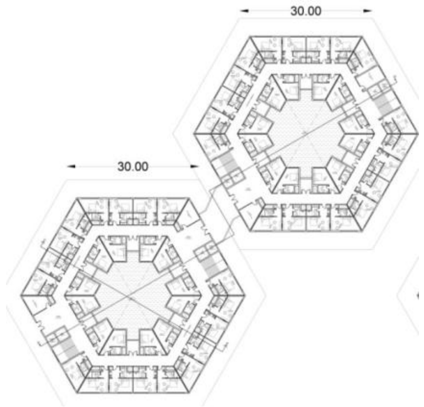


Figure 7 Economical Class Block Plan

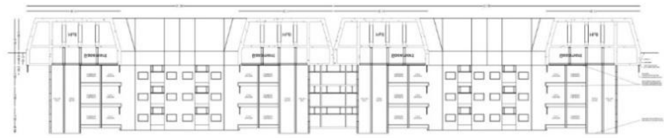


Figure 8 Economical Class Block Section

Stability analysis

Table 1 Business Class Block Calculation

Floating Eco hotel with water sport facility (HOTEL BLOCK- BUSINESS CLASS)					
Size one side	42m				
hexagonal pyramid	**V = (√3/2) a2 h**				
side size	42	m	side size	39.53	m
height	78.37	m	height	70.77	m
Volumn	359159.6786	cu.m	Volumn	287304.1975	cu.m
subrate	71855.48116	cu.m			
hexagonal 3d	**V = [(3√3)/2]a2h**				
Volumn	**10998.8928**	cu.m			
Total Deck Volumn	82854.37396	cu.m	**Total deck kg**	**82854373.96**	**kg**
water	1 cu.m	1000	liters	1000	kg
Genarator		285kva		961	kg
		2	no.s	**1922**	**kg**
PEB (super strucuture)		1	sq.m	25	kg
Floor area				3401	Sq.m
for 1 Floor				85025	kg
				85.025	M.Ton
For G+4 area		**5**		**12921**	**sq.m**
For G+4 PEB weight		**5**		**323025**	**kg**
Hull Self Weight		1		2500	(kg/cu.m)
Concrete volumn		252	79.22	19963.44	
				49908600	**kg**
Fule weight			1 liter	0.78	kg
Fule		730	CU.m	**569.4**	kg
Freash Water		730	CU.m	62068.25	kg
				62.06825	M.Ton
Sea water (balancing)			1 liter	1.25	kg
		730	CU.m	**912.5**	**kg**
bed	1	70	80	5600	kg
dining table	1	40	80	3200	kg
side table	1	5	160	800	kg
WC	1	80	80	6400	kg
wooden Flooring	1	7.32	12921	94581.72	kg
wardrobe	1	25	160	4000	kg
tv	1	28	80	2240	kg
sofa	1	70	80	5600	kg
Total furniture weight				**122421.72**	**kg**
STP		0.45	210	94.5	kg
STP self weight				1000	kg
Total STP weight				**1094.5**	**kg**
Mooring Chain (60mm)	1	29.4	25	**735**	**kg**
Lift (6person)		550	2	**1100**	**kg**
People load		80	210	**16800**	**kg**
Total Load				**50438148.37**	**kg**
15% Factor of safty				**7565722.256**	**kg**
Grand Total				**58003870.63**	**kg**
Free board				**24850503.33**	**kg**

Table 2 Economical Class Block Calculation

Floating Eco hotel with water sport facility					
(HOTEL BLOCK- ECONOMICAL CLASS)					
Size one side	30m				
hexagonal pyramid	**V = (√3/2) a2 h**				
side size	30	m	side size	27	m
height	55.98	m	height	50.38	m
Volumn	130892.436	cu.m	Volumn	95416.79796	cu.m
subrate	35475.63804	cu.m			
hexagonal 3d	**V = [(3√3)/2]a2h**				
Volumn	**5611.68**	cu.m			
Total Deck Volumn	41087.31804	cu.m	**Total deck kg**	**41087318.04**	**kg**
water	1 cu.m	1000	liters	1000	kg
Genarator		285kva		961	kg
		2	no.s	**1922**	**kg**
PEB (super strucuture)		1	sq.m	25	kg
Floor area				1478.89	Sq.m
for 1 Floor				36972.25	kg
				36.97225	M.Ton
For G+2 area		**2**		**2957.78**	**sq.m**
For G+2 PEB weight		**2**		**73944.5**	**kg**
Hull Self Weight		1		2500	(kg/cu.m)
Concrete volumn		171.7	27.76	4766.392	
				11915980	**kg**
Fule weight			1 liter	0.78	kg
Fule		350	CU.m	**273**	kg
Freash Water		350	CU.m	12940.2875	kg
				12.9402875	M.Ton
Sea water (balancing)			1 liter	1.25	kg
		200	CU.m	**250**	**kg**
bed	1	70	76	5320	kg
dining table	1	40	76	3040	kg
side table	1	5	152	760	kg
WC	1	80	76	6080	kg
wooden Flooring	1	7.32	1478.89	10825.4748	kg
wardrobe	1	25	160	4000	kg
tv	1	28	76	2128	kg
sofa	1	70	76	5320	kg
Total furniture weight				**37473.4748**	**kg**
STP		0.45	76	34.2	kg
STP self weight				1000	kg
Total STP weight				**1034.2**	**kg**
Mooring Chain (60mm)	1	29.4	25	**735**	**kg**
Lift (6person)		550	2	**1100**	**kg**
People load		80	210	**16800**	**kg**
Total Load				**12061352.46**	**kg**
15% Factor of safty				**1809202.869**	**kg**
Grand Total				**13870555.33**	**kg**
Free board				**27216762.71**	**kg**

Table 3 Amenities Block Calculation

Floating Eco hotel with water sport facility					
(AMENITIES BLOCK)					
Size one side	21m				
hexagonal pyramid	**V = (√3/2) a2 h**				
side size	42	m	side size	39.53	m
height	78.37	m	height	73.77	m
Volumn	359159.7	cu.m	Volumn	299483.2648	cu.m
subrate	59676.41	cu.m			
hexagonal 3d	**V = [(3√3)/2]a2h**				
Volumn	**13748.62**	cu.m			
Total Deck Volumn	73425.03	cu.m	**Total deck kg**	**73425029.87**	**kg**
water	1 cu.m	1000	liters	1000	kg
Genarator		285kva		961	kg
		2	no.s	**1922**	**kg**
PEB (super strucuture)		1	sq.m	25	kg
Floor area				3401	Sq.m
for 1 Floor				85025	kg
				85.025	M.Ton
For G+4 area		**5**		**6802**	**sq.m**
For G+4 PEB weight		**5**		**170050**	**kg**
Hull Self Weight		1		2500	(kg/cu.m)
Concrete volumn		252	79.22	19963.44	
				49908600	**kg**
Fule weight			1 liter	0.78	kg
Fule		730	CU.m	**569.4**	kg
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tv	1	28	80	2240	kg
sofa	1	70	80	5600	kg
Total furniture weight				**122381.72**	**kg**
STP		0.45	210	94.5	kg
STP self weight				1000	kg
Total STP weight				**1094.5**	**kg**
Mooring Chain (60mm)	1	29.4	25	**735**	**kg**
Lift (6person)		550	2	**1100**	**kg**
People load		80	210	**16800**	**kg**
Total Load				**50285133.37**	**kg**
15% Factor of safty				**7542770.006**	**kg**
Grand Total				**57827903.38**	**kg**
Free board				**15597126.49**	**kg**

View

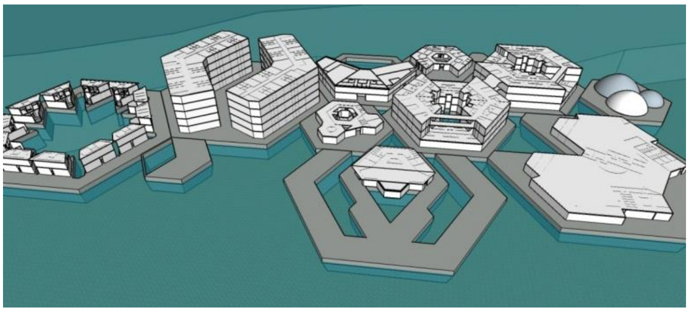

Figure 9: South side Arial View of Eco-Hotel.

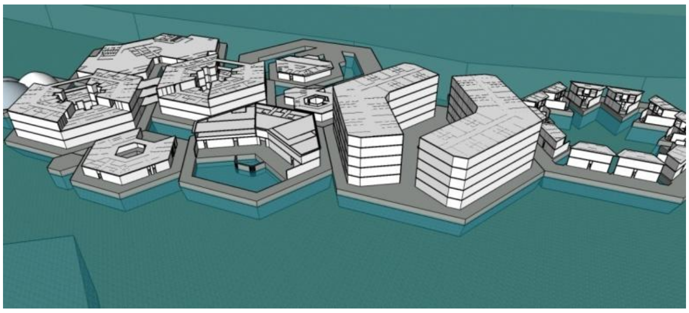

Figure 10: North side Arial View of Eco-Hotel

Recommendation

Buildings that are designed to be adaptable and react to changing weather patterns, conditions, and requirements are known as environmentally responsive architecture. This type of design has numerous advantages, and the structure can be used for a very long time. The floating mobility has the added benefit of acting as a preventative strategy when it comes to relocation. The use of tugboats for movement along a water stream solves the transportation problems. The architecture creates a versatile area that doesn't always maintain its purpose. The same concept that applies to land ownership also applies to floating structures since an upper deck cannot exist without a lower deck. So in this case, the lowest deck serves as the land.

CONCLUSION

Floating architecture can be a robust and appealing answer to the frequent natural disasters, such as earthquakes and flooding, that are a result of climate change. It is practical to construct a floating structure using materials and construction procedures based on earlier research of the floating approach.

Floating buildings on the water have several advantages over conventional buildings on land in terms of the environment, the economy, and society. Durability to an increase in water level, long-term use due to movement, and relocation in the environmental dimension can all contribute to the sustainability of floating architecture. Prefabrication and modular building have economic benefits, and high utilization brought about by global mobility has an economic efficiency.

The structure being in the water will be a huge disadvantage for power and water service. However, we now have floating solar panels, floating wind turbines, desalination plants for drinking water, and STPs for recycling the water to address that issue as well. Additionally, a damp environment can harm people' health and deteriorate building materials. Wet proof construction materials should be taken into account to prevent dehumidification. When a floating construction casts shadows over the water or occasionally blocks fishes' pathways, it can sometimes have a negative impact on the ecosystem.

There are positive and negative aspects to any product, but a successful product should have more positive aspects than negative. Current and foreseeable challenges, such as sea level rise and land reclamation, can be effectively solved by this type of building.

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