AQUATECTURE PRACTICES IN INDIA

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ABSTRACT

It's been thought from our childhood that the Earth is covered with 70% water and 30% land. But with the sudden change in temperature there have been a lot of changes in World's land coverage. Every year land's 1% of area is been covered by water. In the world the most effective natural disasters are hydraulic disaster. Tsunami, floods, cyclones are the most happening disasters. So, with an interest to introduce disaster responsive construction techniques in the field of Architecture, I seek Aquatecture – Water Floating Houses.

KEYWORDS: Aquatecture, Floating Houses, Water Houses

AIM

To introduce methods that reduce life loss during Floods through building construction techniques of Aquatecture in India.

OBJECIVES

- To explain Why Aquatecture is to be introduced. And derivation of Aquatecture.
- What is Aquatecture and Types in Aquatecture
- Under water Construction and Techniques.
- Floating Water Construction.
- Advantages and Disadvantages.

METHODS AND MATERIALS

Methodology

Methodology adopted in this research is shown in figure 1 which given bellow:

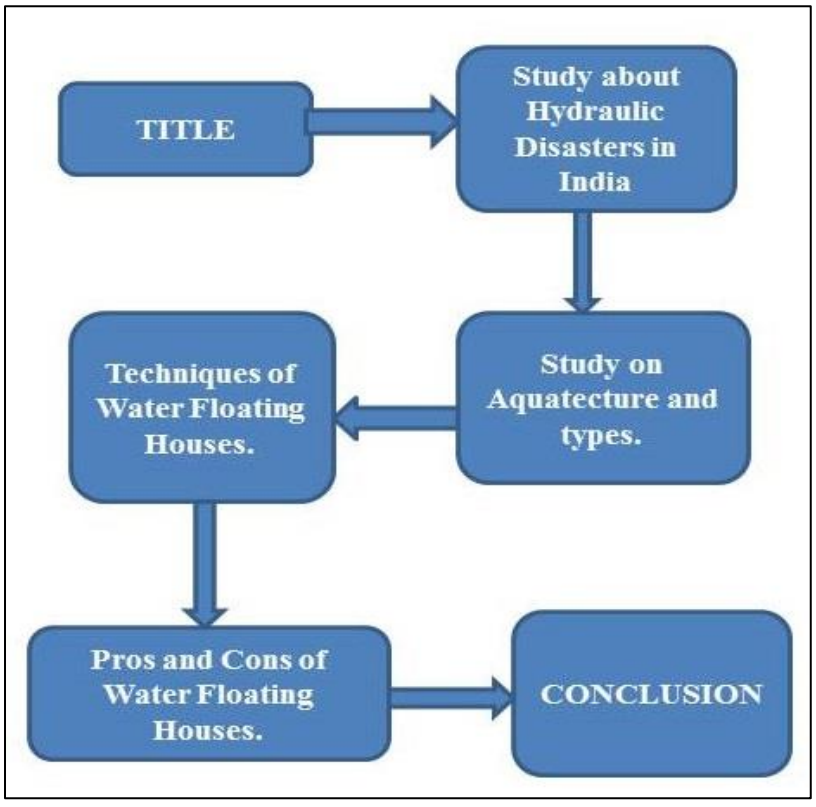

Figure 1: Methodology Chart

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STATISTICS OF FLOODS IN INDIA

As India is called to be a peninsular country which is surrounded by Arabian Sea, Indian Ocean and Bay of Bengal most parts of India are in the Flood prone areas. As per Geological Survey of India, 12.5%of land in India is covered by flood prone area. Floods are the most common disaster cause a huge loss to property and lives in India.

The states that come under “India Flood Prone Area” are West Bengal, Punjab, Orissa, Andhra Pradesh, Haryana, Assam, Bihar, Gujarat, Uttar Pradesh, Kerala, and Karnataka. According to data from the Central Water Commission (CWC), one-fifth of global flood-related deaths take place in India. In the 64 years from 1953 to 2017, more than one lakh people have died due to floods and damage to crops. Also, damage to infrastructure and housing has been pegged at Rs 3, 65,860 crores, which is 3% of the country’s current Gross Domestic Product (GDP).

Floods have caused considerable damage across India this season. Since the beginning of the monsoon, 91 districts in 12 Indian states have been affected by floods. In all, 511 people have lost their lives and 176 people have been injured. Floods have also damaged around 55,000 houses. (Sangomla, 2018)

Average Annual Flood Damage (1953 - 1999) Shown in table 1.

Table 1: Average Annual Flood Damage

State	Area liable to floods (million Ha)
Total damage	Rs.13,400 million
Area affected	8.11 million hectare
Crop area Affected	3.57 million hectare
Human lives lost	1579 Nos
Cattle Lost	95,000 Nos

Source: https://www.mapsofindia.com/top-ten/geography/india-flood.html

Flood Prone Areas in India

Though the north-Indian plains prone to flood more, the "India flood prone areas" can be broadly categorized in three divisions:

Figure 1: Flood Prons Area in India (Source: Parminder, 2013)

Ganga Basin

The Ganga Basin gets flooded mostly in the northern part by its northern tributaries. The badly affected states of the Ganga basin are West Bengal, Bihar and Uttar Pradesh. Besides the Ganga, rivers like Sarada, Rapti, Gandak and Ghagra causes flood in eastern part of Uttar Pradesh. The Yamuna is famous for flooding Haryana and Delhi. Bihar experiences massive dangerous flood every year. River Burhi, Bagmati, Gandak, Kamla along with many small rivers contribute to that. In West Bengal, rivers like Mahananda, Bhagirathi, Damodar, Ajay etc. causes floods because of tidal effects and insufficient river channels

Brahmaputra and Barak Basins

The river banks of Brahmaputra and Barak gets flooded due to the Surplus water found in the Brahmaputra basin and the Barak basin. These rivers along with their tributaries flood the northeastern states like West Bengal, Assam and Sikkim. Jaldakha, Teesta and Torsa in northern West Bengal and rivers in Manipur often overflow their banks.

Hydraulic Disasters in India Happened Recently

- Rivers Overflow as Tropical Cyclone Titli Hits Odisha and Andhra Pradesh 11th – 18th October, 2018.

Figure 3: Rescue team in during Titli cyclone (Source: Davies, 2018)

- 90,000 Affected by Floods in Odisha 5th Seotember 2018.

Figure 4: Flood in Odisa (Source: Davies, 2018)

- 19 Dead in Uttar Pradesh Floods as Rivers Rise. 1st September, 2018
- 12 Dead, Homes and Roads Destroyed After Weeks of Flooding in Nagaland. 26th July, 2018.
- Over 300 Dead in Kerala Floods Described as Worst in 100 Years. 9th July – 30th August, 2018.

Figure 5: Kerala Floods Helicopter View (Source: Davies, 2018)

- Deadly Flash Floods in Jammu and Kashmir. 13th -15th August, 2018.

Figure 6: Floods in Jammu & Kashmir (Source: Davies, 2018)

- 19 Dead After Torrential Rain in Himachal Pradesh. 12th – 15th August, 2018.
- Fresh Wave of Floods in Assam Leaves 3 Dead and 25,000 Displaced
- Deadly Floods Hit Gujarat

Figure 7: Floods in Gujarat (Source: Davies, 2018)

AQUATECTURE

Introduction to Aquatecture

Aquatecture is defined as an architectural adaptation typology used to mitigate and manage flooding. With this typology, water and architectural design can unite to produce dynamic and reliable mitigation solutions (Williams)

Architecture is derived from two Latin words Archi and tekton. “Archi” means “chief” and “tekton” means “builder/creator/designer” which gives a meaning of “chief builder/chief designer/chief creator”.

Aquatecture can be explained by the words “aqua” and “tekton” which means “water builder/water designer/water creator”. Aquatecture

Types of Aquatecture

There are two methods of Aquatecture according to their construction technology. Structures constructed under the water are named as “UNDER WATER CONSTRUCTION”. Structures constructed floating on the water are named as “WATER FLOATING CONSTRUCTION”.

Construction methods and there purpose of designing are completely different in UWB & FWB.

Under Water Buildings

Under water buildings are structure constructed under the sea level. This method considered as the most difficult work. There are two techniques mainly used in Under water Construction .

Caissons

A caisson is retaining water tight structure used in the construction of concrete dam, foundation of a bridge pier, repair of ships. They are sunk in water during the excavation of foundations to divide water which is essential part of the substructure.

There are four different types of caissons:

- Box Caisson
- Open Caisson
- Suction Caisson
- Pneumatic Caisson

Cofferdams

Cofferdams are temporary watertight enclosure pumped dry below the water line to execute the building operation to be performed on dry surface.

There are six types of Coffer Dams:

a. Earth Cofferdam

- Rock-fill Cofferdam

- Cellular Cofferdam
- Single Walled Cofferdam
- Double Walled Cofferdam
- Crib Cofferdam

Water Floating Building

Water floating buildings are structures constructed not only on water but also on shores of any water bodies. Water Floating Buildings are categorized by the foundations type and their relationship with water.

Techniques of Water floating building are below:

- Terp Dwelling
- Pile Dwelling
- House Boats
- Amphibious Houses.

In order to introduce Construction techniques to control the Annual damage to the country I opt to explain

FLOATING HOUSES AND TYPES

Architectural Style

Every different type of Architecture style we find different types of construction techniques which make their appearance and their aesthetic to be unalike. This brings a lot of change of particular style with other styles.

Water floating building has its own style of construction which is evaluation from some eras. Some of these construction types are explained

Terp Dwelling

A terp is an artificial earth space made to provide ground during rise in water levels. Frist treps construction was started in Netherlands in 500 B.C where tides from the nearby rivers affected daily routines. Treps were constructed 5-15 meters high to keep house and cattle space dry and to save the food storage from moisture. Nearly in 1000 A.D trep building inhabitants started connecting mounds in order to prevent sea to flood there lands, they started doing this with help of dyke system. This system is used to construct fish ponds.

Trep dwellings is safer than and more secure than floating dwellings. At the same time it's too dangerous as it's difficult to escape during heavy flooding.

European countries prove many examples of Trep Dwellings. The Bridge House in Achterhoek, Netherlands. In the construction process architect removed top layers of soil to reduce the fertility of soil and this soil reused to make a elevated area under the house which is a traditional Dutch Trep Dwelling.

Figure 2: Trep Dwellings (Source: Architects, Jan 16, 2013)

Pile Dwelling

Pile dwellings are a type of housing built on top of concrete, steel or wooden poles and can be found in shallow water, coastal areas, or lakes where changes in the water level can be predicted. This type of dwelling typically rests 8-15 feet from the ground and has been used throughout the world as means of protection from water. In Indonesia, Singapore, and other countries these housing are called as "kelong" which are built for fishing. The "Nipa hut" is the primary type of housing found in the Philippines and a similar stilt house structure is also popular in Papua New Guinea. Thai stilt houses are often built above freshwater and the "Palafito" is found in the tropical river valleys of South America.

Timber pilings have been used for 6,000 years and continue to be one of the leading types of driven piles. Timber is often used in pile foundations because it is a readily available and renewable resource. Because it is light in weight, timber is also more easily handled, driven and cut than other types of piles. According to the Federal Highway Administration, timber pile foundation underwater will last indefinitely and timber piles partially

above water can last up to 100 years or longer if they are properly prepared and treated. Concrete piles can be pre-cast or cast-in-place, and they can be reinforced, prestressed or plain. They do not corrode like steel piles or decay like wood piles. concrete is more readily available than steel. Pre-cast concrete piles are shaped and molded according to shape, length and size prior to being driven into the ground. Cast-in-place piles are poured into holes in the ground where a rod has been previously driven and removed. Steel pilings can be formed into many different shapes but the most common steel pile types have rolled circular, X-shaped or H-shaped cross sections. They are very strong and are great for driving especially in firm soil and can be easily cut off and can also be easily joined by welding. Although steel pilings can last up to 100 years, they are prone to corrosion, especially when submerged in water.

Figure 9: Pile Dwelling at Alps (Source: Amallean, 27 June, 2011)

House Boats

House boats began with the conversion of ships and fishing vessels into livable environments. These types of houses resemble a land based property in its design and construction yet are buoyant enough to withstand the forces of water. In India houseboats are common on the backwaters of Kerala, on Dal Lake near Srinagar. House boats in Kerala are huge slow moving barges used for leisure trips. They are used to carry rice and spices from different places in early times. These house boats are considered as a convenient means of transportation. It is about 60 to 70 feet long and about 15 feet wide at the middle. The hull is made of wooden planks that are held tightly by ropes and coconut fiber. The roof is made up of bamboo poles and palm leaves. The exterior of the boat is painted with protective cashew nut oil coat. The need for housing brought many workers to transform old fishing boats into residential dwellings.

Some of the more modern examples of floating homes are those built by Dutch architects including Waterstudio, Aquatecture, Factor Architecten and Architectenbureau Marlies Rohmer. The trend to build residences on water has attracted many homebuyers in coastal countries.

Figure 3: House Boat

Advantages and Disadvantages of Aquatecture

Building type	Advantages	Disadvantages
Terp dwelling	Can be used for large plots of land	Difficult access to living areas House can still be flooded due to height limitations Residents cannot leave house when flooding occurs
Static elevation	Elevates house to required base flood elevation level Preserves original architecture Capable of high density houses	Difficult access to living areas Increased vulnerability to winds House can still be flooded due to height limitations
Pile dwelling	A solution when there is a lack of construction ground Capable of high density houses	House can still be flooded due to height limitations Increased corrosion due to its submergence in water
House boats	A solution when there is a lack of construction ground Capable of mobility No height restrictions allow the house to rise and high as any water level	It is subject to stronger external loadings due to wind, rain and ice Increased corrosion due to its submergence in water House must be loaded symmetrically to maintain even levelling Must accommodate all plumbing and sewerage fixtures within the house.
Amphibious dwelling	, A solution when there is a lack of construction ground House remains on the ground under normal conditions but will rise when flooding occurs Utilizes municipal pipes and electrical connections	It is subject to stronger external loadings due to wind, rain and ice House must be loaded symmetrically to maintain even levelling Height limitations are restricted to the mooring post height

CONSTRUCTION DETALIS OF WATER FLOATING HOUSES

Pile Dwelling

Pile Dwelling is one of the Stilt house constructions. First pile dwellings constructed in 5000-500 B.C in parts of Southern Germany, Switzerland and Italy. These dwellings are reconstructive they are built on the shores of Lake Constance. The largest village is having 87 houses in couple of hectares.

- The dwelling was built on platforms supported by piles above the surface of the water and all appear similar in construction.
- First the ends of wooden piles were burned to a point and drilled deep into the mud and surrounded with heavy pebbles
- To form a platform, tree trunks and small branches are tied in lace work over the piles. On the platform one/two roomed were build and the huts were beaten with clay floors for the precaution of fire accidents

- In the present days Pile dwellings were constructed with different materials like concrete, steel or wood.
- Platforms were made the same way by constructing a false bridge to transport materials and machines for construction and construction process is same s grouped houses with stilt parking.

Figure 4: Piles Bridge

Figure 5: Modern Piling (Source: Rajesh, 2012)

Amphibious House

An amphibious house is a building that rests on the ground on fixed foundations but whenever a flood occurs, rises up in its dock and floats there buoyed by the floodwater.

Amphibious houses are located adjacent to the rivers. Based on the practices pioneering non-defensive approach to make space for water within the built environment - the house marks a valuable and critical contribution to both architectural design and flood resilience discourse.

- To construct a Amphibious House First step is to dig the site to some extent 2.7m-3m depth and this depth was cover with concrete on five sides and slide railing was provided at some distance every corner of the wall to move the house vertically.

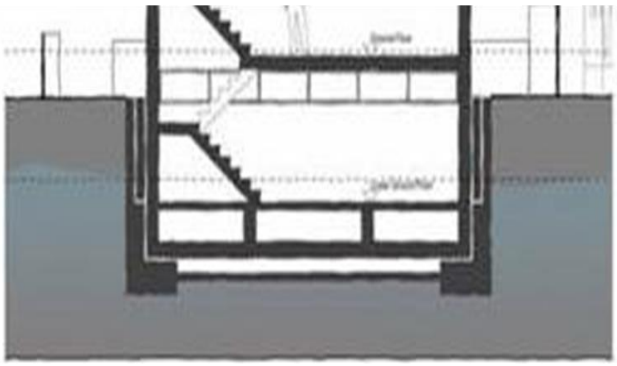

Figure 6: Base of Amphobious House

- Now the pre casted wall are linked to the steel bars length of 6m and fixed in the railings and the interiors are done as usual.

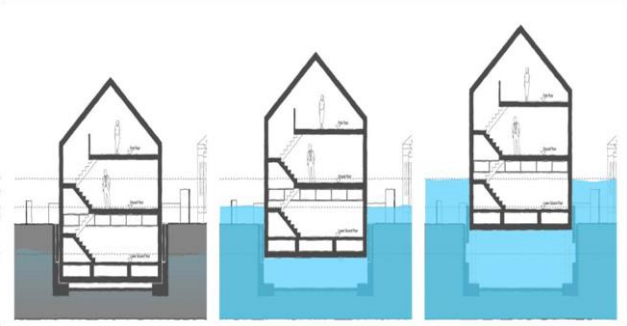

Figure 7: House position at Different times

CONCLUSION

- Life is most precious thing in the whole creation of god. God gave us life in order to live and make others live with joy and love in the face and actions.
- Lots of lives are been losing in the Hydraulic Disasters in India. According to statistics we read India is in first position of Water Deaths.
- According to the Aim I want to introduce construction technique in India to reduce water deaths is
- AMPHIBIOUS HOUSES

- This construction can be done in any place of India. Every material used is available in the present day market.
- We saw great material loss very recently in Kerala, not only that in India there been 13 Hydraulic Disasters from August 16th 2018 till date.
- With the fast changing world India need to change and adapt many construction techniques not only for development but also for the comfort in real space of designing.

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