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Flood Mitigation Measures – Amphibious Housing.

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Abstract*— Floods leads to loss of lives as well as infrastructure which affects the economy of the area for a longer duration, hence to cater the current scenario, an attempt to design a viable structure is the need of future. The aim of this paper is to study new concept of the amphibious house in lowland area as a flood mitigation measure. This report will explore and documents the various ways of protecting and creating a sustainable living environment for seaside and riverside residents. The solution will also include waterproof material and protection of vital utilities, design of buoyant foundation, vertical guidance pole attached to the foundation, which provides resistance from lateral force caused by wind and water. Amphibious Architecture adapts to dry and wet conditions without causing any damage during or after flood. The development of an amphibious community is a long time strategy that will minimize the potential risk of flooding along riverside. The proposal for this dissertation will provide sustainable structure for the people of India to create amphibious structures protected from floods.

***Keywords*— Floods, Flood Mitigation measure, Amphibious House**

1. INTRODUCTION

1.A CONTEXT OF FLOOD

A flood is an overflow of water on land which is Usually dry. Sometimes a water resource (river, lake or pond) gets flushed with too much water. Unusually heavy rain sometimes causes floods. When there is too much water, it may overflow beyond its normal limits. This water then spreads over land, flooding it. Extreme flooding can also because by a tsunami or a large storm that causes a storm surge. Floods that happen quickly are called flash flood. During a flood, people try to move themselves and their most precious belongings to higher ground quickly. The process of leaving homes in search of a safe place is called evacuation.

1.B EFFECTS AND CAUSES OF FLOOD

Causes

Occurrence and Reoccurrence of prolonged heavy rain shower has resulted to floods all over the world Flood are caused by many factors: heavy rainfall, high accelerated snow melt, severe wind over water, unusual high tide, tsunamis, or failure of dams, retention ponds, or other structures. Climate changes also an attribute that cause flooding because when the climate is warmer it results in heavy rains, relative sea level continue to rise around most shore, extreme sea levels will be experienced more frequently. Therefore, climate changes are likely to increase flood risk significant and progressively over time.

Effects

The primary effects of flooding include loss of life and damage to buildings and other structures, including bridge, roadways, and canals. Floods also frequently damage power transmission and sometimes power generation which then has knock-on effects caused by the loss of power. This includes loss of drinking water treatment and water supply; it may also cause the loss of sewage disposal facilities. Lack of clean water combined with human sewage in the flood waters raises the risk of waterborne diseases, which can include typhoid, many other diseases depending upon the location of the flood. Damage to roads and transport infrastructure may make it difficult to mobilize aid to those affected or to provide emergency health treatment. Flood waters typically inundate farm land, making the land unworkable and preventing crops from being planted or harvested, which can lead to shortages of food both for humans and farm animals.

1.C PROBLEM FACED BY INDIA DUE TO FLOOD

India is one of the world's most flood-prone countries, with 113 million people exposed to floods. According to a United Nations report, India's average annual economic losses due to disasters are estimated at US$9.8 billion (S$13.1 billion), of which over US$7 billion can be attributed to floods. Flooding in urban areas is most visible in the monsoon season, which extends from June to September every year. In the past decade, major cities such as Kolkata, Chennai, Delhi, Guru gram and Bengaluru have suffered havoc similar to that seen in Mumbai. Climatic impact on urban environments demands greater scrutiny and better planning. India has failed to offer any long-term solutions. India's southern state of Kerala is suffering its worst monsoon flooding in a century, with more than one million people displaced, and more than 400 reported deaths in the past two weeks. Aid agencies and government groups have set up more than 4,000 relief camps, while rescue personnel are making their way to submerged villages in helicopters and boats, bringing supplies, and evacuating those they can find. Only in recent days have floodwaters begun to recede, allowing more access for aid workers and rescuers. As of 18 July, incessant rain in the southern Indian state of Kerala has forced more than 34,600 people to seek refuge in 265 relief camps across the state, with flood.

2. FLOOD MITIGATIONS MEASURES

2.A FLOOD MITIGATIONS METHODS

a) Amphibious Structure
b) Flood Barrier
c) Flood Wall
d) Hydrosacks
e) Maeslantkering

3. INTRODUCTION TO AMPHIBIOUS HOUSING STRUCTURE

3.A AMPHIBIOUS HOUSING

Amphibious housing is a dwelling type that sits on land but is capable offloating. During a sudden risen water, a house will be lifted by the water, provided either by pontoons or a hollow basement, in order to ensure it remains dry, and will then return to the ground as the water recedes. By sliding along two vertical mooring poles that are driven deep into the ground, the houses are capable of rising vertically while restricting horizontal movements on the water.

Although the amphibious house resembles a houseboat, there are some essential differences between the two types. The hollow basement of an amphibious house is exposed when there is no water, forcing designers to conceal the base in the ground or in water. The second difference is the distribution of forces in the base. When the property is sitting on land it lacks the even upward force of the water which it experiences when it floats, making the basement larger than that of the barge of a houseboat. The biggest difference between houseboats and amphibious homes is their connection to land. Typically, amphibious homes are designed where water levels are moderate but are rarely prone to extreme flooding, therefore all utility services can be connected to the municipal pipes whereas houseboats must contain all utilities within the structure.

3.B MATERIALS

a) EPS

Expanded Polystyrene (EPS) is a lightweight, closed cell, rigid, plastic foam insulation material produced from solid beads of polystyrene. The EPS beads are expanded and then molded into large EPS Blocks then used in walls, roofs, floors, attics, crawl spaces, EIFS, stucco, and architectural shapes. EPS offers design flexibility, high R-Values for thermal insulation, superior dimensional stability, and resistance to moisture absorption and physical degradation.
EPS is the ideal, cost-effective and easy-to-use material in all types of buildings, from houses and offices to factories and schools. Starr foam meets or exceeds the requirements of ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

b) LIGHTWEIGHT CONCRETE

Lightweight concretes can either be lightweight aggregate concrete, foamed concrete or autoclaved aerated concrete (AAC). Lightweight concrete blocks are often used in house construction. Lightweight aggregate concrete Lightweight aggregate concrete can be produced using a variety of lightweight aggregates. Lightweight aggregates originate from:

• Natural materials, like volcanic pumice.
•The thermal treatment of natural raw materials like clay, slate or shale i.e. Leca.
• Manufacture from industrial by-products such as fly ash, i.e. Lytag.
• Processing of industrial by-products such as pelletised expanded slab, i.e. Pellite.The required properties of the lightweight concrete will have a bearing on the best type of lightweight aggregate to use. If little structural requirement, but high thermal insulation properties, are needed then a light, weak aggregate can be used. This will result in relatively low strength concrete.

c) FOAMED CONCRETE

Foamed concrete is a highly workable, low-density material which can incorporate up to 50 per cent entrained air. It is generally self-levelling, self-compacting and may be pumped. Foamed concrete is ideal for filling redundant voids such as disused fuel tanks, sewer systems, pipelines, and culverts - particularly where access is difficult. It is a recognized medium for the reinstatement of temporary road trenches. Good thermal insulation properties make foamed concrete also suitable for sub-screeds and filling under-floor voids.

d) LIGHTWEIGHT STRUCTURAL CONCRETE

Lightweight aggregate concretes can be used for structural applications, with strengths equivalent to normal weight concrete. The benefits of using lightweight aggregate concrete include:

• Reduction in dead loads making savings in foundations and reinforcement
• Improved thermal properties.
• Improved fire resistance.
• Savings in transporting and handling precast units on site.

•Reduction in formwork and propping.

e) FLEXIBLE PIPES

"Flexible pipes" rely upon their deformation of the pipe from imposed loads to mobilize the support of embedment materials on both sides of the pipe. Their primary structural function is distributing the imposed vertical loads to the surrounding soil.

f) PLASTIC BARREL

Polyethylene drums, more commonly referred to as a plastic drum, are industrial-grade containers made with high-density polyethylene (HDPE). They are lighter weight and are considered to be more cost effective than their steel drum counterparts. They have widespread applications spanning both the residential and commercial sectors.

The footing of the floating house design is a structure that is under the house serving to withstand the total load of the building to float the house. This floating house material is plastic barrels that have a good buoyancy, lightweight and easy to obtain as it is commonly available around us

3.C CONSTRUCTION

The construction and retrofit process of the house is relatively simple and it basically works like a floating dock. The process begins by drilling into the ground and inserting the vertical guidance sleeves in the appropriate locations.

Next a steel frame is constructed by securing C-channels to the wood sill beams of the house, and then positioning and securing extended T-beams to the C-channels. The house is then slowing jacked up to five-feet in small increments where the plumbing and utility lines are modified. The plumbing and utility lines have either self-sealing 'breakaway' connections that disconnect gas and sewer lines when the house begins to rise or long, coiled 'umbilical' lines that can stretch as the house rises. The rest of the T-beams and C-channels are connected to form the structural sub-frame as well as the addition of diagonal L-beams. EPS blocks are then inserted into the sub-frame and the frame is then connected to the house.

The house is then lowered in small increments where it rests 3-4 feet off the ground. The vertical guidance poles are inserted into the sleeves and connected to the extended T-beams in the sub-frame. Most of the construction materials are small and light enough to be installed by two persons without machinery. After the buoyant foundation is in place, the house remains supported on its original piers except when flooding occurs.

3.D PRINCIPLES APPLIED

a) ARCHIMEDES' PRINCIPLE

Archimedes' principle states that the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid that the body displaces and acts in the upward direction at the center of mass of the displaced fluid

b) PONTOON'S PRINCIPLE

Pontoon principle states that the mass or volume of the house/ structure should be less then the density of water

3.E WORKING

Amphibious housing is a dwelling type that sits on land but is capable of floating. Amphibious house works on two basic principle Archimedes Principle and Pontoon Principle. During a sudden rise in water, a house will be lifted by the water, provided either by pontoons or a hollow basement, in order to ensure it remains dry, and will then return to the ground as the water recedes. when the house sits on the ground the floating base is almost invisible from outside.

The floating foundation is the fundamental static of hollow or aright block. The structural sub-frame is attached to the underside of the house and supports the floatation blocks made of Expanded Polystyrene Foam (EPS). Extensions of the structural sub frame attach to the tops of vertical guidance poles near the corners of the house that telescope out of the ground to provide resistance to lateral forces from wind and flowing water. When flooding occurs, the flotation blocks lift the house, with the structural sub frame transferring the forces between the house, blocks and poles. The vertical guidance poles keep the house from going anywhere except straight up and down on top of the water. The hollow basement of an amphibious house is exposed when there is no water, forcing designers to conceal the base in the ground or in water. When the property is sitting on land it lacks the even upward force of the water which it experiences when it floats, making the basement larger. In addition, comfort is achieved because all houses will have the same facilities as a house on land, including heating, cooling and ventilation and utilizes the same municipal pipes and electrical connections. The construction and retrofit process of the house is relatively simple.

4. BARRELS CALCULATIONS

4.A CALCULATION OF FLOATING PLATFORMS WITH PLASTIC BARRELS

The calculation analysis of plastic barrels floating footing is conducted to identify the power of the floating footing to be able to withstand the weight of the floating house structure, so it can be identified how many plastic barrels needed to withstand the load of the floating house, with a defined amount of structural stability.

Calculate the Weight of Empty Plastic Barrel

Weight of Plastic Barrel (G) = 8.6 kg /pcs

Diameter of Plastic Barrel = 0.58 m

Height/Length of Plastic Barrel = 0.93 m

Total Weight of Plastic Barrel in Newton = 8.6 kg x 10 N/kg

= 86 Newton

b. Calculate Buoyancy of fully submerged plastic barrel

Buoyancy (Fa) of Plastic Barrel = π. d2/4. e.g. L (d =inner diameter)

= (22/7) x (0,58)2/4 x 1000 x 10 x 0.93

= 2456 Newton /pcs

So the total buoyancy of 1 Plastic Barrel is (Fa - G)

= 2456 - 86

= 2370
Newton/ pcs (upward
direction)
Total floating force of 232 Plastic Barrels = 232 x 2370
= 549,814 Newton (upward direction)

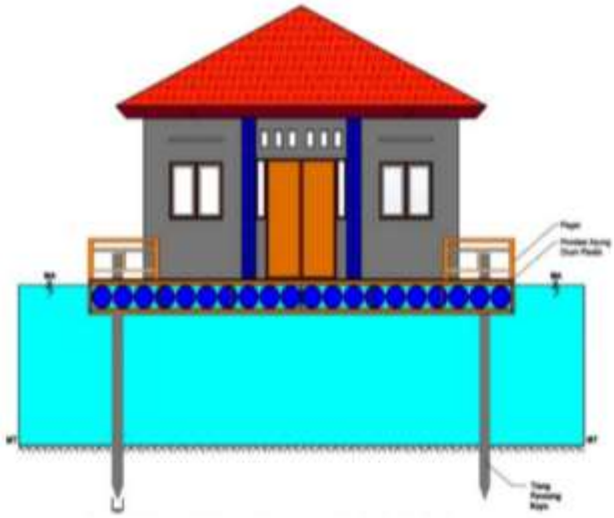

Figure 1. Front View of Floating House with Plastic Barrels as the Footing

Figure 2. Project Prototype made by ([1]Meghanjali Rao, [2]Akash Patil, [3]Mrunmai Gaikwad,[4]Ashwin Bagul)

5 SCOPE OF THE PROJECT

5.A SCOPE OF THIS PROJECT IN INDIA

Amphibious architecture is a breakthrough that can be implemented in existing structures as well. It offers a sustainable, low-cost flood mitigation strategy that focuses on retrofit applications for existing homes.
With each passing year, the monsoon floods increasingly plague the country's urban and rural areas and drain its resources. If the efforts taken to remediate the disasters are redirected to safeguarding flood-prone areas against it, India would be taking a big leap towards ensuring that its steady development is not reversed by nature's fury.

6. CONCLUSION

Amphibious foundations are a proven, low-cost, low-impact flood protection strategy that can increase a flood-prone community's resilience in the face of disaster. As we have been totally inspired by the incident In our very own state of Kerala, it is one of the best examples of most destructive flood conditions in Indian history where Kerala received heavy monsoon rainfall, which was about 75% more than the usual rain fall in Kerala. Over 483 people died, and 14 are missing and about a million people were evacuated. This low impact technology thus provides houses with an even greater resilience to rising flood levels than PSE, without increasing the exposure of the structure to the more regularly occurring strong winds. The long term view that is necessary in taking account of climate change also enables us to view other issues with the same horizon of opportunity facilitating new solution to spatial planning and the location of settlements, best practice in building design, infrastructure development and environmental flood defense. Therefore, it is time to evolve a new relationship with water to ask what is possible of design and construction and begin to look toward a flooded future with confidence and imagination. When looking at how we manage water and design in its close proximity, the immense scale of the challenge of flooding that we are now facing becomes clear. This is the timeframe within which planning, design and development should operate. The buildings and places that we create in the next ten years
will form the backbone of an amphibious lifestyle for the next few decades and beyond. In order to prepare for the future, designers and builders must not look at the limitations of water, but at the opportunities it presents.

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