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Planning and Design of a Flood Resilient Building Based on Impact Study

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Abstract: *Over these years, the world has endured large number of natural disasters. Among them the most disastrous one is flood. Flood can cause a potential treat to both life and property. The influence of global warming is one of the major causes that appears to worry the world, especially the effect of flood happening at the river side that causes potential loses. It difficult to living against water, but it possible to live with water level rising. The rising water occupies the land surface. The land surface taken away by the rising water. The only way to live with rising water is by constructing houses on the water. Amphibious structures are becoming more popular among the people in Kerala. Amphibious structures are buildings that sit on dry land like ordinary buildings, except there is a flood. An in-depth study of permanent housing has done by studying the various ways that flood events affect housing in order to identify guiding criteria that flood resilient housing should address. Furthermore, it is needed to differentiate between flood zones since housing should respond and resist to flooding according to predicted flood characteristics. This project incorporates study of various flood resistant housing projects and the most effective design factors are identified and a new proposal is suggest for the resilient housing. The housing proposal through this study stands well within the boundaries of sustainability, and address the problems of flood related issues of housing in a most efficient way.*

Keywords: Flood, amphibious, flood resilient, sustainability, disaster

I. INTRODUCTION

Kerala with a total area of 38.8 square km is a state in south India. Southwest and Northeast monsoons control the rainfall in Kerala. Kerala experiences 90% of rainfall and storm during monsoon season. It also results in overflow of water in all the rivers. The consistent and overwhelming rainfall during the monsoon seasons in the summer of 2018 resulted in a severe flood disaster. During the beginning of the monsoon season, Kerala experienced 42% above normal rainfall. The first flood event happened at the end of July 2018 due to the result of heavy rainfall which was started during the month of June and July. The state experienced high torrent again during the beginning days of august 2018 at several places in Kerala. A maximum of about 1398mm of rainfall is experienced at the various districts of Kerala. As a result of this heavy rain, the level of water in different reservoirs and dams (35 out of 45) reached more than 90% of their full capacity and the water from these were released. Another heavy rainstorm cause to happen from the end of second week of august and continued till third week which resulted in a big disaster of inundation in several Kerala districts. As per the India Meteorological Department's rainfall records, this calamity occurred due to the heavy rainfall is similar to the cyclone experienced in the year 1924. Kerala had never witnessed such a terrific disaster that resulted in the death of about 400 or more persons during the past 90 years. In this paper we consider the Chalakudy river area in detail. The Chalakudy River is the fifth largest river in Kerala. The main part of the river flows through two districts: Ernakulam in the south and Thrissur in the north.

The Chalakudy river area was one of the most severely affected areas during the flood. Uncommon precipitation events and flooding caused a great human loss and also resulted in damage of ground-works. Hundreds of people from the area had to be evacuated and stayed in relief camps for multiple months. Many people volunteered to help with the relief distribution for commodities such as food water medicines and clothes. The commodities from people as well as organizations were collected at government depots. During the first few days after the flood, considerable uncertainty existed how commodities should be transported to the camps since it was unknown which areas are traversable.

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Humans rely on heavy engineering, tidal barriers and riverside and costal defence to protected our building environment from flooding. In order to protect our residents from floods and rising sea water, alternative design options for coastal residents should be implemented. As much as 90% of 100 largest cities are located near the sea. These cities have largest amount of water from lake,river ,canals , harbour. A new residence for costal side and river side should be design to withstand the rising sea water and frequent floods. Those residence should be safe, flood proof, eliminating the rebuild process after flood and thereby provide healthier and stable family.

This paper discussed flood impact at Chalakudy. Also a case study about different type of flood resilient residential building and we proposed a amphibious structure suitable for flood prone area.

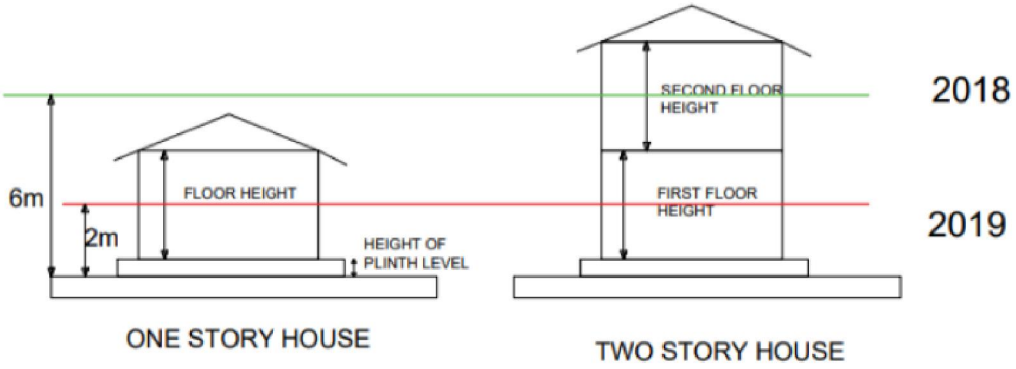

Figure 1: Height of water level during flood of year 2018 and 2019
Source: (AUTO CADD)

1.1 General

Floods have been regular phenomena in the Indian subcontinent from the time immemorial. The flash floods of Uttarakhand in June 2013, Jammu & Kashmir 2014, Chennai Flood 2015, etc. are the major flood events reported in the country. The 'Great flood of 99' was a severe flood reported in Kerala during 1924 which plunged many districts in water. Kerala Flood of 2018 was the highest flood that the Kerala state has ever experienced. This flood inundated 13 out 14 districts in the state. As the rainfall data of IMD, Kerala received about 2346.6 mm of rainfall from June 1st 2018 to August 19th 2018 in contrast to an expected 1649.5 mm. Kerala authorities opened the shutters of 35 of the state's 39 dams, which had reached dangerously high water levels. Floods were so severe that the entire state was brought to stand still for many days. Kerala flood caused the death of more than 483 people and economic damage exceeding $3 billion. More than 1 million people were displaced and 3,274 relief camps were opened. The crops of 54,000 hectares were destroyed and 537 landslides were reported. The roads and bridges were damaged which covered 16000 km and 221 bridges respectively. This study analyzes the flood impact of Chalakudy Municipality, Thrissur District where more than 60% of the municipality was affected by the flood of 2018. The study was done by collecting datas from the municipality and also by conducting surveys in the effected area.

1.2 Chalakudy

Chalakudy municipality came into existence in the year 1970.The municipality covering an area of 25.23sqkm is divided into 36 electorial wards. The municipality has a total population of 45,069 with a density of 1768 per sqkm. Chlakudy is a Grade 11 municipality. Chalakudy is a Midland region. The chalakudy river flows through the southern part of the town. The Kodakkara, Kossery, Pariyaram, Meloor, Kallur, Vadakkummuri and Aloor grama panchayath lie adjacent to Chalakudy Municipality. Chalakudy is at a distance of 35 km away from Thrissur.

Chalakudy River or Chalakudy Puzha is the fifth longest river in kerala, India. The river flows through Thrissur district, Palakkad district and Ernakulam district of Kerala. The total drainage area of the river is 1704 km2 . Out of this,1404 km2 lies in Kerala and the rest in Tamil Nadu. The length of the river is 145.5 km. Though Chalakudy River in strict geological sense is a tributary of the Periyar river, for all practical purposes it is treated as a separate river by Government and other agencies. The river has gained its name since it flows along the banks of the Chalakudy Town, the major settlement along the course of the river. It is perhaps the most unpolluted and pristine river in the state and

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even in India due to the limited amount of industries and wastage disposal around Chalakudy River and its basin area were one of the most affected rivers during the 2018 Kerala floods.

Table 1: Water Levels

Water Level	Area in sq km	Percentage
Non flooded	9.49	37.62
0-45 cm	0.99	3.93
45-110 cm	3.62	14.37
300-600 cm	9.65	18.45
Above 600 cm	3.40	13.47
110-300 cm	3.07	12.16
Total	25.22	100.00

Source:(Chalakudy municipality)

II. IMPACT STUDY

2.1 Questionnaire Survey

From the datas collected we came to know that the Vettukadavu area is also affected in 2018 flood,so we selected vettukadvu area and conducted a survey covering 50 houses in that particular area. Vettukadavu is situated near the chalakudyriver. During monsoon season flood occur in this region. Major flood happened in 2018. Accuracy and level of flood damage estimation methods depends on the availability of the damage data. The data on flood characteristics and damage are important for the development of appropriate damage estimation methods. To understand the impact of flood events on residential areas, and to collect damage data to establish flood damage estimation methods ,detailed household questionnaire survey were conducted in the flood prone areas of Vettukadavu, Chalakudy.

Household questionnaire survey includes:

- Flood marks
- Flood duration
- Damage situations(residential buildings and assets).
- Building characteristics(house types ,construction materials, height of plinth level, floor height, etc.).
- Household information etc

From the details collected from the survey, we selected a site in that area which is situated near the chalakudy river. A small ditch is flowing near the proposed site. During rainy season the water level in the ditch rises and the proposed site also gets flooded

2.2 Materials used for Construction

Sub structure materials

Floor Construction	Galvanized steel
Anchor	Galvanized steel ring pipe
Floating Platform	Metallic frame with EPS block
Reservoir	PVC
Foundation	RR Masonry

Super- structure materials

Roof truss	Light steel construction
Ceiling	Gypsum board
Wall	Bison panel
Floor	GRC panel

2.3. Planning and Design

Planning is a broad term which considers the efficient distribution of occupant spaces incorporating mobility concerns considering the functional and aesthetical approach by maximum exploitation of the given plot from within the stipulation of the KBR (Kerala Building Rules).Planning is the most important part of a construction process where

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safety, economy, and aesthetic approaches are duly considered while execution. The buildings are planned according to KBR rules which specify the building group height, access, and specification, lighting, and ventilation.

Figure 2: Elevation of the proposed structure
Source: (AUTO CADD)

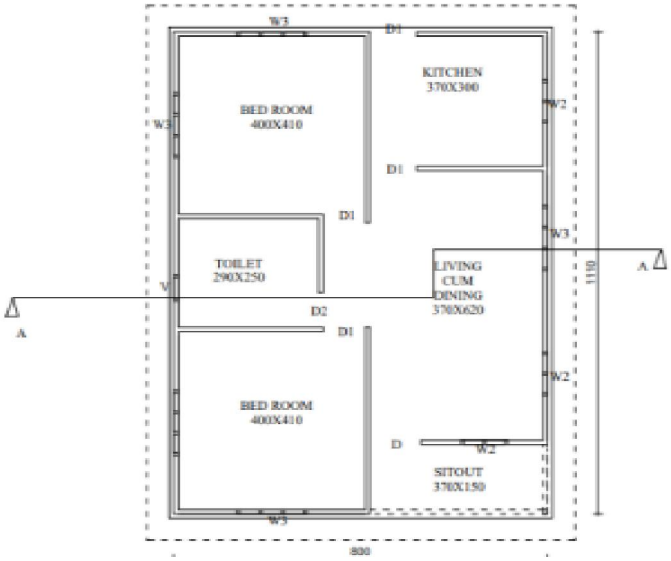

Figure 3: Plan of the proposed structure

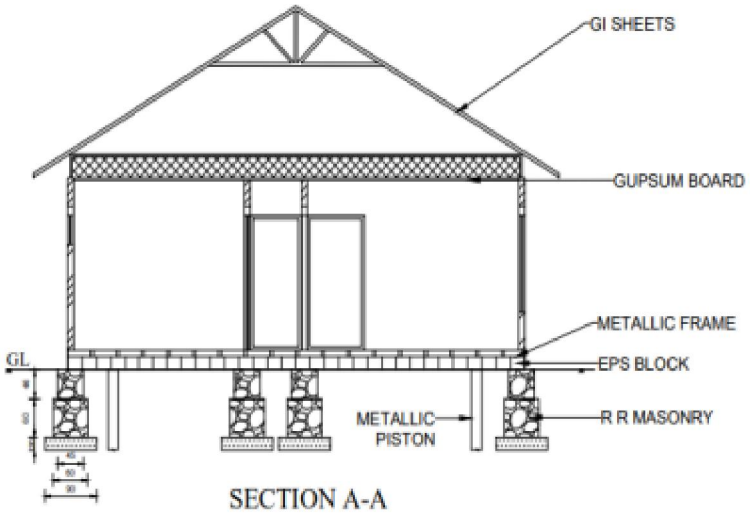

Figure 4: Section of the proposed structure

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2.4 Construction details

As per the structural design, following are the construction details with specifications.

1. The site chosen for the construction is investigated and information about subsurface condition like ground water level at the site is obtained. Here the soil exploration data obtained from PWD Building Division, Irinjalakuda is referred for designing the foundation. The soil investigation was done for the proposed site at Vettukadavu, Chalakudy.
2. The design carried out here is based on the soil type –laterate
3. Metallic frames which can accommodate the total number of EPS block have to be made. Fill the metallic frame with the EPS block and connect to the PCC column.
4. A metallic piston of 25 feet depth is placed at four corners of the house.
5. Flooring is to be done using GRC panels.
6. After flooring, erection of roof truss is done.
7. Rectangular hollow section wall plates of size 80x40x3.2 mm are welded over the column using the steel plates.Then RHS 80x48x3.2mm Are erected at the center to center spacing of 1.05m with proper connection with wall plate. Similarly purlins are supported over rafters and over that traffords shaped 0.35mm thick GI GI sheets are laid.
8. For wall construction, install 60x60cm grid frame to connect the fiber cement board. Screw the fiber cement board.
9. GI frame work for the Calcium Silicate false ceiling is provided on the Veranda space

III. CONCLUSION

By looking at how to manage water and design in its close proximity, the immense scale of the challenge of flooding that we are facing becomes clear. Climate change and it is many effects including increasing sea level, more severe rainfall and increase in flood risk is already being felt in many places of India and it is a true effect that will be measured in decades. This is the time frame within which planning, design and development should be developed. The building and places that we create in the next ten years will form the backbone of an amphibious lifestyle for next few decades and beyond .In order to prepare for the future, designers and builders must not look at the limitation of water but at the opportunities it presents. In this dissertation the effect of climate change and the importance of the water dwellings to response to climate change is discussed and impacts are realized.

Amphibious buildings are proven low impact flood protection strategy that gives a community enhanced flood resilience and improves its ability to recover from disaster .When flooding occurs the water dwelling vertically rises with the water levels to remain safely above water then settles back into places as the water recedes. Successful amphibious foundation system are functioning in the Netherland, New Orleans and Bangladesh, they can provide flood protection that is more reliable and more convenient than the permanent static elevations. Kerala experienced a high rainfall and flood which caused damages to the property and life. The major impact was on the houses of all the people irrespective of their socio-economic status. The government have to rebuild Kerala in all sense. The fund allocation for the reconstruction of houses has also been planned. It is very important to consider the construction of houses that is sustainable in all aspects. This can be done in cost effective manner.

The project includes planning, designing and estimation of flood resistant floating house using light weight building material. The functional planning of building was done as per Kerala Building Rules and designed as per IS Code provisions. The analysis and design of all structure members are done economically. The planning and designing is based the soil condition of Munroe island. The materials used for the construction is light weight, sustainable and flood resistant. The floating house will rise up to 4 m from ground level at the time of flood and will rest to the initial position without any displacement. The cost of construction is very low as compared to the conventional buildings. The conventional houses built in Kerala are ignorant of withstanding any natural calamities especially flood. There are flood proofing techniques that can be adopted in the construction of houses such as wet proofing and dry proofing. Raw materials like recycled plastic wastes, ferrock, hempcrete plays a major role in flood resistance and also in eco-friendly approach. They are also cost saving materials. 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.

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