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Flood Resistant Buildings: a Requirement for Sustainable Development in Flood Prone Areas

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ABSTRACT: Floods are the sources of large scale destruction from the early stages of civilization. Rising rate of population and consequent urbanization leads to deforestation and a high percentage of the paved surface which blocks the infiltration of water in case of precipitation. Lesser infiltration leads to high runoff resulting in rapid and increased hydrograph peak. In India, more than 40 Million Hectare of the total 329 Million Hectare geographical area is flood prone. During last three decades, other than heavy financial losses, millions of people were affected and about 4000 people lost their life due to the flood disaster in India. Increase in the frequency, spatial extent, duration, intensity and timing of extreme weather condition is expected due to climate change. Flood is a natural process which cannot be ceased to occur; thus efficient flood preparation is the need of the time to minimize the damage in flood-prone areas. Sustainable development involves safe, economically feasible, environment-friendly and socially approved growth. Sustainable development in the field of flood hazard mitigation is required. In this paper, an effort is made to discuss the concept of flood resistant residential houses and the new techniques developed and used in different parts of the world.

Keywords: Floods, Flood mitigation techniques, Flood resistant structures.

I. INTRODUCTION

Flood can be defined as the condition in which that land is submerged in water which is normally used to be dry. It can be attributed to an unusual high stage of a river or other water bodies like lakes, oceans etc during which the water spills over the bank and spread to the adjoining land. The low-lying area adjacent to a river bank is called flood plain, which is formed mainly of the sediments of river and consists of a very fertile soil. In the case of flood the water spills to the flood plains which are thickly populated due to the advantages of good water availability and fertility of the land for irrigation purposes. The flood condition can occur due to various reasons depending upon the location of the concerned area and the primary cause of the accumulation of water which cannot be accommodated naturally. For a flat or low-lying land with infiltration or runoff rate lesser than the rate of precipitation, water can accumulate resulting in a flood situation. Due to different natural phenomena like rainfall lasting for a longer period of time, monsoon season, tropical cyclones or a large amount of rapid snowmelt flood situation can occur in rivers or other drainage.

In coastal areas, when the water level is high due to some storm and its combines with the natural high tide the water spills over to the adjoining areas causing a flood. In urban areas due to improper drainage system sometimes due to high precipitation water can accumulate on the streets and maybe sometimes comes back into the building through sewers pipes when rainfall is higher than the drainage capacity. The condition of flood can get worsen in the case of major infrastructure failure like dam failure etc. The consequence of flood can be devastating which includes loss of life and financial losses. The flood can damage the building, roads, bridges etc. affecting the normal life. Disruption of traffic movement leads to further delay in the aid provided to the affected people. Flood disrupt the power and water supply and also the sewage treatment system. Due to the mixing of sewage into the accumulated water there is always a risk of breaking of water borne diseases like typhoid, cholera etc.

In India, more than 12% of total geographical area lies in major flood prone zone. India is a peninsular country as it is surrounded by ocean from three sides namely Arabian sean, Bay of Bengal and Indian ocean (Ahmad *et al.*, 2016).

The monsoon season lasts between june and september and about 80 to 90 percent of the annual rainfall occurs in this season. During this monsoon season various rivers faces flood situation due to the cyclonic precipitation. The flood prone zone in India constituted mainly by Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Kerala, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal (Saqib *et al.,* 2013). During the years 1975 to 1995 around the world, more than 1.5 billion people were affected by floods in which about 318,000 were killed and 81 million losses their homes (IFRCRCS, 1997). In recent years the main floods occurs in India includes North India floods 2013, Kashmir floods 2014, Maharashtra flood in July 2015, Gujarat flood in June 2015 etc. Thousands of people were dead and heavy financial losses were reported. Summary of flood losses in India during 1953-2011 are shown in table 1.

Table 1: Average flood damage/ Heavy rains in India.

Average annual flood damage (1953 - 2011)	
Total damages Crops, Houses & Public utilities	Rs.3612.12 Crores
Area affected	7.22 million hectare
Population affected	32.43 million
Human lives lost	1653 nos.

Source: Water related statistics (2013)

Flood is a natural event which cannot be ceased to occur, so flood mitigation is a way to be well prepared to avoid heavy losses. The losses of life and properties can be reduced if well preparations are made in advance. Irrespective of all the protective works the flood danger cannot be vanished. The flood losses are becoming several billion US dollars annually worldwide (Kundzewicz and Takeuchi, 1999). The flood preparation works can be categorized into structural and non-structural measures. Dams, dikes, floodways, reservoir for flood control etc comes into structural measure category; whereas efficient flood fore-casting warning system, following laws and regulation, awareness raising etc came into non-structural approach. Also small scale structural approaches like flood proofing etc. comes into non-structural approach. Non-structural approaches are found to be in sync with the sustainable development (Kundzewics, 2002). In the present paper, flood resistant domestic buildings are discussed with different methods used for the purpose in some parts of the world.

II. FLOOD RESISTANT BUILDINGS

Around the world, there are many ways are proposed for making the buildings more capable to resist floods. In here some commonly used methods are discussed

Rising the elevation: The elevation of living area is raised above the base flood elevation (B. F. E.). The house is raised on some supports which should be sufficiently strong enough to bear the load of the structure and forces acting by the flood water and have ample space for the passage of flow in case of flood. For an area with a low probability of flood the space below the living area can be utilized for parking the vehicle, laundry or bathroom etc. The B. F. E. is the water surface level for a flood of 100 years return period. There are many methods available for estimation of flood; for some sites with lesser available data or for sites with no data available at all, regional flood frequency analysis can be used (Alam *et al.* 2015, 2016).

Building the lower levels water tight: The walls and openings of the lower levels are sealed to stop the water from penetrating the house. The sealing should be sufficiently strong to bear the forces in the flood conditions acting in the form of lateral forces and uplift thrust of the flood water. The house for such purpose should be designed by taking all these forces in consideration. Enclosures, sealants, membranes and coatings can be used to make the lower levels water tight.

Wet flood proofing: Wet flood proofing involves the controlled and safe passage of flood water through the lower levels of the house. The sewers and water system should be above the water level or should be sealed when the water rises above them to avoid any health hazards. Electrical appliances and outlets should also be at higher levels. The inlets points should be opened well before any pileup of water to avoid pressure at the structure.

III. AMPHIBIIOUS HOUSES

The word amphibious is used for something related to both land and water. Amphibious houses are made in such a way that they are free to float on the flood water and rose with the water level and comes back to their initial position as the flow recedes. Such houses are built in Maasbommel, Netherlands, and at Raccourci Old River, Louisiana, New Orleans and Bangladesh. The foundation in this case is found to be economical, the house is reliable and convenient (English, 2009). Amphibious house can also be called floating house and broadly classified into two types:

(i) Boat type and (ii) Lift type

Boat type: This type of floating house is free to move in both the direction i.e. in vertical direction as well as in horizontal direction. The floor of the house should be water tight so the water does not enter from the base. The house is provided with some anchor system for stopping the house to dislocate with the flow of water from its original position.

Lift type: In the case of lift type, the house is free to move in only vertical direction in a controlled way along with the rising water level in flood type situation. The house is restrained to move in horizontal direction by guiding columns at the corners. The house remain on ground surface until the flood water starts lifting it up by buoyant forces. Both the houses can be provided with a suitable base to be supported on and to provide sufficient buoyant forces to initialize the movement. The foundation used in these houses can be termed as buoyant foundation. Underside of the house buoyancy blocks is provided. Buoyancy blocks lift the house in case of flood and can be made of recycled, recapped plastic bottles.

IV. CONCLUSIONS

A lot of work is going on for flood resistant houses in different parts of the world. It is found to be sustainable in its nature. In India, there is a need of an efficient and exclusive research in this direction as the annual losses due to floods are very high. The amphibious foundation is an economical option for poor rural areas. The recycled materials used for floating houses also help in solid waste management if applied at a larger scale.

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