International Journal on Emerging Technologies **8**(1): 285-290(2017)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Need For Development of Coastal Architecture

Angelika Ajrawat* and Ar. Anoop Kumar Sharma**
[*]Student, Department of Architecture and Landscape Design,
Shri Mata Vaishno Devi University, Katra, Jammu & Kashmir, INDIA -182320
[**]Department of Architecture and Landscape Design,
Shri Mata Vaishno Devi University, Katra, Jammu & Kashmir, INDIA -182320

(Corresponding author: Angelika Ajrawat)
(Received 28 December, 2016 accepted 18 January, 2017)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: India lies on the Indian Plate, the northern portion of the Indo-Australian Plate, whose continental crust forms the Indian subcontinent. The country is situated north of the equator between 8°4' to 37°6' north latitude and 68°7' to 97°25' east longitude. It is the seventh-largest country in the world, with a total area of 3,287,263 sq. kilometers. India measures 3,214 km from north to south and 2,933 km from east to west. It has a land frontier of 15,200 km and a coastline of 7,516.6 km. India has a long coastline with numerous forces developing on the coast faced by the structures on the coast.

Keywords: Disaster, Coast, India, Architecture, Climate.

I. INTRODUCTION

Coastal areas are commonly defined as the interface or transition areas between land and sea, including large inland lakes. Favorable biophysical and climatic conditions, together with the ease of communication and navigation frequently offered by coastal sites (by sea or up river valleys), have encouraged human settlement in coastal zones since prehistoric times. Many of the world's major cities are located in coastal areas.

The coast is a dynamic place and its dynamism makes it susceptible to stresses and changes in a number of ways. Because the coast is where the land interacts with the sea, it is open to the action of wind, waves, tides, and currents that not only erode the shore but also can expand it with sedimentary deposits. Situation of coastal areas is the worst due to human-induced pressures on environment and lack of sustainable development. The coastline is a unique condition where a fusion of many forces occurs. There are two main ways the coastline has been addressed: the manmade and the natural. The human population typically sees this condition as a harsh edge where our known entity of land ends and our unknown entity of water begin. The coastline is in a state of constant flux, acted upon by a multitude of forces.

II. CONCERN/NEED

Around 171 million people live in India’s coastal districts. By 2100, the homes of around 12.8 million people will be submerged, or will experience frequent flooding. Many have already been forced out of their ancestral homes and may be displaced again. Mumbai and Kolkata are two of the most at-risk cities in India. By 2070, they are expected to experience more frequent flooding than ever before. Every year, more than 1000 people die from storm-related events in India. The number is expected to rise as a result of climate change.

India is exposed to nearly 10% of the world’s tropical cyclones, due to a long coastline of 8,041 kilometers. On an average, five to six tropical cyclones form every year, of which a couple of them could be destructive. Andhra Pradesh, lying in the east coast of peninsular India, is the worst hit by cyclones every year. Orissa and Bengal bear the brunt of cyclones in October, Andhra Pradesh in November and Tamil Nadu in December.

III. VULNERABLE EAST COAST OF INDIA

The east coast has got a narrow shelf and lined with deltas, estuaries, bays, salt marsh, lagoons and some smaller islands and it receives maximum northerly wind and active with cyclones and flood during the period October to November. Most of the Indian rivers flow across the east and they bring large quantities of sediments, which are suitable for agriculture.

The east coast experience high sediment flow rate and regular cyclonic damages by flooding. During the December 2004 Tsunami the housing stock along the East coast of India, as well as bridges and roads, suffered extensive damage by direct pressure from tsunami waves, and scouring damage was induced by the receding waves. A study conducted after the 2004 tsunami in 18 coastal hamlets along the south-east coast of India reiterates the importance of coastal mangrove vegetations and location characteristics of human inhabitation to protect lives and wealth from the fury of tsunami.

IV. CONSTRUCTION PLANNING FOR THE NEXT GENERATION OF RURAL COASTAL INDIA

The tsunami caused human death and loss of wealth was decreased with the area of coastal vegetation, distance and elevation of human inhabitation from the sea. The aim of reducing future life loss and property damage can be achieved only by a long term commitment.

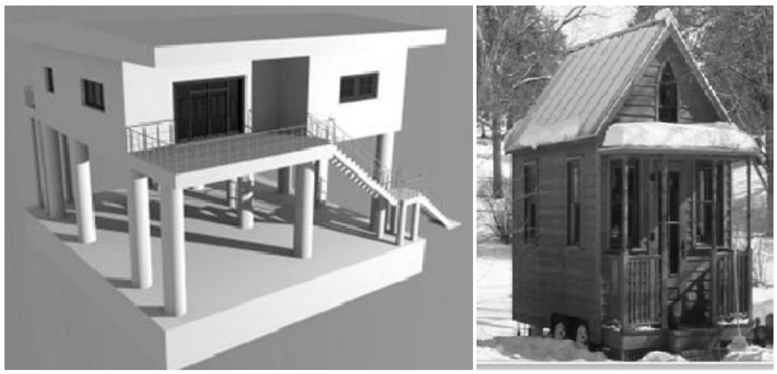

Fig. 2. FDN Design (Ventasal, 2012) and Tumblewood houses
(Source: Effects of Sea Level Change on Vulnerable East Coast of India By Praveen Khanna Udaya Kumar, Department of Earth Science, Uppsala University, 753 12 Uppsala Shttps).

At the Tsunami in Japan, lots of buildings were flooded by Tsunami waves and some of them were moved by the waves. Ventasal (2012) tried some Tsunami resistant house design and Tsunami resistant building design to withstand extreme forces including tsunami. Jay Shafer (2008) has come up with Tumbleweed houses which can be put nearly anywhere. He declares that it produces less than 4 tons of greenhouse gases during a typical Minnesota winter.

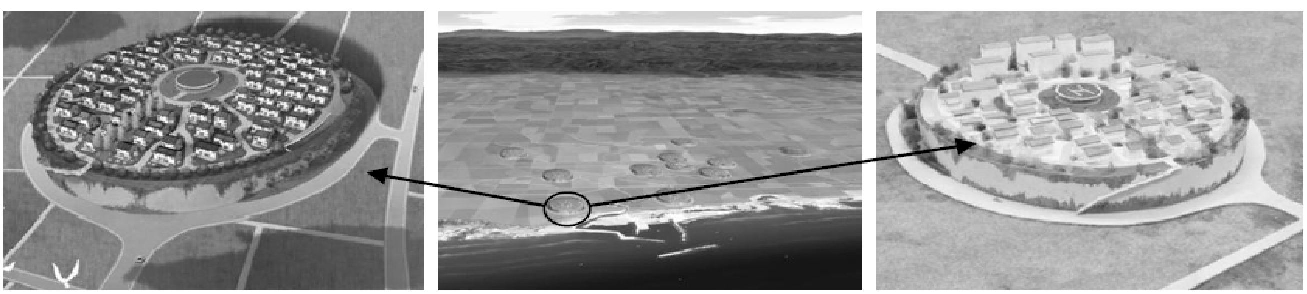

Fig. 2. A new Anti-tsunami Archipelago for Japan.
(Source: Effects of Sea Level Change on Vulnerable East Coast of India By Praveen Khanna Udaya kumar, Department of Earth Science, Uppsala University, 753 12 Uppsala Shttps).

Japan has proposed an anti Tsunami system. In total, of all the requirements, a planning for safety construction with control system becomes the prime need of the hour. Andhra Pradesh government constructed 1230 dwelling units in the proposed tsunami-resistant housing colonies for fishermen in the coastal villages of Vizianagaram district. Soil investigations were carried out in the proposed sites and recommendations / guidelines were given for better tsunami resistant building.

Appropriate Coastal Planning

The increasing frequency and ferocity, the extent of the damage both human and economic the resources required for reconstruction work, all compelled the policy makers and administrators to do a reappraisal of Institutional and policy frameworks and to develop new frameworks for holistic disaster management in India. A legal and institutional framework for disaster management was established through the Disaster Management Act that was passed by the Indian Parliament in 2005 and the National policy on disaster management was approved in 2009. An ideal coastal construction planning for habitation is aiming for

- A good lay out at a safely planned long standing land use
- Permanent shelters resistant against EQ, Tsunami/SLR, floods and cyclone
- Coastal protection against erosion,
- Protection for sea water intrusion and Tsunami.
- Prediction and early warning against disasters
- Permanent power supply and exploitation of renewable energy.
- Water supply and drainage forever and common facilities and
- Evacuation structure for emergency

Coastal Disaster Resistant Structure

Coastal erosion, sea water intrusion, sea level rise, and backwater problems exist throughout the year in the East coast of India. Seasonal hazards and the unexpected Tsunami bring catastrophic, causing heavy loss of lives and properties. Therefore the structure should be oriented for resistance against the coastal forces with properly shaped. Various house plans that divert the tsunami waves. Specific design principles for Tsunami should involve distance from the sea and elevation above mean sea level. Engineers are designing methods and techniques to design a building on columns for coastal areas where Tsunamis can take place. In such cases much attention should be given for earthquake resistance.

Control System

A conceptual controlled design shall be developed for coastal zone by a proper permanent protection system including disaster warning system, land use planning and Tsunami evacuation system incorporating several elements as follows:

- A complete protection by bio-shield having mangroves and woodlands
- Proper land use planning (at least 1km away from the coast line)
- A evacuation building(EB) with salient features
- The EB should be raised on columns to allow seawater to pass beneath the structure and open in other times to make activities.
- The safe floor level shall be set above the most of the rare tsunami events.
- A roof terrace shall be designed to provide more refuge area.
- Exterior stairs should be visible to easily identify the evacuation building.
- The lower level accessibility shall be planned with the use of elevators designed to be functional after the earthquake.
- Strategies for wave energy dissipater to reduce tsunami actions on the TEB can be provided.
- Exploitation of renewable energies can be promoted.

A coastal protection system should be cost effective. There is not much attention given to coastal protection in Indian coastal line. Only in few locations sea erosion was protected by several means of provisions like fencing with cut palm trees, walling with stone boulders and development of mangrove forests.

Variety of methods has been suggested for shore protection and bio shield seems to be more appropriate for the east coast. Human inhabitation should be encouraged more than 1km from the shoreline in elevated places, behind dense mangroves and or other coastal vegetation. Some plant species, suitable to grow in between human inhabitation and the sea for coastal protection.

Recommended Practices

- **Siting**– Site buildings away from eroding shorelines and high-hazard areas.
- **Building Form**– Flat or low-sloped porch roofs, overhangs, and gable ends are subject to increased uplift in high winds. Buildings that are both tall and narrow are subject to overturning. In the design process, choose moderate-sloped hip roofs if possible.
- **Lowest Floor Elevation**– Elevate above the DFE the bottom of the lowest horizontal structural member supporting the lowest floor. Add “freeboard” to reduce damage and lower flood insurance premiums.
- **Free of Obstructions**– Use an open foundation. Do not obstruct the area below the elevated portion of the building. Avoid or minimize the use of breakaway walls.
- **Foundation**– Make sure the foundation is deep enough to resist the effects of scour and erosion; strong enough to resist wave, current, flood, and debris forces; and capable of transferring wind and seismic forces on upper stories to the ground.
- **Connections**– Key connections include roof sheathing, roof-to-wall, wall-to-wall, and walls-to-foundation.
- **Exterior Walls**– Use structural sheathing in high-wind areas for increased wall strength. Use tighter nailing schedules for attaching sheathing.

- **Windows and Glass Doors–** In high-wind areas, use windows and doors capable of withstanding increased wind pressures. In windborne debris areas, use impact-resistant glazing or shutters.
- **Flashing and Weather Barriers–** Use stronger connections and improved flashing for roofs, walls, doors, and windows and other openings. Properly installed secondary moisture barriers, such as house wrap or building paper, can reduce water intrusion from wind-driven rain.
- **Roof–** In high-wind areas, select appropriate roof coverings and pay close attention to detailing. Avoid roof tiles in hurricane-prone areas.
- **Porch Roofs and Roof Overhangs–** Design and tie down porch roofs and roof overhangs to resist uplift forces.
- **Building Materials–** Use flood-resistant materials below the DFE. All exposed materials should be moisture- and decay-resistant. Metals should have enhanced corrosion protection.
- **Mechanical and Utilities–** Electrical boxes, HVAC equipment, and other equipment should be elevated to avoid flood damage and strategically located to avoid wind damage. Utility lines and runs should be installed to minimize potential flood damage.
- **Quality Control–** Construction inspections and quality control are essential for building success. Even "minor" construction errors and defects can lead to major damage during high-wind or flood events.

V. COASTAL BUILDING MATERIALS

Special considerations must be made when selecting building materials for a coastal building. The harsh environment requires that more substantial building materials be used and more care taken when using these materials in order to ensure durability, hazard resistance, and reduce maintenance. The following are some key considerations when screening materials.

- **Flood Resistant Materials:** Lumber, Concrete, Masonry, Structural steel, Insulation.
- **Wind Resistant Materials:** Roof coverings, Double-hemmed vinyl siding, Wind-borne debris resistant glazing.
- **Corrosion and Decay Resistance:** Stainless steel hardware, avoid aluminum, Copper flashing, vinyl flashing.
- **Moisture Resistance:** Wood finishes, avoid exposure of end grain cuts, treated wood, cavity wall.
- **Termite Resistance**

Table 1: Comparative Study: Analysis.

FACTORS	GOLCONDA (PONDICHERRY)	WTC BAHRAIN	REMARKS
STRUCTURE	R.C.C. Structure	Steel/concrete	Carbonation occurs in concrete structures
ORIENTATION	North west to South east	North West	WTC could double production of wind energy if was oriented in the true wind direction
VENTILATION	Louvers	Central	Openings can reduce humidity level
WATERPROOFING	Rubberier and sedan	SBS modified torch Membrane.	
FOUNDATION	-	Piled Raft foundation	Open foundation leads to easy flow of water
MATERIALS	Stone, wood, concrete.	Concrete, glass, steel.	Concrete corrodes.
CONCLUSION	It is reputed as the most comfortable building of Pondicherry, although has no mechanical cooling as it has conquered problems faced by structures and people living on coast.	Wind turbines renew the wind energy. It is successful to some extent due to the orientation of building. Sail shaped building doesn't let the prevailing onshore wind to effect the structure.	-Wind pressure affects a building. The correct orientation of the building can reduce this pressure and also help in energy conservation. -Appropriate usage of materials can help to increase the life of building -Openings should be provided keeping in mind wind and sun direction.

VI. INFERENCES

- Enhance value by protecting and conserving natural system.
- Identify natural hazards and reduce vulnerability.
- Applying comprehensive assessment to site.
- Lower risk by exceeding standards for siting and construction.
- Adopt successful practices for dynamic coastal condition.
- Use locally available material
- Protect fragile water resources on coast
- Commit to stewardship that will sustain coastal areas.

VII. RECOMMENDATIONS

A Proposed Model House

Tsunami resistance houses suitably planned and recommended for a rural coastal rehabilitation are shown in figures. These houses will have utilities as listed.

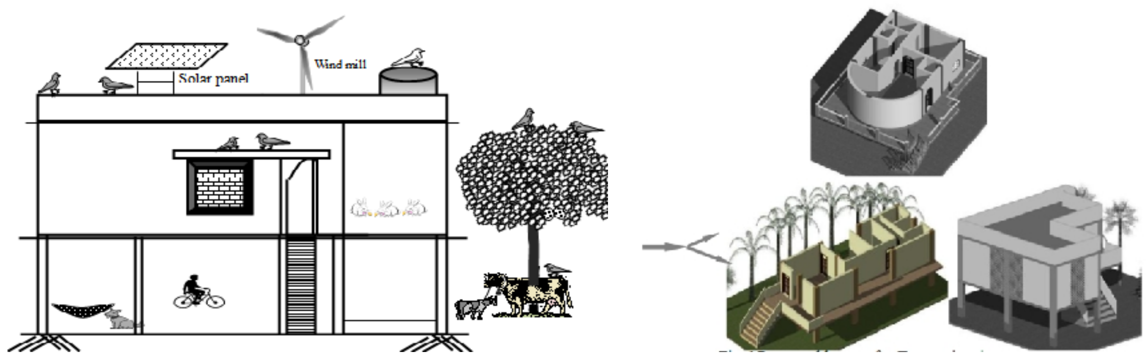

Fig. 3. Proposed house for Tsunami resistance.
(Source: Effects of Sea Level Change on Vulnerable East Coast of India By Praveen Khanna Udaya Kumar, Department of Earth Science, Uppsala University, 753 12 Uppsala Shttps).

- The building is designed as EQ/Tsunami/cyclone/flood resistant type of RCC.
- Corrosion free Fibre reinforced Polymer rebars are used instead of conventional steel
- The building is raised on columns to allow seawater to pass beneath the structure (soft story) and open in other routine times to make multipurpose.
- Disaster information and alert system is accessible for the people of the house
- The Terrace level is set above the most of the rare tsunami events.
- Terrace is designed to provide additional accommodation.
- Emergency power supply is made possible with the solar/wing energy.
- Water supplied from elevated water tank is directly discharged in to the small capacity water tank provided at the terrace in each house.

Bio Shield. It is highly recommended to develop a proper control system for the forces acting on the coasts. So, a complete protection by bio shields having woodlands and mangroves will be a good proposal in the design.

Stop Banks. Stopbanks are continuous mounds of earth built near rivers to stop water from the river flooding nearby land. Americans call them levees. The building should be raised on columns to allow seawater to pass beneath the structure. Safe floor level should be set.

Sea Walls. A sea wall is a form of coastal defense constructed where the sea, and associated coastal processes, impact directly upon the landforms of the coast. The purpose of a sea wall is to protect areas of human habitation, conservation and leisure activities from the action of tides and waves. As a seawall is a static feature it will conflict with the dynamic nature of the coast and impede the exchange of sediment between land and sea.

Surge Channels. A surge channel is a narrow inlet on a rocky shoreline. As waves strike the shore, water fills the channel, and drains out again as the waves retreat. The narrow confines of the channel create powerful currents that reverse themselves rapidly as the water level rises and falls. Creating channels for easy flow of water reducing destruction level. Flat surfaces cause destruction.

Orientation. Correct orientation of the building reduces wind and wave pressure as angles cut the flow.

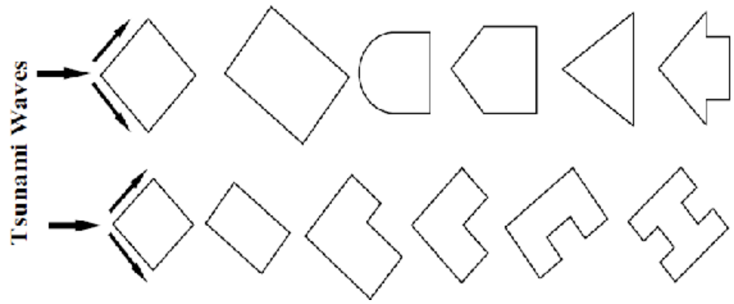

Fig. 4. Appropriate houses for rural coastal areas.

(Source: Effects of Sea Level Change on Vulnerable East Coast of India By Praveen Khanna Udaya Kumar, Department of Earth Science, Uppsala University, 753 12 Uppsala Shttps).

Pier Foundation. A Pier foundation consists of a cylindrical column of large diameter to support and transfer large super-imposed loads to the firm strata below. High pier foundation to be made keeping in mind rising sea level.

Louvers. A louver (American English) or louver (English) is a window blind or shutter with horizontal slats that are angled to admit light and air, but to keep out rain and direct sunshine. The angle of the slats may be adjustable, usually in blinds and windows, or fixed.

Energy Conservation. Wind Turbine is a device that converts the wind's kinetic energy into electrical power. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels.

VIII. CONCLUSION

The goal of all coastal buildings especially the building the coasts which are highly vulnerable to disasters should be to resist the different fluctuating forces acting on a coast. Also to maintain a good life of the building by using the suitable materials for the moisture and pressure level acting on it. The high energy generated due to multiple forces acting can be conserved and used. Proper design principles if established will generate safer techniques for building designs on coastal areas.

REFERENCES

[1]. Effects of Sea Level Change on Vulnerable East Coast of India By Praveen Khanna Udaya Kumar ,Department of Earth Science, Uppsala University, 753 12 Uppsala Shttps.
[2]. Construction Planning For The Next Generation Of Rural Coastal India by S. Selvamuthu Kumar and Dr. G. Mohan Kumar Department of Civil and Structural Engineering, Annamalai University, Annamalainagar- 608002, INDIA.
[3]. FEMA, Coastal building Guidelines.
[4].https://www.fema.gov/media-library-data/20130726-1538-20490-2983/fema499web_2.pdf
[5]. https://sites.google.com/a/alaska.edu/far-eastern-borderlands/home/chukotka/coastal-vernacular-architecture
[6].http://archidose.blogspot.in/2006/03/golconde.html
[7].http://sustainablefuture2014.blogspot.in/2014/01/documentry-about-bahrain-world-trade.html
[8]. http://www.archdaily.com/106639/golconde
[9]. http://www.google.com/images
[10]. http://www.greatbuildings.com