Consideration of Various Design Aspects In Analysis of Coastal Buildings

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Abstract-*As there are various factors that affect the coastal building both directly and indirectly like erosion of footings, breaking waves, high winds etc. Because the most hazardous coastal areas are subject to erosion and extreme flood loads, the only practical way to perform these two functions is to elevate a building on a deeply embedded and "open" (i.e., pile) foundation. The main Objective of this paper is to develop independent and creative thinking, correlating fundamental, theoretical knowledge learned in the course and apply the same in the practical way in the field of designing.*

Keywords- erosion, footings, Structural Aspects, coastal buildings, Analysis

I. INTRODUCTION

The developing need for multi-functional materials and the act of making on a greatly reduced scale leads to the development of new materials.Structural design is the primary aspect of Civil Engineering. The very basis of Construction of any building, residential house, coastal buildings or dams, bridges, culverts, canals etc. is the designing. The basics for construction is the design of basic components and members of a building i.e, slabs, Beams, Columns and Footings.

In order to design coastal buildings, it is important to first obtain the effects of that particular building to which there are various factors that affects the coastal building both directly and indirectly like erosion of footings, breaking waves, high winds etc. Because the most hazardous coastal areas are subject to erosion and extreme flood loads , and to plan the positioning of the particular rooms such that they serve their respective purpose and also suiting to the requirement and comfort of the inhabitants, it is a serious discussion to be carried on, and in this paper, the purpose of a new material called green board[dry wall] in coastal building is explained with a schematic structure.

Thereby depending on the suitability, plan layout of beams and the position of the columns are fixed. Thereafter depending on the suitability, plan layout of the beams and the columns are fixed. The loads are calculated namely the wind loads,seismic loads which depends on the type of zone and the live loads, which according to the code IS: 875-1987 are taken and analyzed using a software called staad pro.

II.SELECTION OF SITE

In order to design a proper foundation , it is necessary to first obtain the Geotechnical properties of the soil of the particular area to which there are various factors that may affect the coastal building in future.The Site chosen is located in cherai [kerala].

Co-ordinates:-10.8508°N,76.2711°E

Fig. 1. Map of Kerala with its boundaries and various districts. (Source: www.mapsofkerala.com)

The major concepts of coastal engineering design which are necessary in a coastal building code include

1. Foundation design criteria for erosion and scour.
2. various loading (including wind, waves,Seismic hydro-static, and hydrodynamic loads).In this paper wind and seismic loads are used for analysis.

III. FOUNDATION DESIGN CRITERIA

(Source:-Fema article)

There are various factors to be considered while designing a foundation .The foundations for buildings in flood hazard areas must be constructed with flood-damage-resistant materials and must do two things in addition to meeting the requirements for conventional construction:

(1) Elevate the building above the BFE (Base Flood Elevation).
(2) Prevent flotation, collapse, and lateral movement of the building, resulting from loads and conditions during the design flood event (in coastal areas, these loads and conditions include inundation by fast-moving water, breaking waves, floating debris, erosion, and high winds).
(3) This approach resists storm-induced erosion and scour, and it minimizes the foundation surface area subject to lateral flood loads – it is required by the National Flood Insurance Program (NFIP) in V zones (even when the ground elevation lies above the BFE) and is recommended for coastal A zones. However, even a deeply embedded open pile foundation will not prevent eventual undermining and loss due to long-term erosion in those areas.

IV. RECOMMENDATIONS FOR ELEVATED HOMES.

0-15	Very loose
15-35	Loose
35-65	Medium
65-85	Dense

(Source:-Fema Article)

According to Fema article the foundations in coastal areas should be elevated above the Base Flood Elevation (BFE), as it should withstand flood forces, high winds, scour and erosion, and floating debris.

(1) Foundations used for inland construction are generally not suitable for coastal construction.

(2) Deeply embedded pile are required for many coastal areas; but in other coastal areas, they are not recommended – instead of solid wall, crawlspace, slab, or other shallow foundations that can be undermined easily. "Deeply embedded" means sufficient penetration into the ground to accommodate storm-induced scour and erosion and to resist all design vertical and lateral loads without structural damage

V. EXPERIMENTAL RESULTS -SOIL TEST

(A) Relative Density -7.2 %
Specific Gravity -2.77.

The relative density (7.2%)of this soil indicates that the nature of the soil is very loose and a deeply embedded pile foundation should be designed

Determination Of Chlorides- 134.71 Mg/Litre.

The amount of chloride content is considerably high since the site is located in a coastal area.Corrosion in coastal area buildings is generally associated with deposition of sea salt in presence of moisture on steel and light metals. Chloride is the most important corrosive species compared to sulphate attack in the salt particles. It is influenced by the amount of salt on the metal surface and directly related to speed and direction of wind, distance of structure from the shore, elevation of the structures, degree of sheltering and frequency and amount of rain washing. Other factors that influence corrosion include time of wetness, relative humidity, metal surface temperature etc.Generally steel has poor resistance in coastal regions and hence requires protection for durability.To prevent the penetration of chloride ions a dense, impermeable concrete needs to be produced. This can be achieved by using Ground Granulated Blastfurnace Slag (GGBS). Where GGBS cement hydrates, dicalcium silicate and tricalcium silicate are formed.

VI. MATERIALS-GREEN BOARD [DRY WALL]

Used in basement walls

Dry wall [green board] has many unique properties including is absorbing capacity of water and the major constituents to form a green board are gypsum cores,paper fiter,silica and Ca2So4. Greenboard alone does not inhibit mold growth. It must be treated with mold-resisting agents.

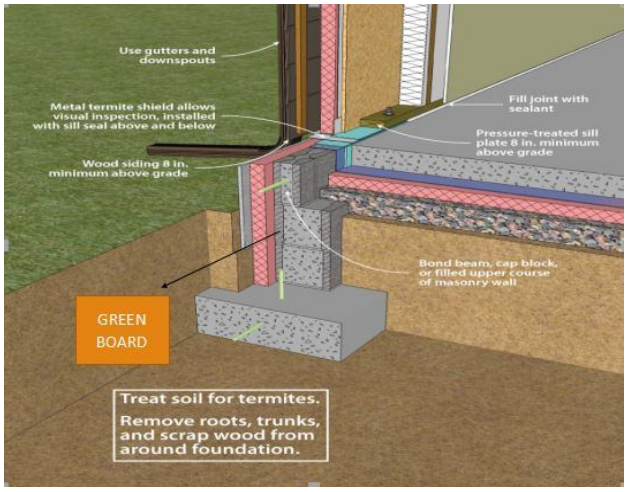

Fig. 2. Typical Representation of green board in basement wall

VII. ANALYSIS -STAAD PRO

Length of the building = 13.69 m
Breadth of the building = 9.89 m
Number of floors =(G+1) 2 floors ,Single roof
Floor space Index =1.15
Total Built-up area=158 m2
Location= Kerala, Cherai [10.8508°N, 76.2711°E]

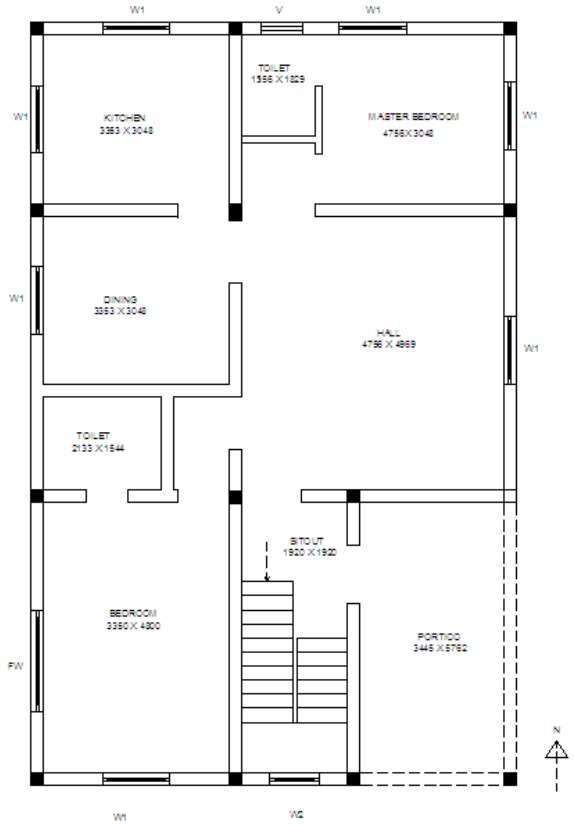

Fig. 3. Top view -Plan

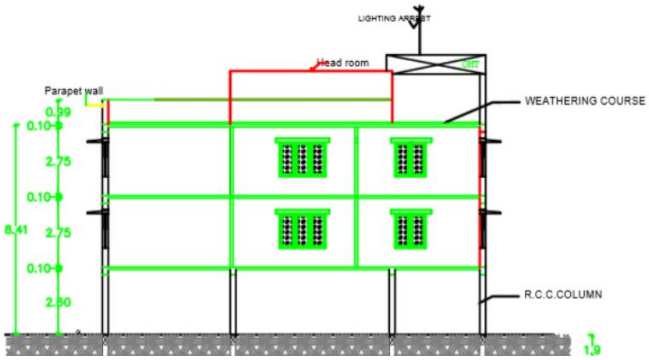

Fig. 4. Side view -Base Elevated Home

LOADS (AS PER IS 875)

1. Dead load(IS 875 –part 1):1987
   a. self-weights (Rcc-25 kN/m³)
   b. Dead imposed load (Brick work – 13.5kN/m³)
   c. Finishes – 2N/m²

2. Live load (IS 875- part 2):1987
   a. Staircases- 4kN/m²
   b. All other areas -3kN/m²

3. Wind loads (IS 875- part 3):1987
4. Seismic loads(IS 1893 – part 1):2007
5. Combination of loads(IS 875- part 5):1987
6. Auto load combination

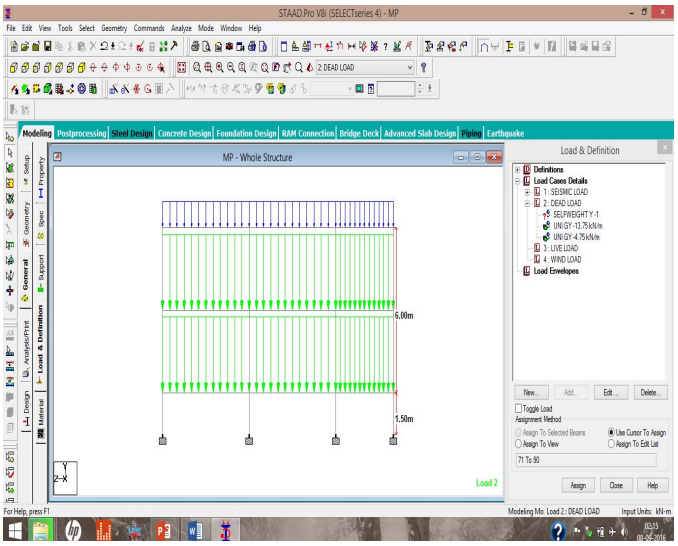

Fig. 5. Dead load

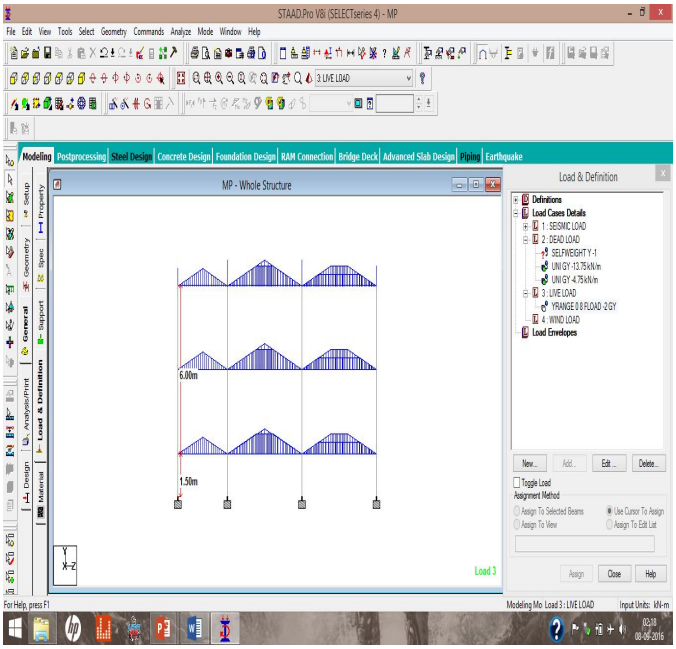

Fig. 6. Live load

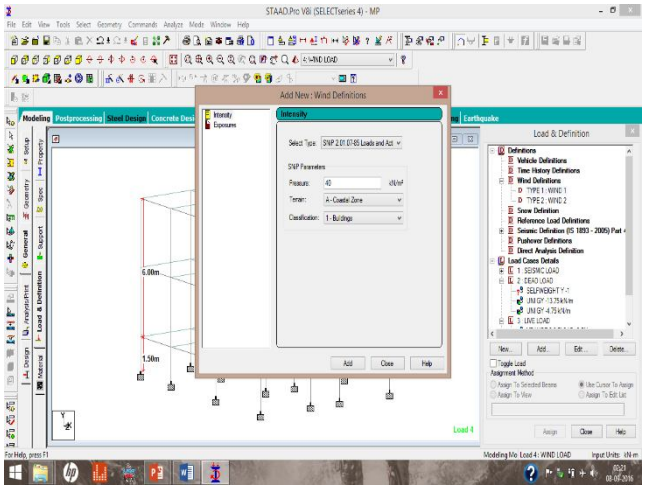

Fig. 7. Wind load

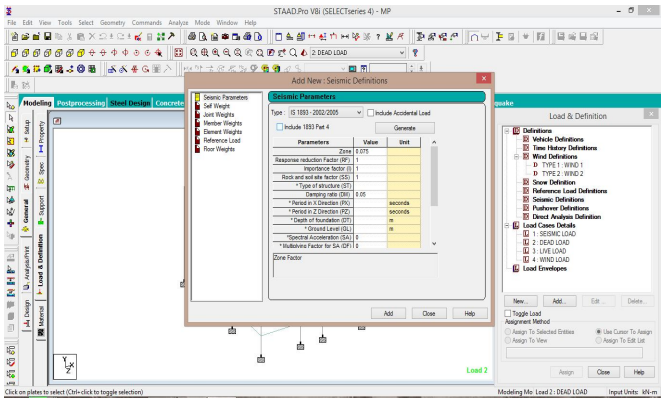

Fig. 8. seismic load

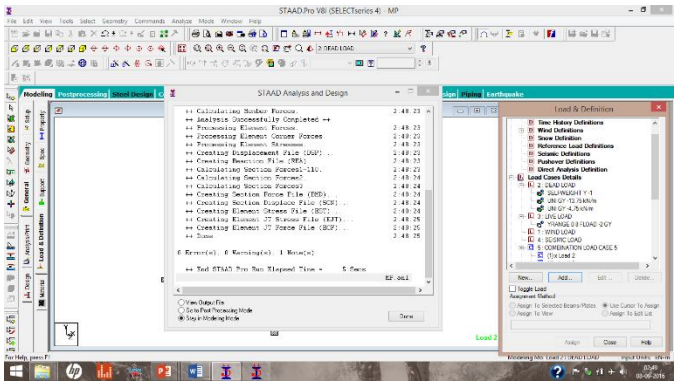

Fig. 9. Output results

VIII. CONCLUSION

Considering various ill- effects and structural design aspects of the coastal building both directly and indirectly like erosion of footings, breaking waves, high winds etc. As the most hazardous coastal areas are subject to erosion and extreme flood loads. Our aim is that the building is to be properly designed and analyzed and the ultimate goal of the project is to increase the life span of the coastal buildings.

Based on the Soil test results ,the type of foundation suitable is embedded deep pile foundation and is designed ,whereas as with the application of material called Green Board/Cement Board proves excellent material towards moisture absorbtion in the basement wall .Finally the Foundation should be designed within the coastal construction building zone as per Coastal regulation zone rules in coastal panchayats (villages) of kerala,India.

REFERENCES

[1] Ralph R.Clark “Structural Design aspects of Coastal Building Code,” 1982.

[2] A. Ramachandrana, , B. Enserinkb and A.N. Balchandc “Coastal regulation zone rules in coastal panchayats (villages) of Kerala, India vis-a` -vis socio-economic impacts from the recently introduced peoples’ participatory program for local self-governance and sustainable development”Volume 48,Issue 7-8 ,2005 pages 632-653.

[3] FEMA Article “Foundation Requirements And Recommendations For Elevated Homes” FEMA-DRs-4085-NY and -4086-NJ / May 2013.

[4] FEMA Aricle “Home Builder’s Guide To Coastal Construction” FEMA 499/August 2005 Technical Fact Sheet No. 11.

[5] Dr.V.L.Shah & Dr.S.R.Karve “Illustrated design of reinforced concrete buildings.(fourth edition 2014, Structures publications).

[6] Bureau of Indian Standards - Indian Standards - "Code of Practice for design loads other than earthquake for building and structures: IS 875(Part1&2):2011 .

[7] Bureau of Indian Standards - Indian Standards - "Code of Practice for plain and reinforced concrete: IS 456-2000 .