ANALYSIS, DESIGN AND PERFORMANCE EVALUATION OF FLOATING BUILDING USING FEA

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Abstract - *Various features of the arena probably disappear from the map due to rising sea levels and the disappearance from the undersea. The company needs to adapt, and people may one day stay in floating houses. Depending on their geographic position and the results of the world's warming, and then on the rising sea level, some foreign places are in addition to its model. This project analyses and develops a floating house based on the flooring concept. Different elements, such as building height, water depth and wave loads, moor and no moors, analyse the floating structure. This analysis is used to conduct a comparative research. And ANSYS software is used to implement all approaches.*

Key Words: Floating Building, Floating Residence, ANSYS, Structural Engineering, FEA, Buoyancy.

1.INTRODUCTION

Environmental issues such as fast population increase, depletion of energy resources, global warming, and increasing water levels have all had an impact on the environment and biodiversity, which must be addressed through long-term planning strategies and solutions. The use of green energy in the house raises a number of concerns and issues concerning the built environment, as well as the search for new ideas and things to look forward to. Power generation has an ecological consequence and plays an essential role in meeting the needed testing conditions in the built environment.

Because of environmental and energy concerns, the architectural community wishes to consider the human problems and hazards involved. In the face of troubling commerce in the climate, rather than a notion, the concept of floating on the water position might be offered as a current procedure. Floating forms not only offer a new shape style, but they also serve as a visible link between renewable marine energy and the built environment. The concept of living and walking in water is also not new.

In reality, there exist several types of floated dwellings from the Mesopotamian period that were built throughout the style of the tribes throughout the marshes of Mesopotamia. There are significant guidelines for designing floating dwellings. The usage of the water and water in automated houses must be addressed in advance of many aspects for the implementation of the right methods and approaches to build floating houses. For example, due to temperature variations between most water and outside air, hydropower may play a significant role in supplying a source of energy that can be utilized for both cooling and heating.

1.1 FLOATING BUILDING

Floating construction is a construction unit with a lubricant at its base, which allows it to flow through water. It is described as a “perfectly shaped” structure and is no longer used for navigation. Floating homes are often drawn to the area with the help of using any delivery and are unable to move under their control. Floating houses have natural blessings that include resisting sea change, and minimizing environmental disturbances at the port.

They can be built offline online and then dragged closer, reducing the disruption of the built-in website. If construction is halted, it can be relocated. The term “Floating” within the engineering foundation has been used while the ground beneath the foundation is now no longer applicable to any major load, because the conditional load is the same or much lower than runoff. Floating houses are similar in concept and can be described as houses that can be built on water in such a way that the load is the same or even lower than the water pressure that facilitates the floating of the living space in the water.

Traditional homes such as houseboats move simultaneously as floating houses are now considered those that can be used as living quarters that may be a small stockpile without overflowing with the flow of waves. Unlike a house boat, the flow area is not self-contained, although a few flowing houses can be operated with the help of attaching a car outside them. Floating homes are currently constructed in such a way that they easily flow through all the floods. Therefore, there are a variety of floating homes, one that flows completely and the other that flows easily in all the flood waters that are found on the ground, especially throughout the dry season when there is no water.

1.2 PRINCIPLE OF FLOATING BUILDING

Buoyancy is the concept of design. The principle may be described by Archimedes: "No substance is sprayed by force that is equivalent to the weight of the liquid removed from the surface, which is submerged in or partly immersed in the liquid." The Archimedes force is this greatest power. This energy corresponds to the weight of water evacuated from houses. The gravitational strength (m / s2) is equal to the quantity of water ρ (kg / m3), and multiplies the volume of water leaving a residue V. (m3). This offer is formulated:

FA = ρ.g.v

The weight of the floating structure is equal to the strength of Archimedes in order for a structure to float freely in balance.

FA (Force of Archimedes) = F g (gravity force)

1.3 OBJECTIVE

1. To analyze a floating building with gravity-vertical loading condition (DL + LL).
2. To analyze floating buildings with lateral-dynamic loading conditions (DL + LL + WIND + WAVE).
3. To study the effect of building on the mooring system.
4. To study the effect of building height.
5. Comparison of output results such as total sink, lateral movement of the building, pressure on the building.

1.4 METHODOLOGY

- Preparation of residential plan
- Calculation of design loads
- Design of floating base using pontoon principle with EPS (Expanded Polystyrene)
- Design of mooring System
- Analysis of the structure using ANSYS software
- Comparing the results
- Conclusion

2. LITERATURE REVIEW

A. Ambika and K. Venkatraman in their paper it has a floating home with a dimension of 6.15m x 4.33m x 3m. The software Staad.pro v8i is used to evaluate structural members in the floating bay. For the complete floating home, the manual design was developed. For the safety of the structure, a stability study is also carried out. Design with lightweight building materials and a stable fit of the overall structure. In most regions of the world, this next technology will be adopted if the current surface is distant from sea levels.

Emilin Sara Varkey, Fayiz Ameen M M, Sonam G Bose, Syamlal V, Linda Lawrance in this magazine, they are designing a temporary residential building using the Pontoon principle. And they analyze the structure using ANSYS software. They concluded that temporary housing could be considered an effective alternative to traditional housing.

F. Ishaque, M. S. Ahamed, M. N. Haque, the researchers have tried in this publication to construct a cheap dwelling for individuals in inland locations such as Bangladesh. The proposed floating house was constructed using local resources that were proven to be sustainable and economically viable. The floating house is developed for areas devastated by the flood and gives a permanent address for homeless and gypsy. Airtight plastic cylinder can be used instead of drums to enhance life expectancy. Other floating homes will be constructed as well as the main building for poultry and animals.

Professor Wang Chien Ming here the hydrostatic reaction in the combination of integrated connections and killing cells by big, floating structural structures, but with a restricted range of large floating structures, is considerably decreased in this work. By altering the form of its borders, you may minimize the hydro elastic reaction of very big float structures.

Inegiyemiema M, Nitonye S, Dick I.F and Erekosima A here the project is creating a cottage mooring fit-for-purpose system for stability and for the dynamic placement of a 5000-ton offshore working barge with a helicopter and crane carrier. Mooring is based on engineering and the scientific Theory, which derives and uses elastic catenary equations to calculate dynamic responses; the ambient level energy in the floating structure and the minimal mooring line required.

3. DESIGN OF FLOATING BUILDING

Referring the details from the above-mentioned literature reviews a floating building is designed and analysis is done by applying various parameters such as building height, water depth, wave loads, mooring and non-mooring. And comparative study is done based on stress, lateral movement and pressure on the building.

3.1 BUILDING PLAN

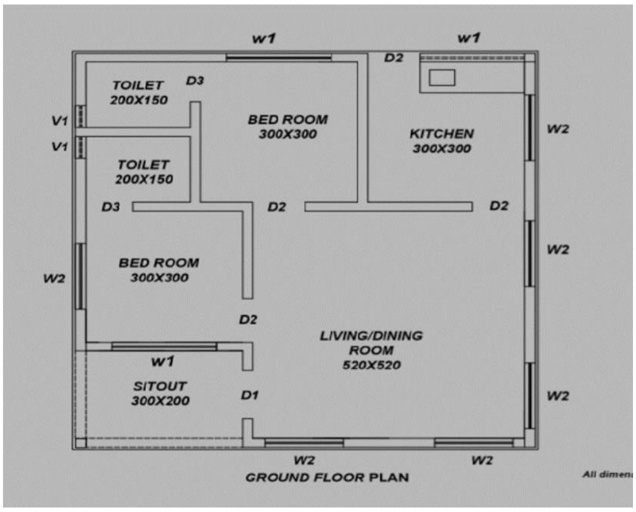

Figure - 1: Plan of the building

3.2 LOAD CALCULATION

- Total centre line quantity of building = 61*0.2*3 =36.6m^3
- Roof Slab = 9.3*9.1*0.15 = 12.7m^3

Table - 1: Load Details

Wall Load	585.6KN
Self-weight of roof slab	12.7*1440 = 182.88KN
Live load (IS code 875 (PART 2), 1987)	2KN/m^2
Total live load on floor	134.48KN
Wind load (IS code 875 (PART 3),	104.24KN

1987)	
Maximum wave load	5.025KN

3.3 SUPER STRUCTURE-WALLS

Table - 2: Wall Details

Material	Carbon fiber composite panels/Epoxy sandwich panels
Density	Lesser compared to other building materials
Strength	High
Weight Density	1600kg per cubic meter
Advantage	Resistance of the separate panel components to full impact loads

3.4 ROOF SLAB

Table - 3: Roof Details

Material	Light weight aggregate
Weight Density	1440kg per cubic meter
Advantage	Since it is light weight material so no risk for the wall to carry roof load

3.5 FLOATING BASE

- Technique opted – Concrete EPS system
- Consist of – Expansive Polystyrene core with a thick core, a thin coating of concrete on top, stiffness and protection provided by concrete side walls
- Expanded Polystyrene – The material is having 90-95% air but has strength sufficient to carry a building, weight density is 60-640 kg per cubic meter

3.5.1 LOADS DUE TO FLOATING BASE

Table - 4: Floating Base Load Details

Material	EPS blocks of density 28kg/m^3 Separated using LWA concrete of density 1440kg/m^3
Dimension of floating base	12m*12m
Assumed EPS blocks size	4*4*36 = 1.36m^3
No. of blocks	81
Weight of pontoon	2223.29KN
Weight of EPS blocks	30.27KN
Total weight of floating base	2223.29+30.27 = 2253.56KN
Reinforcement load from roof slab	8733.87N = 8.73KN
Total load transferred from the superstructure	3019.66KN

3.5.2 DIMENSION OF FLOATING BASE

Table - 5: Floating Base Dimension Details

Density of water	997Kg/m^3 = 9.77KN/m^3
F = Density*Volume of water 3019.66 = 99.77*V V = 3019.66 / 9.77 = 309.07m^3 V = l*b*d; d = 309.07 / (12*12) = 2.2m	
Draught	2.2m
Free board	0.6m
Total depth	2.8m

3.6 MOORING SYSTEM – CATENARY LINE EQUATION

Table - 6: Mooring system Details

$F_{environmental} = F_{Wave} + F_{Wind} + F_{Current}$	
Length of anchors chain (L)	25m
Number of anchors used	6 Anchors
Horizontal pretension (T_H)	172KN
Anchor weight in water	10KN/m
water depth height (h)	10m
work barge length (L_P)	12m
work barge breadth (B_P)	12m
work barge height (H_P)	2.2m

4. NUMERICAL INVESTIGATION

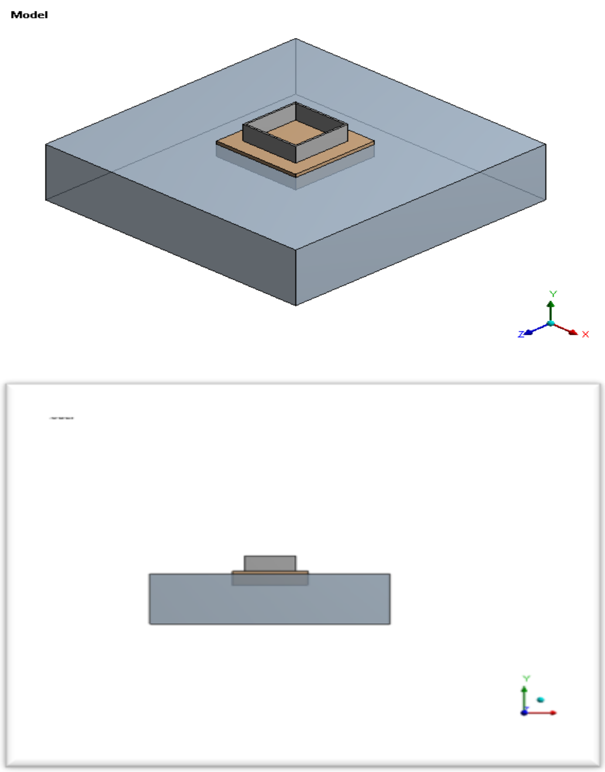

Figure-2: Floating building model

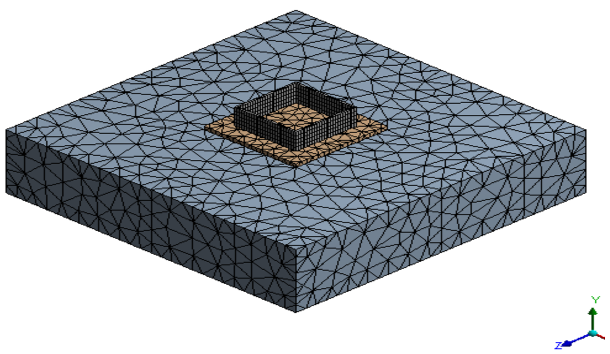

Figure - 3: Mesh structure

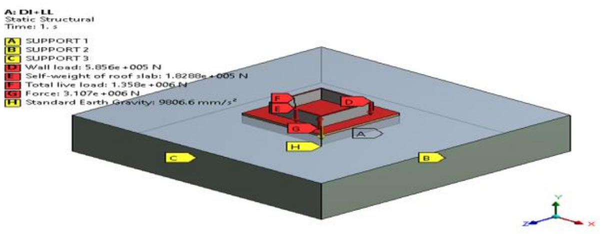

Figure - 4: Dead Load +Live Load

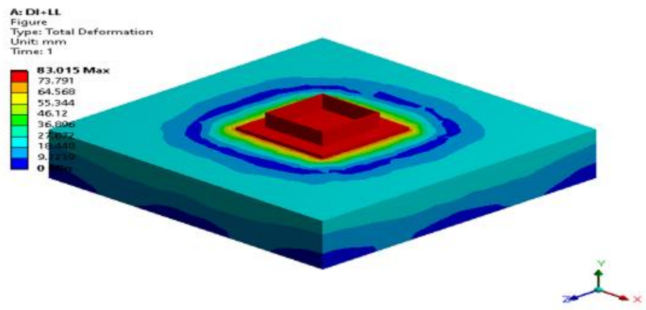

Figure - 5: Result

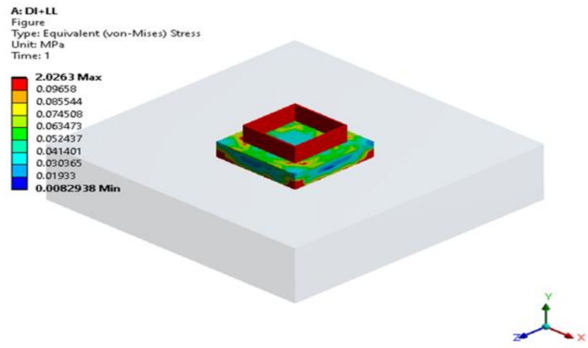

Figure - 6: Result

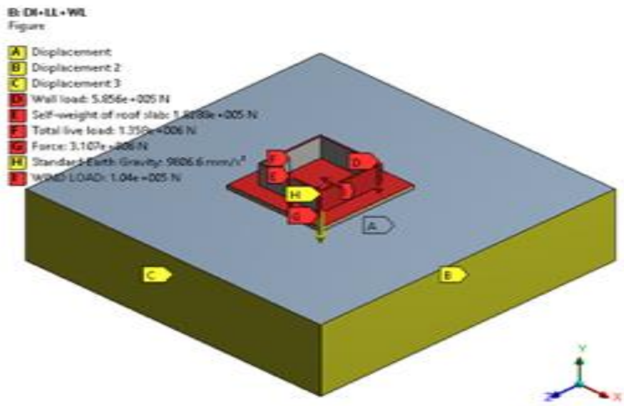

Figure – 7: Dead Load +Live Load +Wind Load

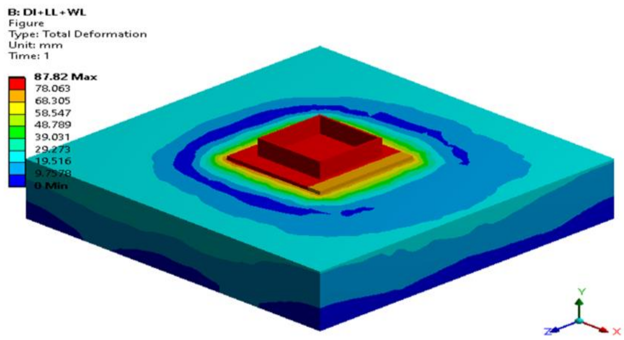

Figure – 8: Result

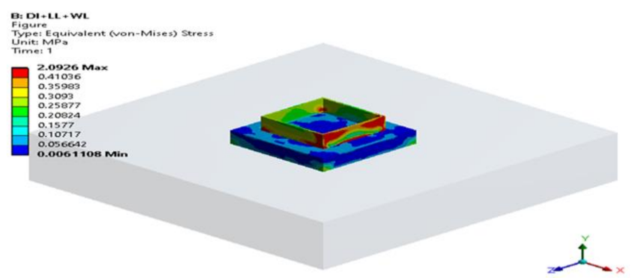

Figure – 9: Result

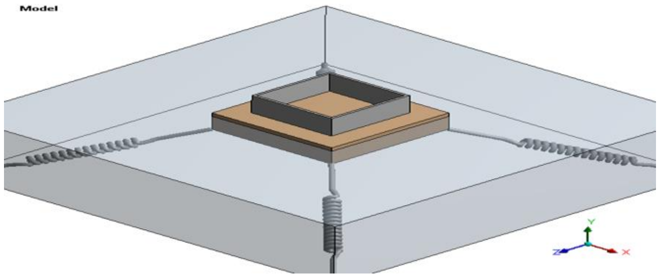

Figure – 13: Dead Load +Live Load + Wave Load+ Mooring

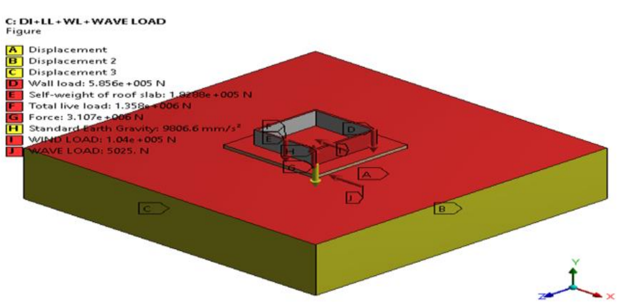

Figure – 10: Live Load +Wind Dead Load + Load +Wave Load

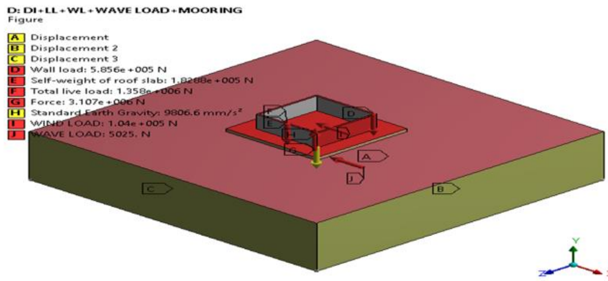

Figure – 14: Model

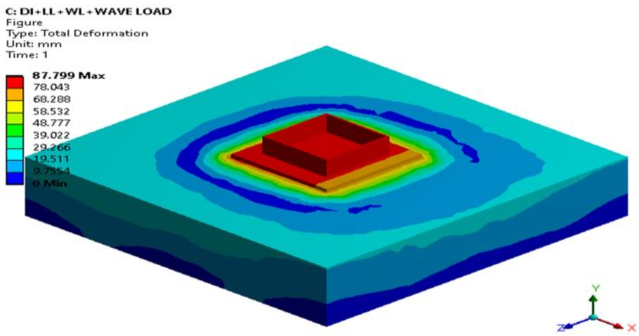

Figure – 11: Result

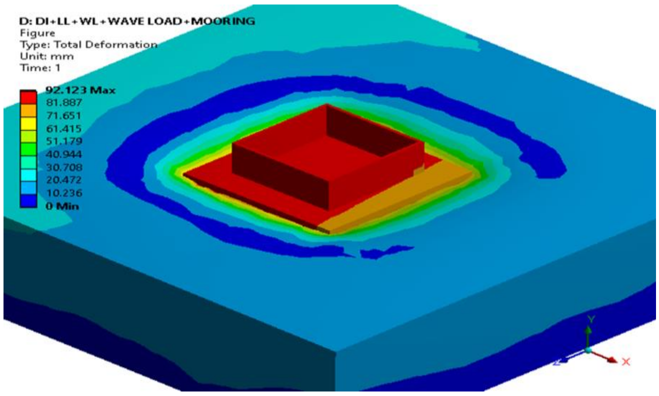

Figure – 15: Result

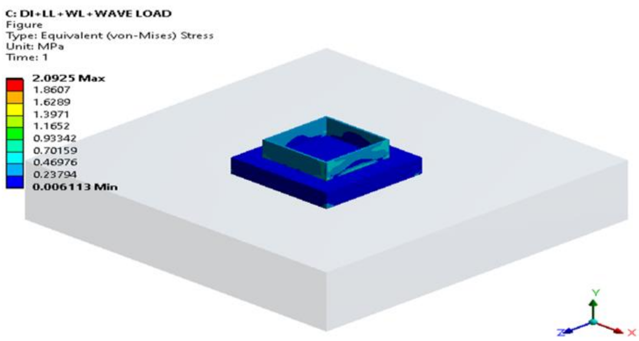

Figure – 12: Result

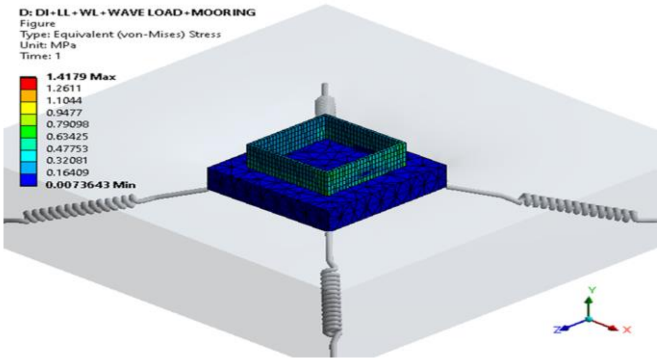

Figure – 16: Result

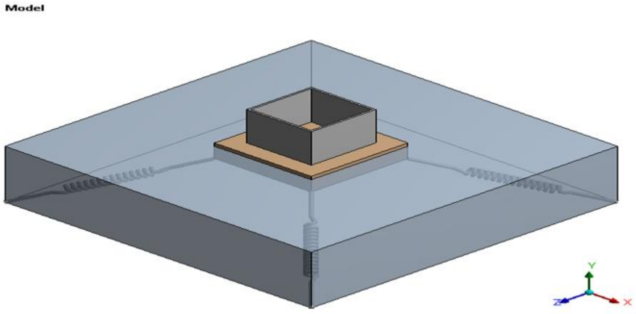

Figure – 17: 6m Height +Dead Load Live Load + Wave Load + Wind Load+Mooring-Boundary Condition

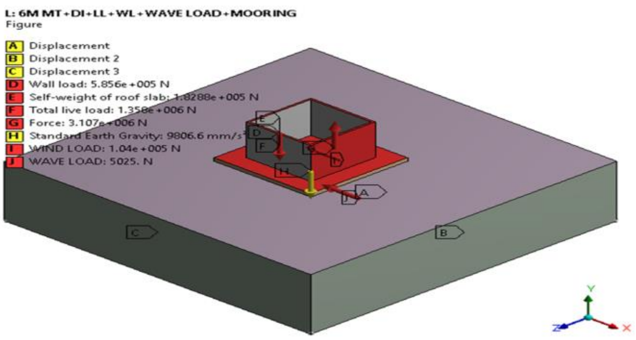

Figure – 18: Model

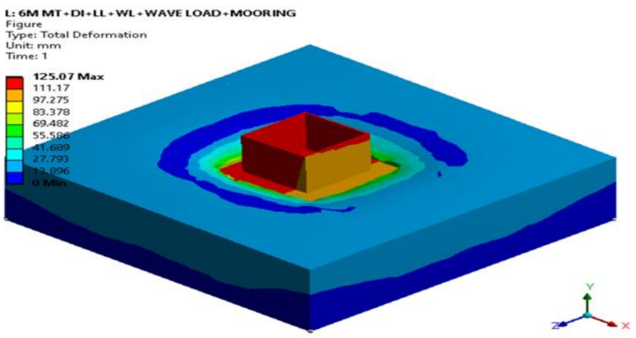

Figure – 19: Result

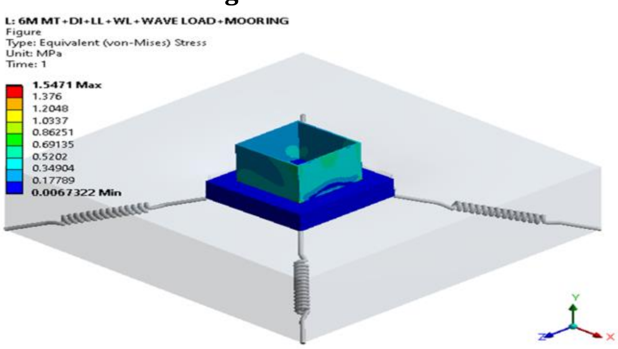

Figure – 20: Result

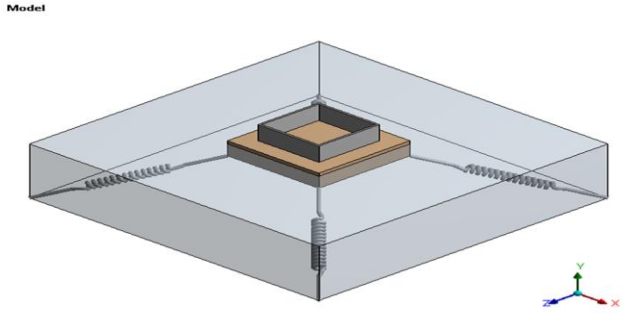

Figure - 21:5 Times Wave Load+ Dead Load+ Live Load+ Wind Load+ Mooring – Boundary Condition

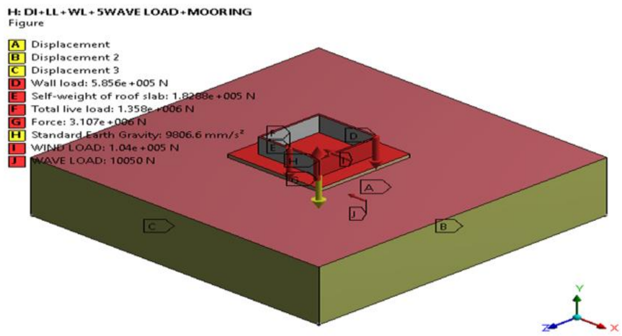

Figure – 22: Model

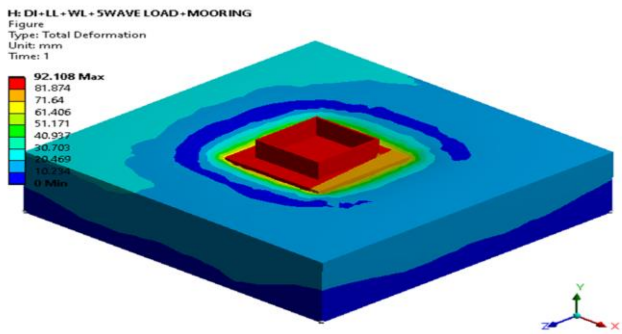

Figure – 23: Result

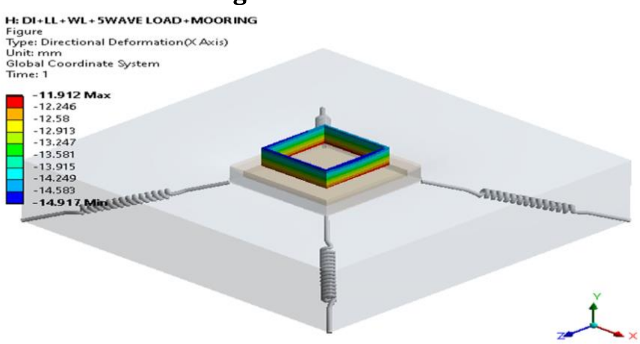

Figure – 24: Result

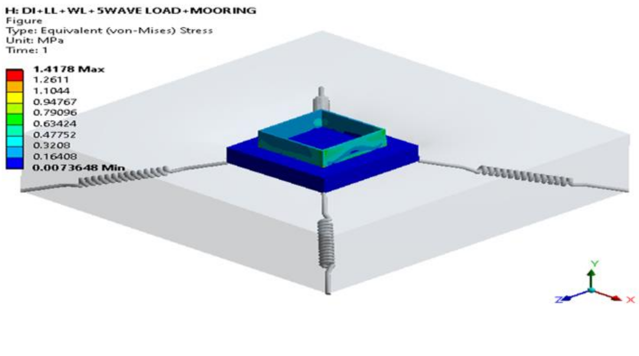

Figure – 25: Result

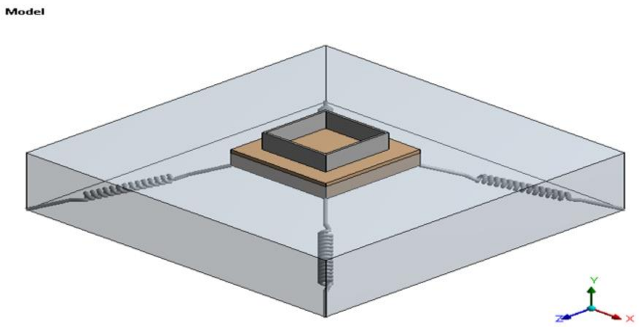

Figure – 26: Dead Load+ Live Load+ 10 Times Wave Load + Wind Load+ Mooring – Boundary Condition

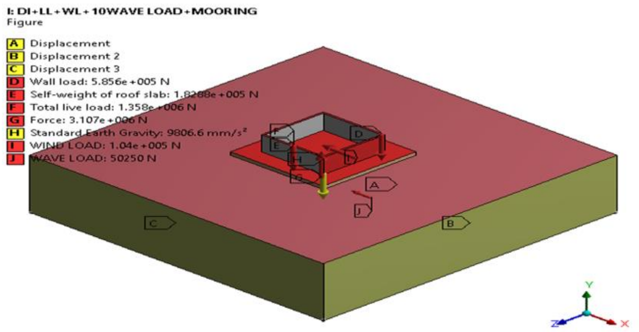

Figure – 27: Model

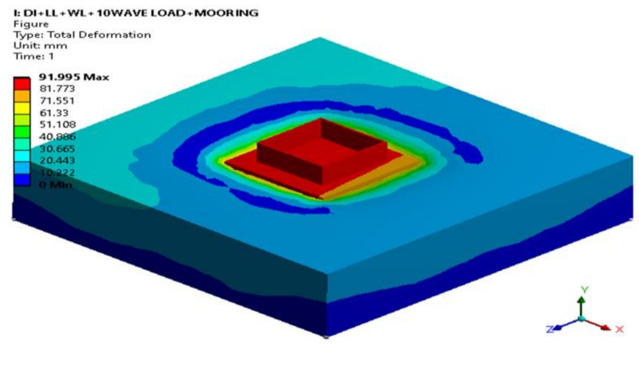

Figure – 28: Result

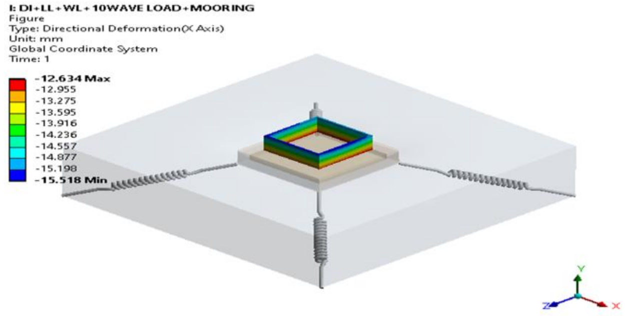

Figure – 29: Result

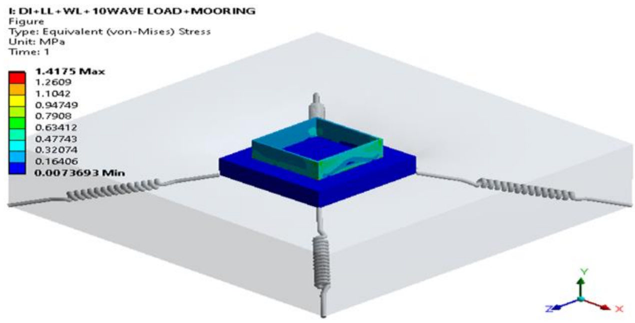

Figure – 30: Result

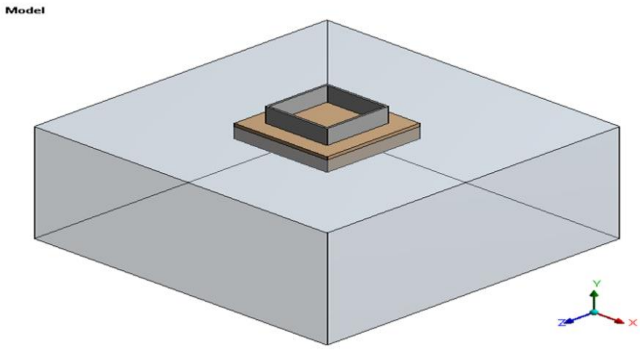

Figure – 31: Dead Load+ Live Load+10 Times Wave Load+ Wind Load+2 Times Water Height-Boundary Condition

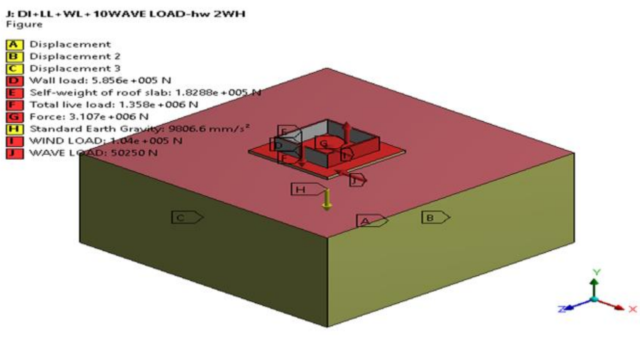

Figure – 32: Model

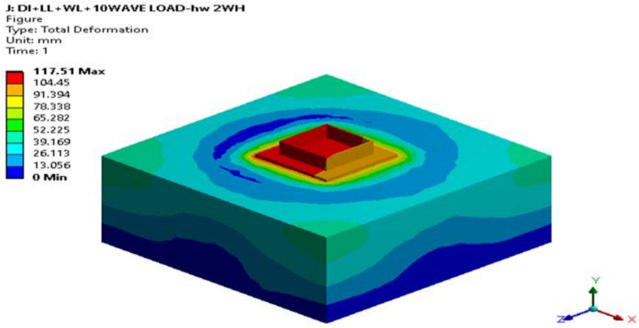

Figure – 33: Result

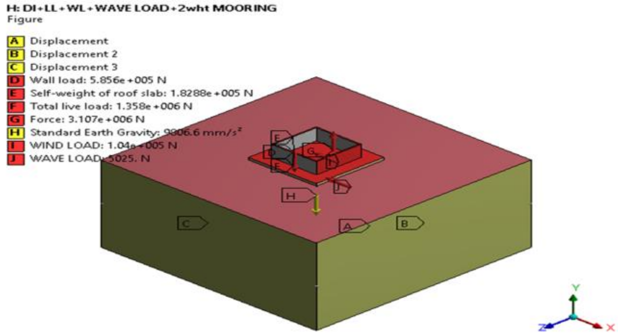

Figure – 37: Model

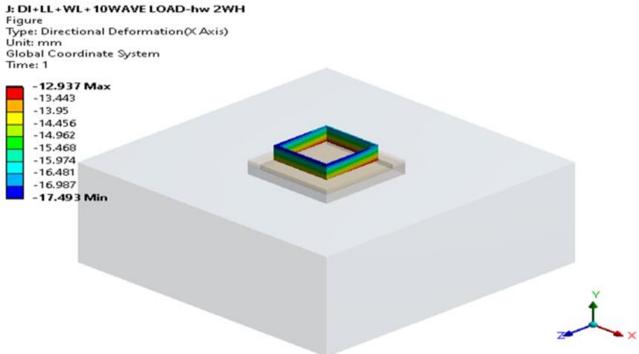

Figure – 34: Result

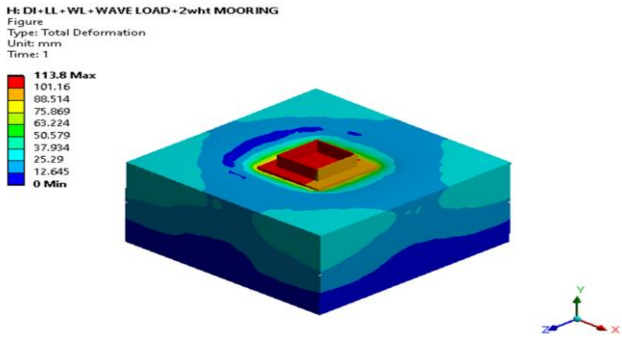

Figure – 38: Result

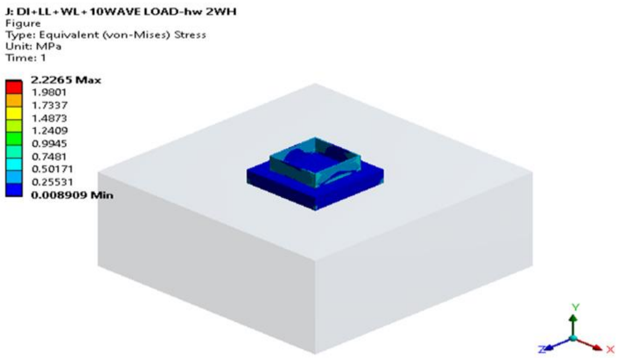

Figure – 35: Result

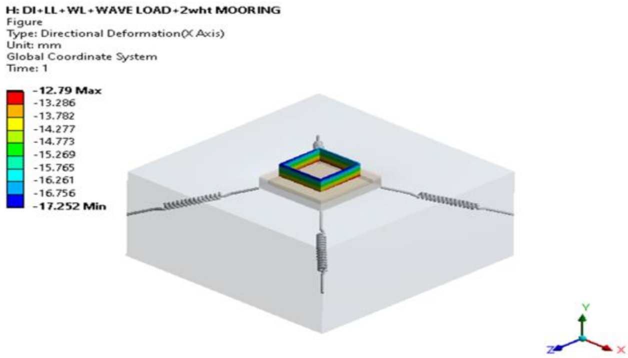

Figure – 39: Result

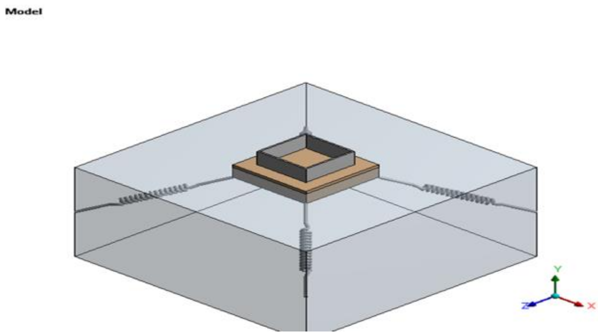

Figure - 36: Dead Load+ Live Load+ Wave Load+ 2 Times Water Height+ Mooring-Boundary Condition

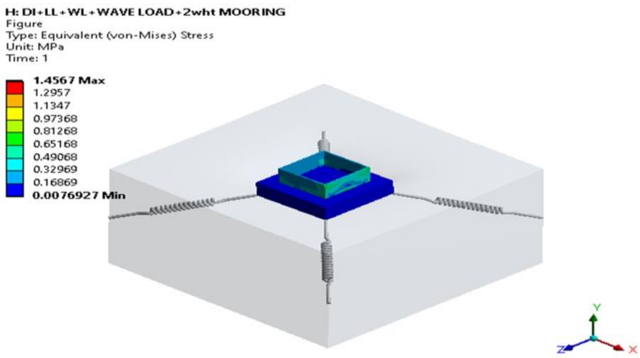

Figure – 40: Result

5. COMPARISON OF RESULTS

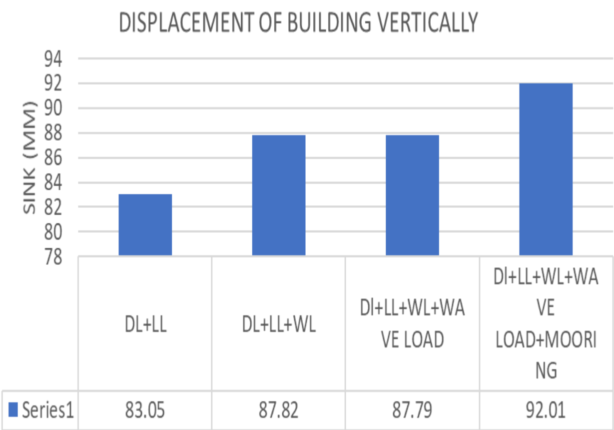

Chart - 1: Sink

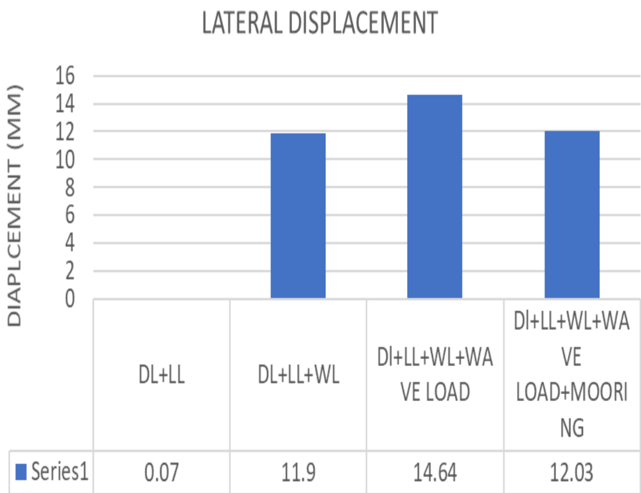

Chart - 2: Lateral Displacement

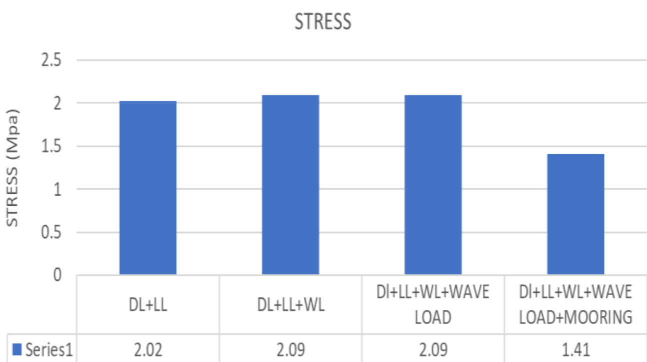

Chart - 3: Stress

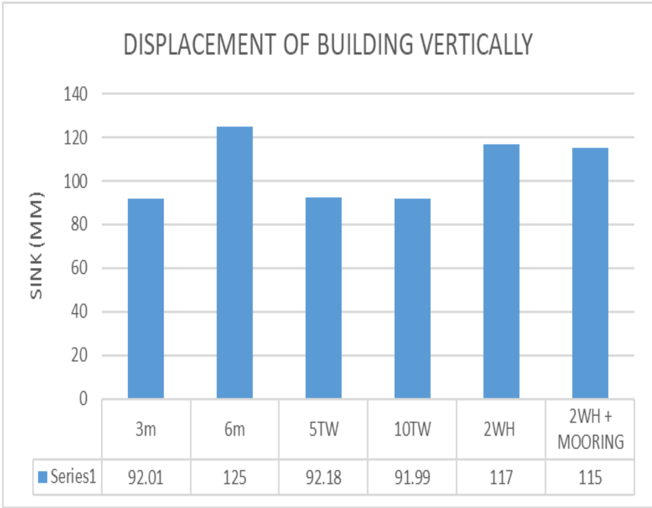

Chart - 4: Sink

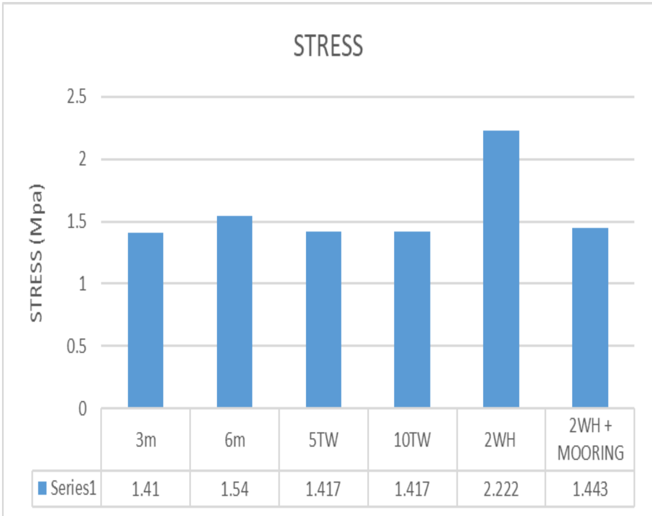

Chart - 5: Stress

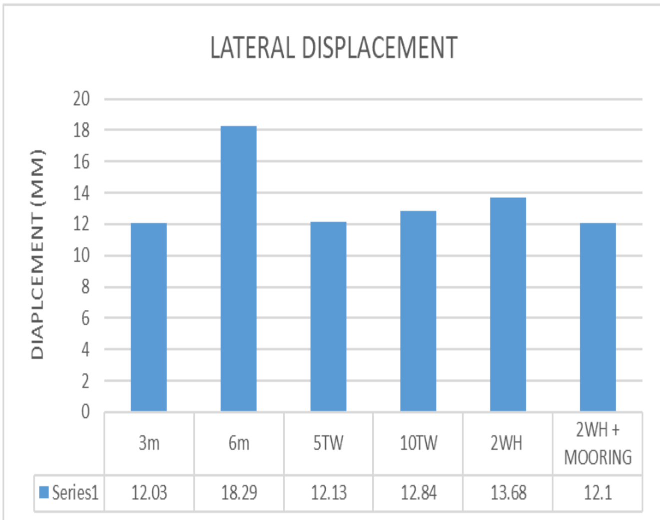

Chart- 6: Lateral Displacement

6. CONCLUSION

- Under dynamic condition it is observed that 5 percent of increase in the vertical displacement
- It is observed that on acting wave load along with wind load lateral movement of building is 23.02 % more compared with wind loading alone
- Up on including the mooring system it is observed that 17.82 % of displacement is controlled under dynamic condition.

BASED ON HEIGHT OF BUILDING

- When height of the building is increased from 3m to 6m;
  - Total sink is increased by 26.392%
  - Here only building height is increased but base is not increased. Hence in order to decrease the sink, we need to increase the base size.
  - Lateral movement of the building is increased by 34.22%
  - When the height of building increases, the exposure increases, hence lateral movement also increases.

BASED ON WAVE LOAD

- When wave load is increased to 5 times and 10 times the actual wave load
  - On comparing the parameters of the wave loadings, only negligible difference is occurred.
  - Here the effect on sink is negligible and also the lateral movement is also slightly varying about 5.529%.
  - Hence the wave loadings do not have much effect on the performance of building.

BASED ON WATER DEPTH

- With and without mooring are done
  - Lateral force is decreased when the mooring is provided.

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