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# Seismic Analysis of Honeycomb Structure over Conventional Structure with the Comparative Study by Using STAAD PRO

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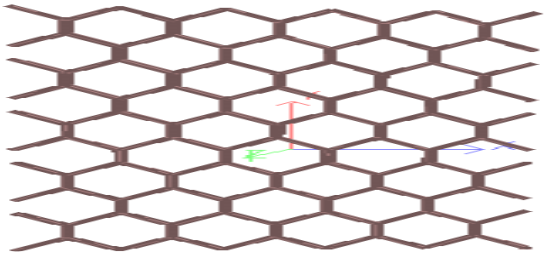
**Abstract: - All over the world new innovations have been done by researchers so as to minimize the structural and environmental damage to the society. It has became a new trend to construct tall buildings with innovative design, Biomemitic structure is one of them which has some advantages over the conventional structures therefore honey comb system used in tall structure construction. This paper gives a newly evolved technique which is done on the normal conventional structure and also the effect on the building due to seismic forces is studied in this paper. For comparing the results of conventional structure over hexagrid structure software based analysis has been carried out by considering various seismic parameters to check the effect of seismic forces on the structure.**

Keyword: - Honey Comb Structure, Strength, Innovations, Seismic Behavior, Efficiency.

## I. INTRODUCTION

This type of structure is a biomemitic structure evolved from the inspiration of bee hive. The honeycomb structure consists of hexagram system which is used as the exoskeleton to the conventional type building. this biomemitic structure has various advantages as it provides more ventilation and sunlight. The hexagrid used in the structure has symmetrical element as honeycomb structure is constructed of hexagrid which forms a continuous structure. In this honeycomb structure concrete is arranged in the form of hexagrid which is arranged at the outer face of the structure or between column spacing, size of each grid in exoskeleton is kept same. This structure has maximum windows so the stiffness is not obstructed by the windows. In various seismic zones it seems that there is the need of more techniques which resist seismic forces which will prevent the failure of the structures. The driving force behind these tall structures is nothing but the interest of the architects towards the new challenges and also to improve the aesthetic appearance.



## II. OBJECTIVE

The objective of the project is to study the seismic forces which affect the structure, hence by adopting new techniques skyscraper failure can be minimized. The combination of forces such as dead load live load and earthquake load is taken into the consideration. The time period of the structure, axial forces of the columns in the, shear force, bending moment of the structure is to be studied. By using software based results comparison of conventional structure and honeycomb structure is carried out to find out which structure has greater resistance to lateral forces such as wind and seismic forces. This paper also gives a new innovative structural system which will be environment friendly and consumes natural energy and provides comfort and safety to the structure.

## III. SCOPE

Honeycomb structure is very rigid so the seismic effect is reduced, This structure uses natural energy as the conventional structures are constructed of heavy materials. As tall buildings are of great interest to the world today which creates the

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hazards with the rapidly growing tall structures. As the structure has greater vulnerability to damage because these are the most exposed structure in natural disasters hence by adopting new techniques honeycomb structure can be constructed easily which will play an important role to minimize the failure of tall structures.

## IV. METHODOLOGY

Methodology includes the study of software based analysis in STAAD PRO. It involves the analysis of G+12 building. The plan of the building is rectangular which is same for all the structures. The methodology of this project is to compare a conventional structure with the honeycomb structure. Conventional structure is analyzed first then new innovative biomemitic multistory building having hexagram will be analyzed for same loading conditions. The hexagram system which will be optimized further. All the sizes of beam and columns are kept same in all the structures.

### *A. Conventional Structure*

The plan of the structure used in analysis is shown in the figure. Conventional type structure consists of following load. IS 1893 :2002 is considered for seismic loads. Structure is taken as ordinary frame reduction factor is taken as 5 and soil is of medium type. The sizes of beams and columns are same for all the structures.

IS875-1987 (Part I)is considered for dead load
IS875-1987 (Part II) for imposed load
IS875-1987(Part III) for wind load.

The total height of the building is 36 meter above the plinth level. The depth of foundation is taken as 2.5meters.

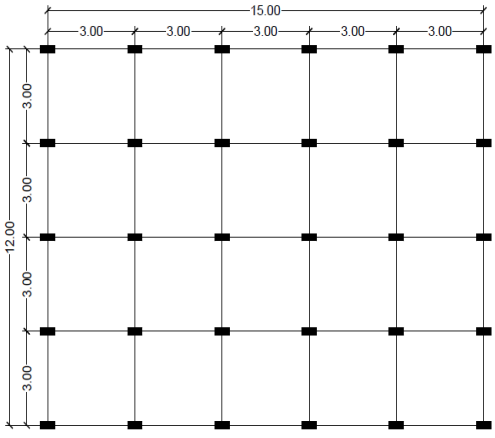



Fig. 1: Plan of the building used for analysis purpose with its column orientation

### *B. Honeycomb Structure And Optimized Structure*

- All the sizes of beams, columns and slab in case of honeycomb structure is same.
- The hex grid is of 200 mm X 200 mm made of concrete. There are 2 small hex grids placed between two column between a vertical floor.
- In optimized structure there is only one hex grid between two columns of a vertical floor.

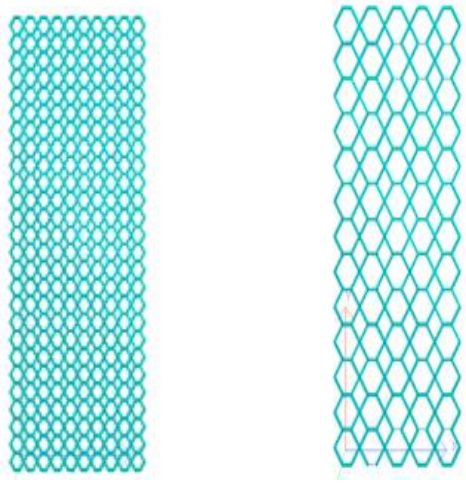
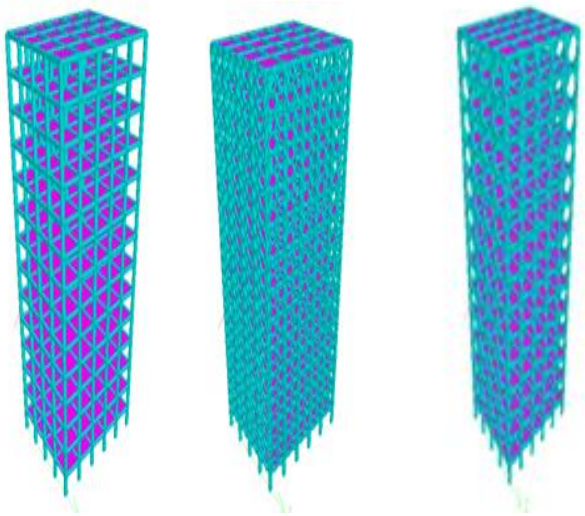


Fig.2: Hexagrid and Optimized Structure



(a) (b) (c)

Fig.3: (a),(b),(c) is the 3D view of Conventional Structure,Hexagrid Structure,Optimized Hexagrid Structure.

### *C. Details of the Structure:*

*A) Conventional Structure:*

- The column sizes = 500 X 230 mm

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- The beam sizes are
  B1=230 X 400 mm
  B2=230 X 500 mm
  B3=230 X 500 mm
- The plate thickness is
  S = 120 mm

*B) Honeycomb Structure and Optimized Structure*:

All the sizes in Honeycomb Structure and Optimized Structure are same.

*D. Load Case Details:*

The different load cases used for analysis are as per Indian Code:

- EQRX
- EQRZ
- DL
- LL
- RESPONSE SPECTRUM
- 1.5DL
- 1.5 (DL + LL)
- 1.2 (DL + LL)
- 1.2 (DL + LL + EQX)
- 1.2 (DL + LL - EQX)
- 1.2 (DL + LL + EQZ)
- 1.2 (DL + LL - EQZ)
- 1.5 (DL + EQX)
- 1.5 (DL – EQX)
- 1.5 (DL + EQZ)
- 1.5 (DL – EQZ)
- 0.9DL + 1.5EQX
- 0.9DL – 1.5EQX
- 0.9DL + 1.5EQZ
- 0.9DL – 1.5EQZ

Where EQX stands for earthquake load in X direction
EQZ stands for earthquake load in Z direction
LL= Live Load of the Structure = 2.5 kn/m as per IS 875 part 1
RL= Roof live load= 1.5 kn/m
Earthquake load is as per IS:1983 part IS 1983:2002 part 1
Earthquake zone is taken as zone IV.
Response reduction factor is 5 and soil is of medium type.

I =Importance factor is 1

## V. RESULT

Both the static and dynamic analysis has been carried out and following are the results:

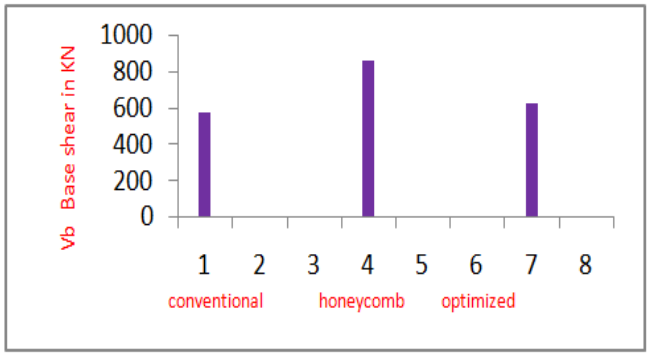



Fig.4: Graph 1 Comparison of dead load of all structures.

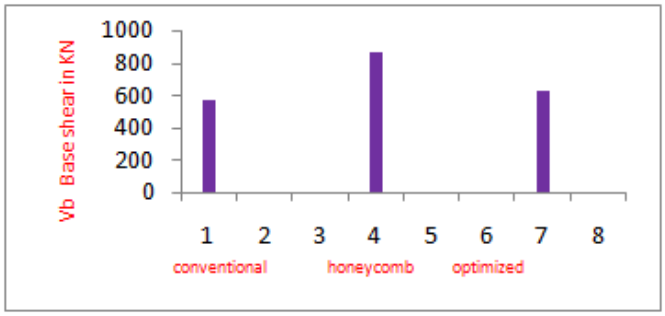
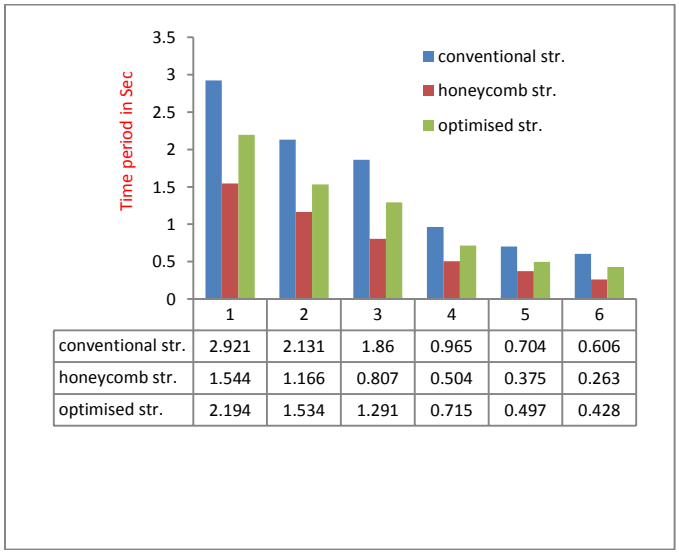



Fig.5: Graph 2 Difference of base shear of the structures




| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| conventional str. | 2.921 | 2.131 | 1.86 | 0.965 | 0.704 | 0.606 |
| honeycomb str. | 1.544 | 1.166 | 0.807 | 0.504 | 0.375 | 0.263 |
| optimised str. | 2.194 | 1.534 | 1.291 | 0.715 | 0.497 | 0.428 |

Fig.6: Graph 3 Comparison of time period of structure

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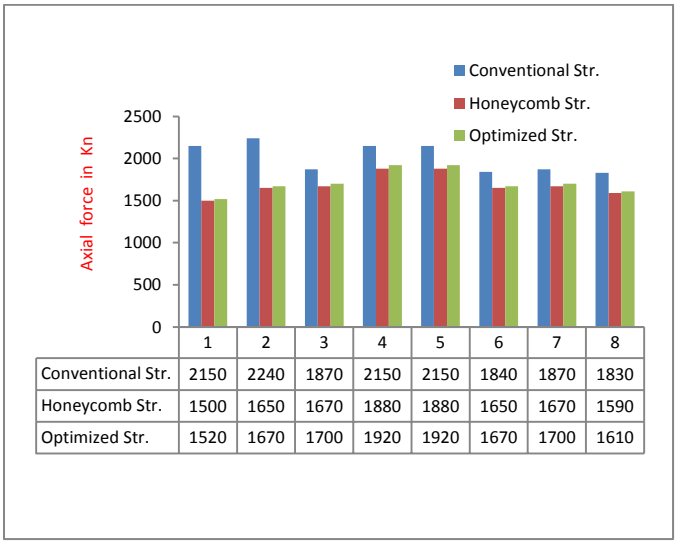
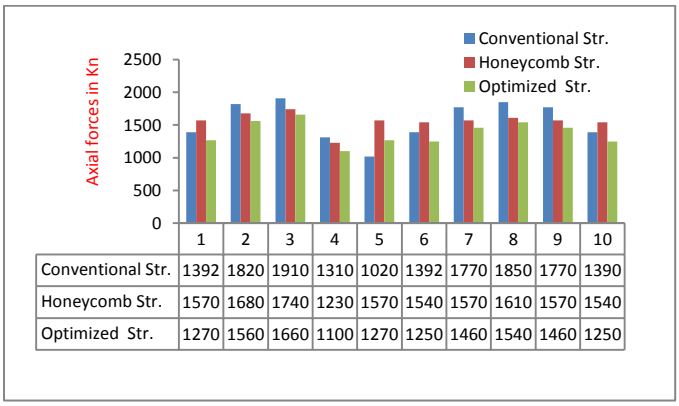


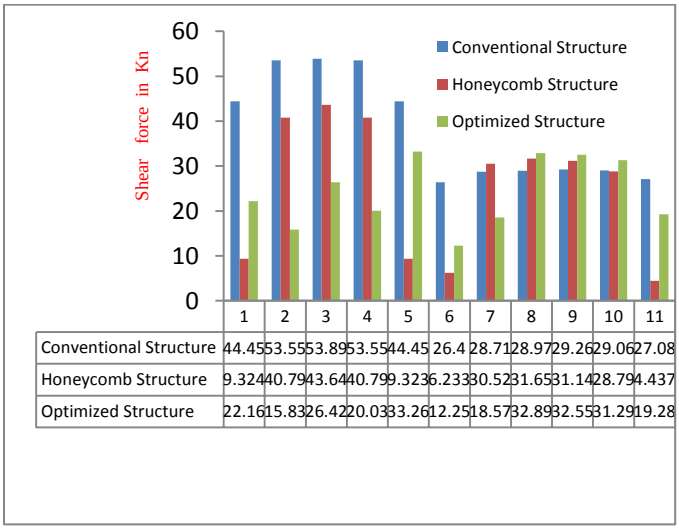

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Conventional Str. | 2150 | 2240 | 1870 | 2150 | 2150 | 1840 | 1870 | 1830 |
| Honeycomb Str. | 1500 | 1650 | 1670 | 1880 | 1880 | 1650 | 1670 | 1590 |
| Optimized Str. | 1520 | 1670 | 1700 | 1920 | 1920 | 1670 | 1700 | 1610 |

Fig.7: Graph 4 Comparison of axial forces of inner columns of the structure for critical load combination.



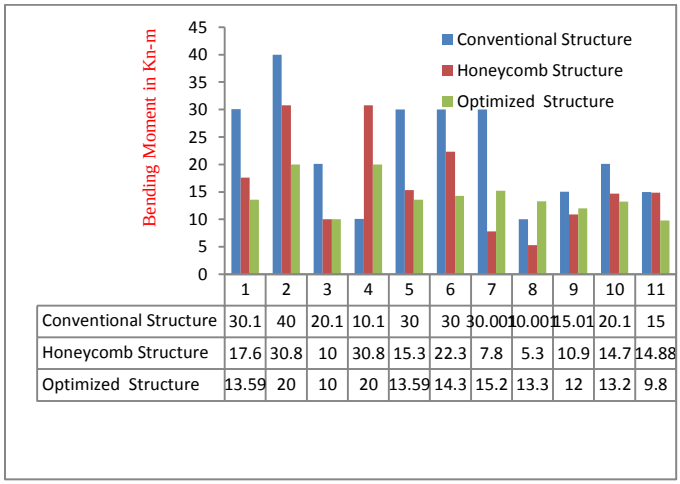

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Conventional Str. | 1392 | 1820 | 1910 | 1310 | 1020 | 1392 | 1770 | 1850 | 1770 | 1390 |
| Honeycomb Str. | 1570 | 1680 | 1740 | 1230 | 1570 | 1540 | 1570 | 1610 | 1570 | 1540 |
| Optimized Str. | 1270 | 1560 | 1660 | 1100 | 1270 | 1250 | 1460 | 1540 | 1460 | 1250 |

Fig.8: Graph5 Difference of forces of outer columns of the structure for critical loading




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conventional Structure | 44.45 | 53.55 | 53.89 | 53.55 | 44.45 | 26.4 | 28.71 | 28.97 | 29.26 | 29.06 | 27.08 |
| Honeycomb Structure | 9.324 | 40.79 | 43.64 | 40.79 | 9.323 | 6.233 | 30.52 | 31.65 | 31.14 | 28.79 | 4.437 |
| Optimized Structure | 22.16 | 15.83 | 26.42 | 20.03 | 33.26 | 12.25 | 18.57 | 32.89 | 32.55 | 31.29 | 19.28 |

Fig.9: Graph6 Comparison of maximum absolute Shear Forces of all type of structure




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conventional Structure | 30.1 | 40 | 20.1 | 10.1 | 30 | 30 | 30.001 | 10.001 | 15.01 | 20.1 | 15 |
| Honeycomb Structure | 17.6 | 30.8 | 10 | 30.8 | 15.3 | 22.3 | 7.8 | 5.3 | 10.9 | 14.7 | 14.88 |
| Optimized Structure | 13.59 | 20 | 10 | 20 | 13.59 | 14.3 | 15.2 | 13.3 | 12 | 13.2 | 9.8 |

Fig.10: Graph7 Comparison of maximum absolute Bending Moment of all type of structures

## VI. CONCLUSION

- The dead load in case of honeycomb structure is less than conventional structure is found to be less By 16% and after optimization it is found to be less by 38%
- The time period in case of honeycomb structure is reduced by 49% and after optimization it is found to be less by 28% as compared to conventional type structure.
- The critical load combination of the exterior beams is found to be load case 14 ie; 1.5(Dead load - EQX).
- The critical load combination for internal central 8 beams is found to be load case number 13.
- The bending moment and shear force has obtained to be decreased at the internal beams in all the type of structure.
- After optimization the values are considerably reduced.
- The deflections in beams of all the structure are found to be in permissible limit.
- The most critical load combination for all the outer columns is found to be load case 13 ie;1.5(DL+EQX)
- The average total difference in the axial force in outer corner columns is of 338 KN that is 4% more in honeycomb structure.
- After optimization of honeycomb structure the axial forces are found to be reduced in honeycomb structure by 592 KN ie 8% of conventional structure.
- In case of peripheral interior columns the axial forces are more in conventional structure by 790 KN that is by 10% And again it is reduced in case of

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honeycomb structure after optimization by 630 Kn that is 8%.

- The total decrease in the axial forces in honeycomb structure is after optimization of all the out columns is 12%
- The total difference in the axial forces in case of honeycomb structure is 9584 KN less that of conventional structure. The difference is 17 % .
- After optimization the axial forces are still are found to b less by 11864KN , the difference is found to be 21% .

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