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Seismic Analysis of Honeycomb Structure over Conventional Structure with comparative Study by using STAAD PRO

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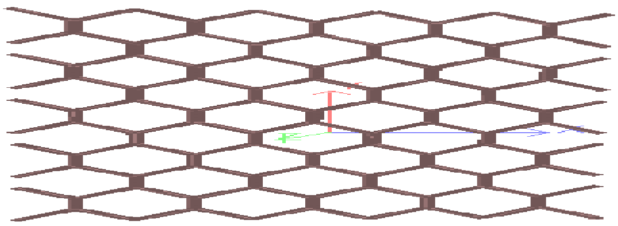
ABSTRACT
All over the world new innovations have been done by researchers so as to minimize the structural and environmental damage to the society. It has became a new trend to construct tall buildings with innovative design, Biomemitic structure is one of them which has some advantages over the conventional 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: *Honeycomb Structure, Strength, Innovations, Seismic behavior, Efficiency.*

1 INTRODUCTION

This type of structure is a biomemitic structure evolved from the inspiration of bee hive. The honeycomb structure consists of hexagrid system which is used as the exoskeleton to the conventional type building. This structure has many structural advantages apart from its aesthetic advantages. This technology is very environment friendly as it improves ventilation and direct sunlight. The peripheral part of the structure does not have brickwork. The outer hexagrid skeleton is enough to act as the outer wall of the structure. It has all the advantages which a glass facade structure has. The hexagrid used in the structure has all the element symmetrical and hexagrid used is horizontal type. The members of the structural hexagrid can be concrete or steel also. And size of each grid in exoskeleton is kept same it can also be varying with the height of the structure. This structure has number of windows so the stiffness is not obstructed by the windows. In major seismic zones of the world it seems from the literature that there is the need of more techniques which will be efficient enough to resist seismic forces. Every building built in this environment has to be enough resistance to carry vertical forces and horizontal forces.



2. OBJECTIVE

The objective of the project is to study the seismic forces which affects 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

3. 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 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.

4. 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 hexagrid will be analyzed for same loading conditions. The hexagrid system which will be optimized further. All the sizes of beam and columns are kept same in all the structures.

4.1 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.

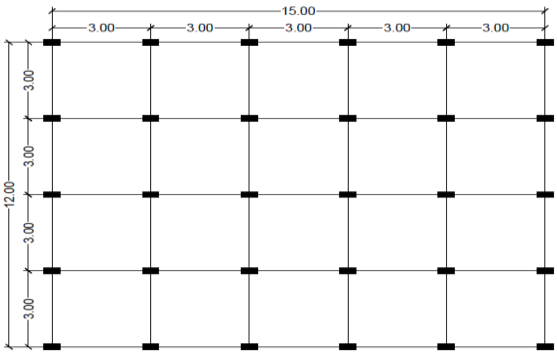


Fig. 1: Plan of the building used for analysis purpose with its column orientation

4.2 HONEYCOMB STRUCTURE AND OPTIMIZED STRUCTURE

- All the sizes of beams, columns and slab in case of honeycomb structure is same as in case of conventional structure.
- The hexagrid is made up of concrete section of size 200 mm X 200 mm. Initially the hexagrids where placed in such a way there are 4 or 2 small hexgrids assembled between two column between a vertical floor to floor height of 3m.
- After optimization the hexagrids are placed such that between the vertical distance of 3m there is only one hexagrid between two columns. The assembly of hexagrid system is shown in the figure 2

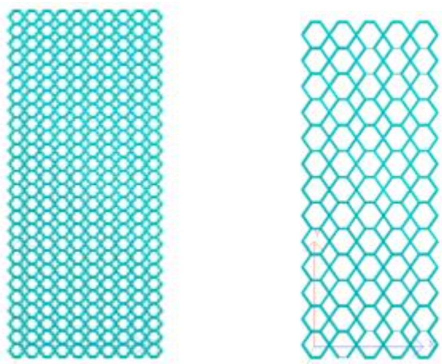


Fig.2: Difference in Hexagrid and Optimized Structure

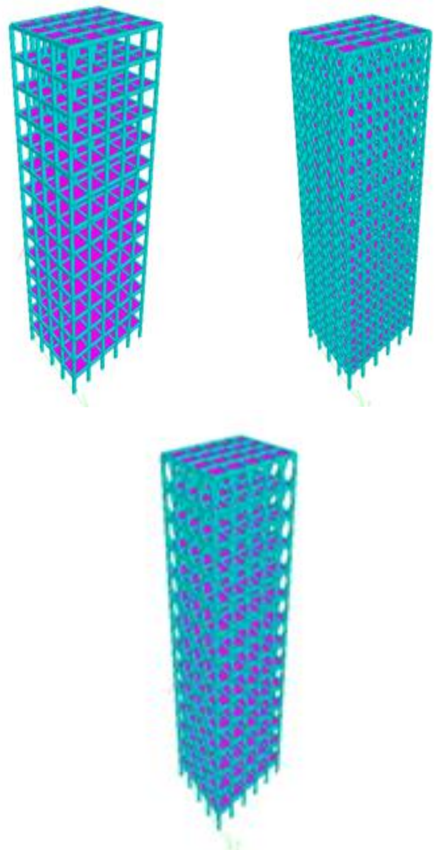


Fig.3: (a),(b),(c) is the 3D view of Conventional Structure,Hexagrid Structure,Optimized Hexagrid Structure.

4.3 DETAILS OF THE STRUCTURE:

A) Conventional Structure:

- The column sizes = 500 X 230 mm
- 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 case of Honeycomb Structure and Optimized Structure are kept same.

4.4 LOAD CASE DETAILS:

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

1) EQRX
2) EQRZ
3) DL
4) LL
5) RESPONSE SPECTRUM
6) 1.5DL
7) 1.5 (DL + LL)
8) 1.2 (DL + LL)
9) 1.2 (DL + LL + EQX)
10) 1.2 (DL + LL - EQX)
11) 1.2 (DL + LL + EQZ)
12) 1.2 (DL + LL - EQZ)
13) 1.5 (DL + EQX)
14) 1.5 (DL – EQX)
15) 1.5 (DL + EQZ)
16) 1.5 (DL – EQZ)
17) 0.9DL + 1.5EQX
18) 0.9DL – 1.5EQX
19) 0.9DL + 1.5EQZ
20) 0.9DL – 1.5EQZ

Where EQX stands for earthquake load in X direction

EQZ stands for earthquake load in Z direction

LL= Dead 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

Z=Zone is taken as IV

R=Response reduction factor is taken as 5

I =Importance factor is taken as 1

Sa/g, average response acceleration coefficient is taken for medium strata calculate as 1.25.

5. RESULT

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

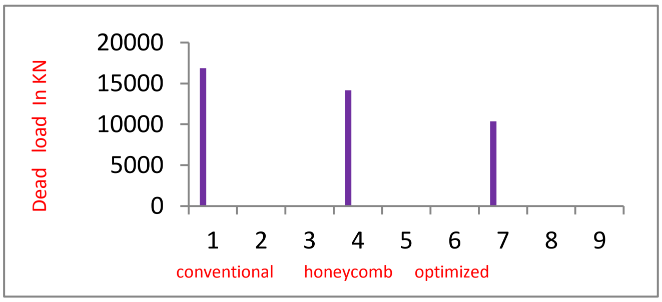


Fig.4: Graph 1 Comparison of dead load of all three type system.

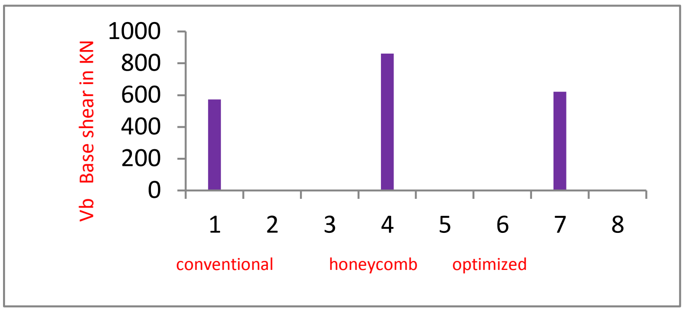
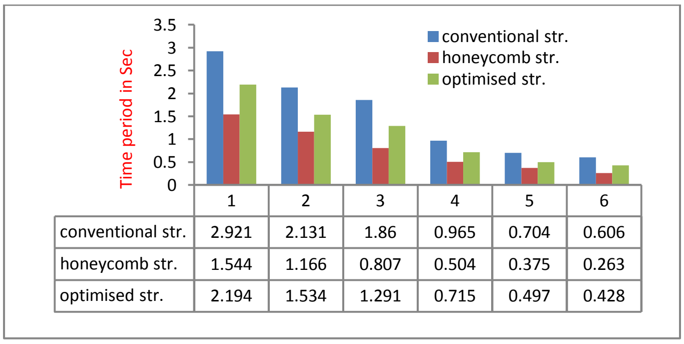
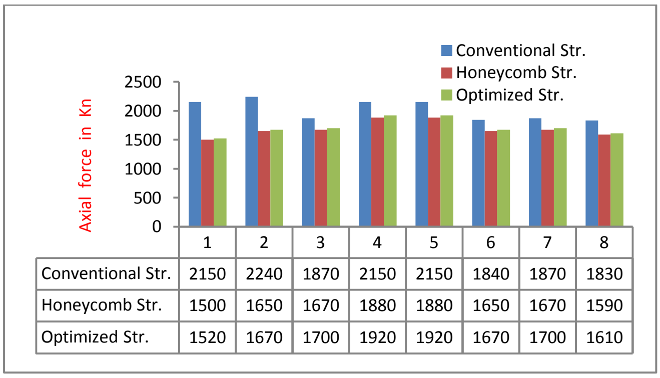


Fig.5: Graph 2 Difference of base shear of the structures



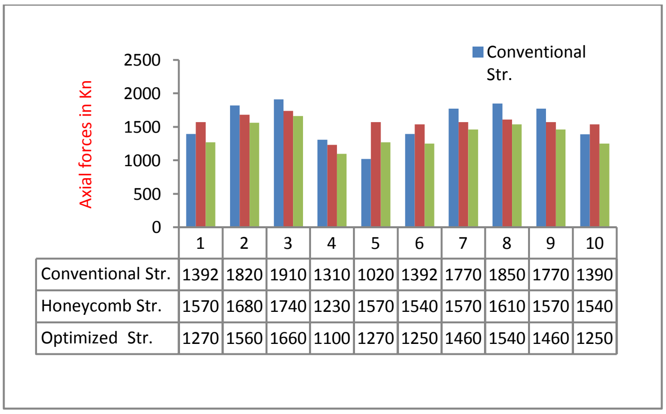
	1	2	3	4	5	6
conventional str.	2.921	2.131	1.86	0.965	0.704	0.606
honeycomb str.	1.544	1.166	0.807	0.504	0.375	0.263
optimised str.	2.194	1.534	1.291	0.715	0.497	0.428

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



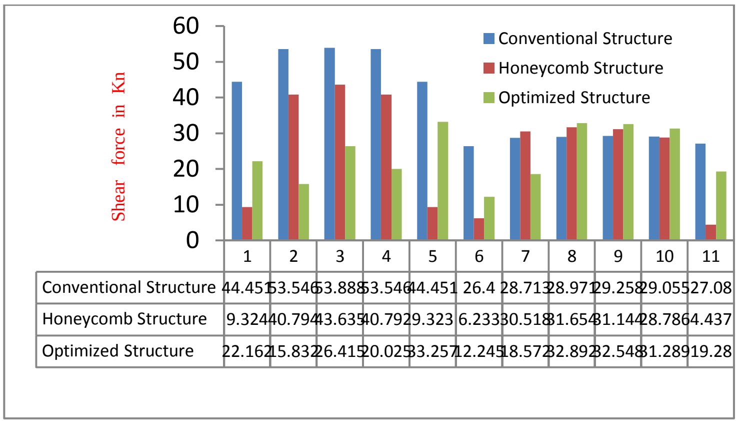
	1	2	3	4	5	6	7	8
Conventional Str.	2150	2240	1870	2150	2150	1840	1870	1830
Honeycomb Str.	1500	1650	1670	1880	1880	1650	1670	1590
Optimized Str.	1520	1670	1700	1920	1920	1670	1700	1610

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



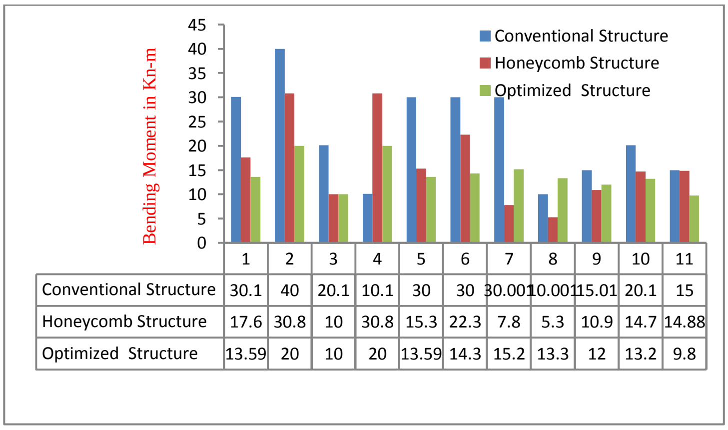
	1	2	3	4	5	6	7	8	9	10
Conventional Str.	1392	1820	1910	1310	1020	1392	1770	1850	1770	1390
Honeycomb Str.	1570	1680	1740	1230	1570	1540	1570	1610	1570	1540
Optimized Str.	1270	1560	1660	1100	1270	1250	1460	1540	1460	1250

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	44.451	53.546	53.888	53.546	44.451	26.4	28.713	28.971	29.258	29.055	27.08
Honeycomb Structure	9.324	40.794	43.635	40.792	9.323	6.233	30.518	31.654	31.144	28.786	4.437
Optimized Structure	22.162	15.832	26.415	20.025	33.257	12.245	18.572	32.892	32.548	31.289	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

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 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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