Seismic Behavior of Honeycomb Structure with Conventional Structure by using STAAD Pro

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Abstract— Tall buildings are very common these days because of the main advantage that these buildings use land very efficiently. The study is about honey combed system which also known as the hexagrid structural system used in tall structure construction. This paper deals with the technique and its effect on the normal conventional type structure. The response of the building with the seismic forces is studied. The comparative analysis is done by using software based results. All over the world new innovations are been done by researchers so as to minimize the structural and environmental damage to the society. This technique used in this paper is one of such newly evolved technique by using which a software based experiment is carried out to check the effect various seismic parameters are considered.
Key words: Honeycomb (Hexagrid) Structure, Seismic Behaviour, Efficiency

I. Introduction

The honeycomb structure consists of hexagrid system which is used as the exoskeleton to the conventional type building. This type of structure is a biomemitic structure evolved from the inspiration of bee hive. 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 sysmetrical 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.

II. Objective

The objective of the project is to check the seismic behaviour of hexagrid structure with respect to the conventional type structure. The response of the structure to earthquake forces and combination of forces such as combination of dead load plus live load plus earthquake load etc. the storey displacement of the structure, time period of the structure ,axial forces of the columns in the structure is to be studied. The effect of hexagrid after its optimization is also studied. And the results are to be compared with respect to the efficiency of each type of structure.

III. Scope

The conventional type structures is constructed of heavy materials . honeycomb structure uses natural energy very well it is advantageous just like of all glass building system also. This structure is very rigid type so the seismic response is reduced on higher scale. If more technologies are evolved this type of structure can be constructed easily which will lead to the savings of resources and more usage on environmental energy. The degradation of society and environment due to structural damages due to disasters will be considerably reduced.

IV. Methodology

Methodology involves the analysis of G+9 building. The plan of the building chosen is rectangular type. The plan is kept same for all the three types of structures. The methodology of my project consists of transforming a conventional type structure into honeycomb structure. The plan of conventional type structure is shown in the figure. Structural analysis software has been used for dynamic analysis. The hexagrid system which is used will be optimized so as to make it efficient. All the sizes of beam and columns are taken same.

A. *About Conventional Type Structure*

The plan of the structure used in analysis is shown in the figure. Conventional type structure consists of following load. The seismic load is taken as per IS 1893 :2002 for zone IV , medium soil type is used, the type of structure is taken as ordinary frame so the response reduction factor is taken as 5. All the sizes of beam and columns are taken same for all the type of structure. All the live load and dead load is taken as per IS 875 . The density of outer brickwork is taken as 20 kN/cubic meter. The total height of the building is 27 meter above plinth level. The depth of foundation is taken as 2.4meters.

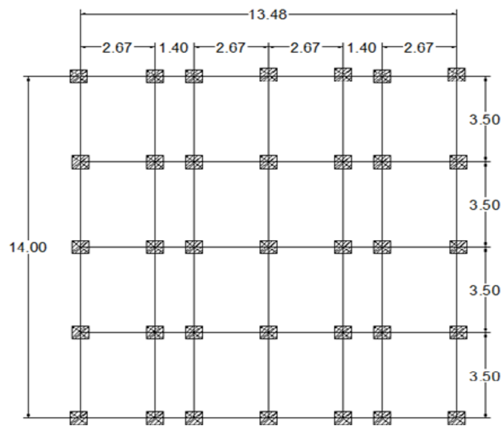

Fig. 1: Plan of the building used for analysis purpose with is column orientation

B. About Honey Comb (Hexagrid) Structure And Optimized Honeycomb Structure

- All the sizes of beams, columns and slab in case of honeycomb structure is as in case of conventional structure.
- The hexagrid is made up of concrete section of size 200 mm X 200mmInitially 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

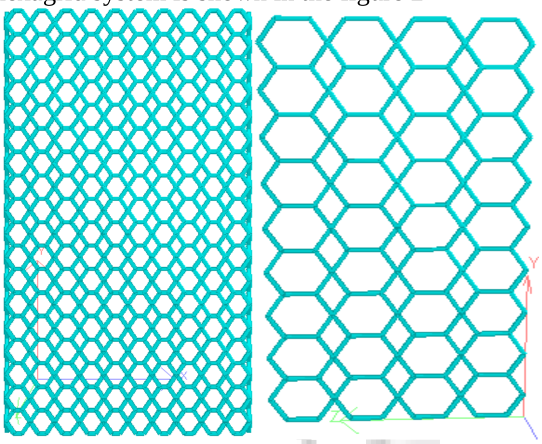

Fig. 2: Difference in the hexagrid after optimization

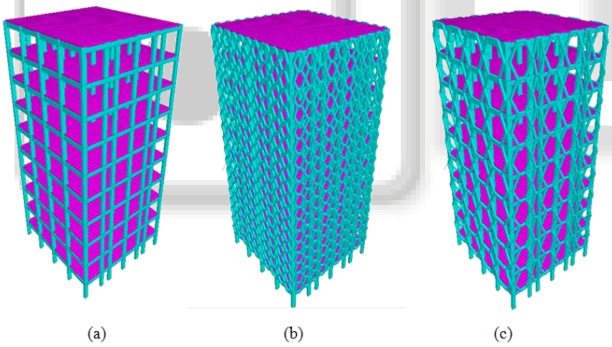

Fig. 3: (a),(b),(c) shows the 3D view of conventional structure, hexagrid structure, optimized hexagrid structure

V. RESULT

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

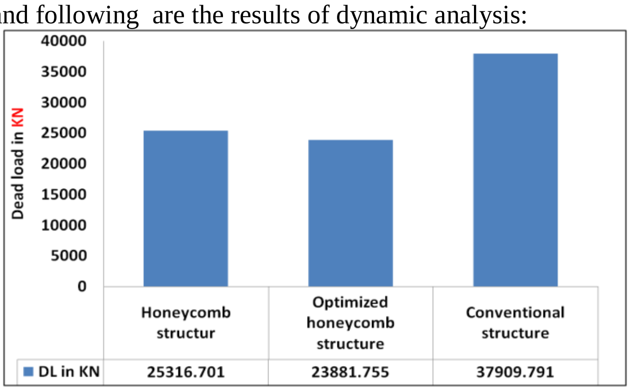

Fig. 4: Graph 1 Comparison of dead load (dl) by of the three type system

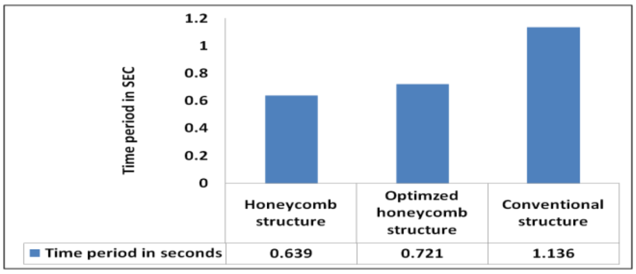

Fig. 5: Graph 2 Comparison of time period of structures

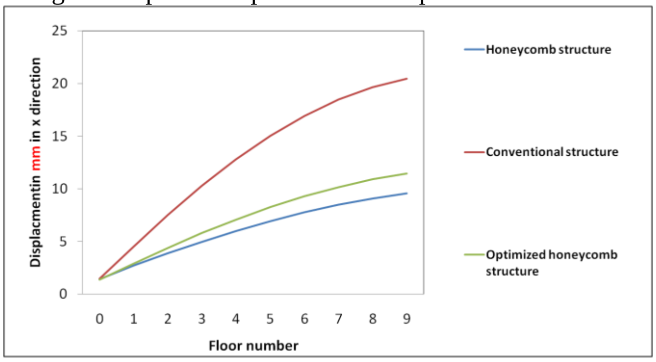

Fig. 6: Graph3 Comparison of floor displacement for earthquake horizontal force in negative x direction

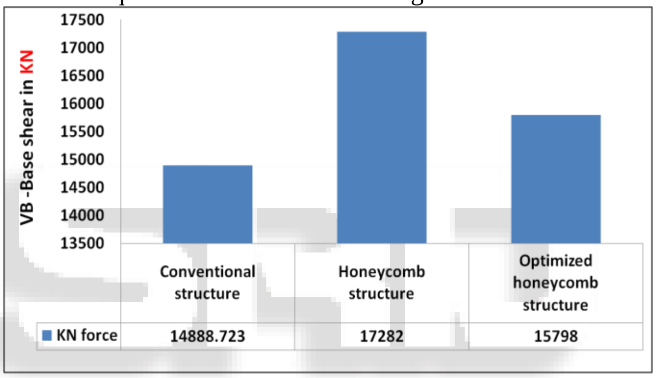

Fig. 7: Graph4 Difference of base shear of the structures

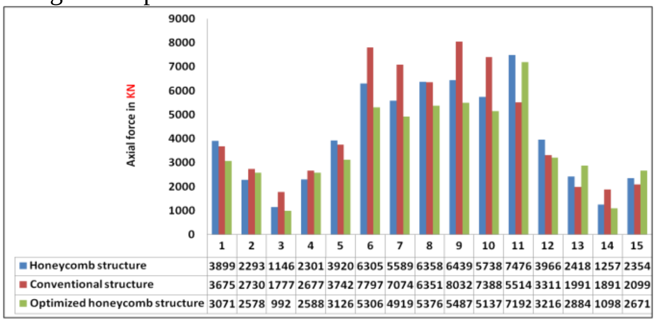

Fig. 8: Graph 5 Difference of forces of outer columns of the structure for critical loading

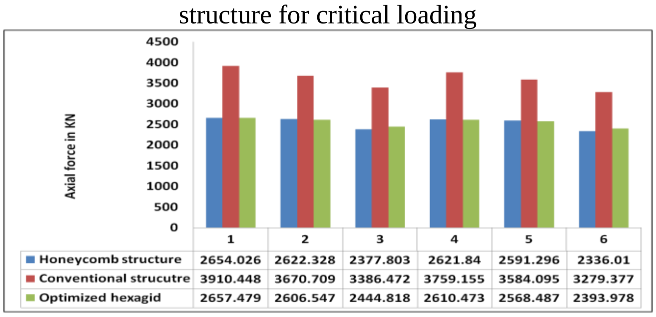

Fig. 9: Graph 6 Comparison of axial forces of inner columns of the structure for critical load combination

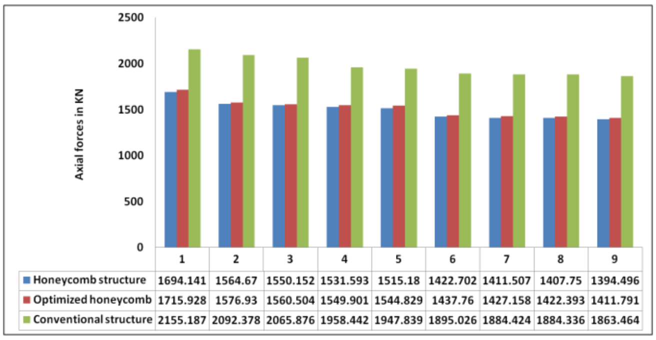

Fig. 10: Graph 7 Comparison of absolute axial forces of central columns of the structure for critical load combination

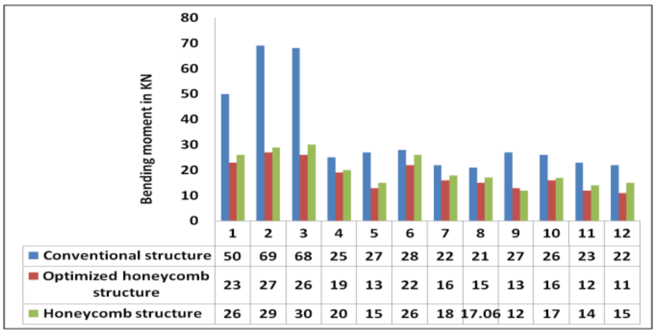

Fig. 11: Graph 8 Comparison of maximum absolute bending moment of all these mentioned three type of structures

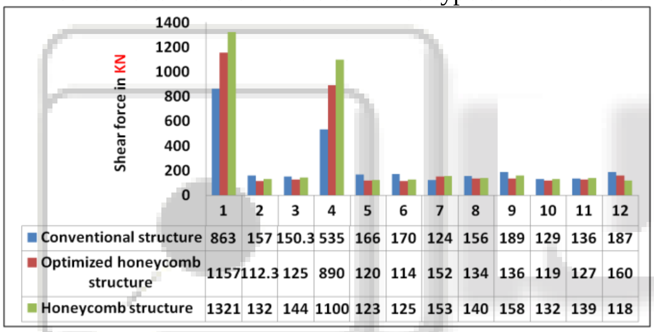

Fig. 12: Graph 9 Comparison of maximum absolute shear forces for all the type of structure

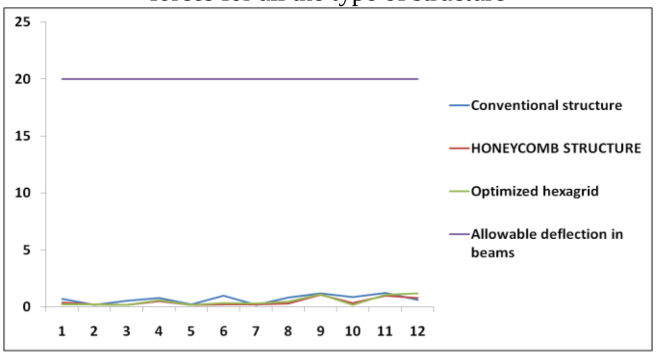

Fig. 13: Graph 10 Comparison of maximum absolute shear forces for all the type of structure

VI. Conclusion

– •The dead load in case of honeycomb structure is less than conventional structure is found to be less By 33% and after optimization it is found to be less by 38%
– •The time period in case of honeycomb structure is reduced by 50% and after optimization it is found to be less by 30 % as compared to conventional type structure.
– The most critical load combination for all the outer columns is found to be load case 9 ie; 1.5 X Dead load + 1.5 X earthquake load
– The average total difference in the axial force in outer corner columns is of 341 KN that is 6% more in honeycomb structure.
– After optimization of honeycomb structure the axial forces are found to be reduced in honeycomb structure by 300 KN ie 4% of conventional structure.
– In case of peripheral interior columns the axial forces are more in conventional structure by 511 KN that is by 11% And again it is reduced in case of honeycomb structure after optimization by 500 Kn that is 12%
– The total decrease in the axial forces in honeycomb structure is after optimization of all the out columns is 8%
– The total difference in the axial forces in case of honeycomb structure is 10642 KN less that of conventional structure. The difference is 28 %
– After optimization the axial forces are still are found to b less by 10412KN , the difference is found to be 26%
– Considering all the columns the axial forces in case of honeycomb structure is less by 22% that of conventional structure.
– After optimization the axial forces are reduced by nearly 30%
– The critical load combination of the exterior beams is found to be load case 9 ie; 1.5 X Dead load + 1.5 x earthquake load.
– The critical load combination for internal central 9 beams is found to be load case number 4
– 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.