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WIND EFFECT ON DIFFERENT STRUCTURAL CONFIGURATION AND ANALYSIS – A REVIEW

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Abstract - *The main intention of this review is to know the effect of wind on high rise building structures of different configurations. In modern high rise buildings, lateral load has great significance in design as the height of building increases, lateral load becomes more dominant than gravity load or vertical load of building. In this review paper, the comparison different types of lateral load resisting systems are discussed. Various shapes have been considered like L,T,U, circular Rectangular, square etc . Software's like E-TABS, STADD-Pro are used for analysis. For the analysis of gravity, live and wind loads codes are IS: 875 part-1, IS: 875 part-2, IS: 875 part-3 and for load combinations IS: 456 are used. The study mainly focuses on determining the most effective and economical system which can resist wind load and seismic load.*

***Key Words*: — Lateral load, Lateral displacement, E-TABs, Storey drift, Wind speed, Wind zone.**

1. INTRODUCTION

In modern world due to rapid growth in population and scarcity of land the high rise building is playing an crucial role in the development of any country. It shows the potential of the country in the development of Infrastructure. The recent trends in construction have given most importance to vertical growth, i.e., due to rapidly growing urbanization the land become very scarcer, to that the alternate is vertical occupancy. Most of the taller buildings are different in their design and aesthetics. In high rise buildings the lateral load has greater significance in design, as the height of the building increases lateral load becomes more dominant than gravity load or vertical load of building. Wind acts as a lateral load on multistory /high raised structures and it is the most powerful and unpredictable force affecting on tall buildings. Unlike live loads and dead loads, wind loads change rapidly and even abruptly with time. Due to this lateral displacement is occurred, if neglected there will be structural damages. Wind forces can break the building's load path or punch a hole in the building envelope. Sometimes the actual force of high winds can cause a door or window to break open. As per Indian standard Code 875 (part 3) 1987, the basic wind speed is specified in map as well as categorized in several zones. Wind pressure mainly depends on exposed area of multistory or buildings in opposite to wind direction. Wind pressure or force is exerted homogeneously on all faces on the building. The higher the structure, the greater the force as wind influences lesser by friction with respect to the earth and nearby topography, therefore analyzing wind load is a greater contest for high-rises. The study of wind effect was first limited to loading on buildings and structures only, possibly because of its most dramatic effects are seen in their collapses.

2. SCOPE AND SIGNIFICANCE

The main objective of this work is to contribute to the development of the design guidance for high rise buildings in relation to different shapes of building to control wind excitation load as a reference for architects, engineers, developers, and students. In this research, the concept of high rise building, which include the definition, basic design considerations, and lateral loads; shape modifications of tall buildings, are studied. Then the results for different conditions are interpreted and conclusions are made as to which shaped buildings out of four taken in the consideration is most stable. Further work can also be done on more complicated shapes of buildings and come to conclusion as to which is most stable and economical shapes under given condition for wind and loads.

3. LITERATURE REVIEW

(Abhay Guleria 2014): Presented the analysis of multi story RCC building for different plan configuration. The analysis has performed for the earthquake loads. The specification of lateral loads has been taken from IS 1893 (Part 1)-2002. The modeling and analysis has done by using finite element based software ETABS. From the analysis and results, they conclude that the effect of shape is very important. And also they compare the result of different plan configuration buildings such as story shear, overturning moment, story drift, story displacement and mode shapes. In addition, this study suggests that L-shape and Ishape structure gives almost similar response against overturning moment, story drift, and Story displacement.

(Anupam Rajmani and Priyabrata Guha 2015): The main objective of this work is to contribute to the development of the design guidance for high rise buildings in relation to different shapes of building to control wind excitation and earthquake load as a reference for architects, engineers, developers, and students.In this research, the concept of high rise building, which include the definition, basic design considerations, and lateral loads; shape modifications of tall buildings, are studied. Then the results for different conditions are interpreted and conclusions are made as to which shaped buildings out of four taken in the consideration is most stable. Further work can also be done on more complicated shapes of buildings and come to conclusion as to which is most stable and economical shapes under given condition for wind and earthquake loads. A tall building, whose shape is unsuitable, often requires a great deal of steel or a special damping mechanism to reduce its dynamic displacement within the limits of the criterion level for the design wind speed. hence for this research work four shaped buildings are generally studied namely circular, rectangular, square and triangle For 15 storied building the most stable structure is circular shape and triangular shape for maximum earthquake and maximum wind load respectively, similarly for 30 storied building, rectangular shape is most stable for maximum earthquake and wind load and for 45 storied building circular shape & rectangular shape is most stable for maximum earthquake and wind load respectively.

(Shaikh Muffassir and L.G. Kalurkar 2016): The reinforced concrete structures are mostly used from many decades because of its stiffness, most convenience, high durability and ease to construct. The multi story high rise RCC structures are more bulky and less ductile in nature as compare to composite structures. This study investigates the comparison between RCC and composite structure under the effect of wind, additional to it composite structure also includes different plan configurations. In this study total fifteen number of building model are prepared and analysis for wind load by using ETABS 2015. The primary objective of this study is to determine the most effective shape under complex wind environment and also to determine the effective structure between RCC and Composite. This paper overviews the entire effect of wind on high rise structure and detailed study of current challenges due to wind. In this paper work, steel-concrete composite has used instead of RCC and compare both for different parameter such as, story displacement, story stiffness, base reaction, maximum bending moment in columns and time period. In addition, the composite beam mainly subjected to bending and is a composite of steel section and concrete deck. Due to high susceptible and ductility of steel material it leads to effective in wind load resistance. Wind analysis has performed for different story of composite buildings such as (G+5), (G+15) and (G+25) and also for different plan configuration. In this study the composite structure has used because the composite column made up concrete encased hot rolled steel section which increased strength for a given cross section dimension, stiffness and susceptible to lateral loads. The main purpose of this study, to perform the wind analysis of composite structure and estimating the parameter for wind load effect. A composite building having plan dimension 15 X 15m in square shape and RCC building having plan dimension 15 X 15m in square shape has taken for comparative study. The comparative study conclude that the composite structure are larger ductile in nature as compare to RCC structure and having parameters within acceptable limit. Composite structure are more susceptible to wind effect than the RCC structure therefore composite structure are preferable for wind prone zone. Composite structure provides large space for utilization and economical with high durability and rapid erection. The study of different shape of composite structure conclude that H-shape and U-shape type buildings gives almost same response for (G+5) building but however at (G+15) and (G+25) the parametric response of U-shape buildings abruptly changes as compare to other shapes. The result of different shape of composite buildings suggest that the rectangular shape building is more preferable in wind prone zone compare to other shape buildings.

(Megha Kalra, Purnima Bajpai and Dilpreet Singh 2016): This analysis was conducted to study about wind analysis of G+49 storied building having different uniform and non-uniform plan shapes by using STAAD Pro software & IS 875-Part III. The comparison has been done by taking into consideration different parameters such as storey drift, node displacement, intensity of shear & bending moment. It came to the conclusion that L-shape and U-shape was more efficient while dealing with the wind force.

(Alkesh Bhalerao and S.B. Shinde 2016):

The study involves different high rise structures used generally for residential, commercial and hospital building, which is typically square shape, rectangular shape, U-shaped building and Bundled tube symmetric RCC structure. The study is focused for G+ 25 structures built in RCC material, the object of study to find displacement in structure and story drift in all the structure mentioned. The displacement and drifts performance in wind prone zone. The study also important to design proper section using ETABS software. Result are analysed for Effective structure in wind lateral load prone zone. RCC structure is preferred for stiffness and durability in high rise structure. The study concluded that the effective shape for to resist wind lateral load is rectangular shape structure for G+25 consideration. Generally symmetrical structure is preferred for high rise structure but in this case square shape found to be less stiff compare to rectangular structure in wind load consideration. The structure in RCC made bulky and less economical but more rigid and durable in nature. U-shape structure is not preferred as it gives the maximum displacement and maximum drift due to its geometric shape most susceptible for wind load. Bundled tube symmetric RCC structure is need to analysed for special provision and improved cladding surface to attain optimised result.

(Potnuru Avinash, Shaik Yajdani 2017): The present study describes the effect of wind on multi-storied building. It deals with the analysis of G+15 multi-storied framed structure for different plan configuration i.e. Rectangular, I-shape, C-shape and L-shape building plan configuration are considered. The basic wind speed considered is 50m/s. For the analysis the software tool is used i.e. E-TABS. Different load combinations considered and compared the results of Lateral Displacement, Base shear, Over-turning moment, Torsion etc.., for all four models and concluded that which one is the best configuration among them. In analysis for gravity, live and wind loads used codes are IS: 875 part-1, IS: 875 part-2, IS: 875 part-3, for load combinations used IS: 456, Compiled all the results and tabulated. Carryout analysis of a multi-story building subjected to wind load by considering a Rectangular Building, L-shape Building, C-shape Building, I-shape Building. All buildings have 15 stories with plot area of 40.1574mX40.005m. To ensure that the structure is safe against all possible loading conditions and to fulfill the function for which they built. To present the factors which are taken into account in the analysis of multi storied Building and the methods, which can be adopted. To gain a better understanding of the structure behavior under the action of the applied loading. To check for the best plan of a building among three different shapes in certain design specifications. To illustrate the decrease in lateral displacements using shear wall. From the results and graphs it is inferred that the lateral displacement for all load combinations is increasing with the increase in asymmetry of plan. From the results it was interpreted that the Overturning moment is less for Rectangular shape and very high for L Shape plans. Maximum Shear force in a beam is changing drastically between rectangular and L Shape. It was found that the maximum shear force has been increased to 23.41% in case of L shaped plan when compared to the rectangular plan. Maximum Bending moment in a beam for different load combinations is differ by 17.2% to Rectangular and L shape building. It is inferred that the moment in columns are doubled when compare with rectangle and L shape building. Lateral displacement in L Shape building is decreased by nearly 55% for all combinations by providing Shear wall.

(Jayant Shaligram and Dr. K.B Parikh 2018): Paper mainly focuses on determing the most optimal system which can resist the wind load and seismic load. They concluded that for 10-20 storeys building steel bracings can be used for lateral load resisting system and also for storeys between 20-35 can be used for lateral load resisting system. And hence the most effective and economical for the high-rise building having greater than 35 is diagrid system, it also gives flexibility in planning of building space and elevation of the building.

(Shoeb Najad N, Anjali Sudhakar and Shiv Shankar Nair 2019): Wind power is a key component of renewable energy utilisation. The execution of building integrated wind turbines contributes positively to the environment as a climate change mitigation option. Built in environment wind turbines are those located in an urban or suburban environment. They can be integrated into a building and included in the building design from architectural, structural, and economic perspectives. The application of BEWT systems to high-rise buildings can be done in different ways. Five different ways by which turbine can be installed to buildings are discussed in this paper. Static and dynamic analysis are done for this models. And the behavior of the buildings are studied. Using ANSYS 19.1, both static and dynamic structural analyses were performed. The scope of the work presented in this thesis is the static and dynamic analysis of building integrated with wind turbine structure subjected to loading due to the dynamic action, external pressure, earthquakes etc. Five cases of building integrated with wind turbine are analysed based on ANSYS finite element software. To choose the position of wind turbine, it placed and the structural modifications required in order to make this new structure meet the structural requirements better. To study the sudden changes of building occurred due to an earthquake. From the dynamic analysis performed for different cases it was concluded that model 5 is the optimized model.

(Shivendra Nath Mishra and Prof. M.C. Paliwal 2019): The main intention of this project is to find the effect of wind while designing a multi-storey Building of G+6 floors in 3D frame by using Staad-pro software. The design procedure used in the software analysis are Indian standard code of practice associated with limit state design method. The least requirements for structural protection of buildings are being covered by way of putting down the minimum design loads which should have to be understood for imposed loads, dead loads and further external loads. Hence after design in post processing mode, we can perform analysis on structure and study about bending moment, shear force, axial loads, and deflections on different part of the structure. In this study we focused on deflection values on different nodes situated on different part of the structure like interior, edge and corner. When wind load is applied along the length of the building frame displacement for rectangular frame is very high when compared to square shaped frames and maximum value of displacement was obtained at the edge of the structure. When wind load is applied along length of the building the displacement value was increased with increased aspect ratio (length/width) of building. The value of maximum bending moment in top floor beams in z direction was more in case of square plan configuration as compared to rectangular plan configuration when wind load was applied in x direction. In rectangular plan configuration the displacement value was 30 to 45% more in z direction as compared to x direction.

4. CONCLUSION

Hence it is clear that from the above mentioned research papers RCC structure is preferred for stiffness and durability in high rise structure. Generally symmetrical structure is preferred for high rise structure than the asymmetrical structures. It is observed that lateral displacement is more for asymmetrical structures. The structure in RCC made bulky and less economical but more rigid and durable in nature. From the results and graphs it is inferred that the lateral displacement for all load combinations is increasing with the increase in asymmetry of plan. It was also inferred that Base shear and Torsion remains unchanged irrespective to the plans. The story displacement varies with increase in height the maximum bending moment in columns has been evaluated for RCC and composite structure for different number of stories and also for different shape of composite buildings. It is observed that the stiffness of RCC structure is greater than the composite structure but for (G+25) building the stiffness of RCC structure is slightly less than Composite structure. The parameter study show that the effect of wind load on multi story structure is accountable for high rise structure and also depends on shape of buildings.

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6. REFERENCES

[1] Anupam rajmani,Prof. Priyabrata Guha,February 2015:"Analysis of Wind and Earthquake Load for Different Shapes of High Rise Building", International Journal of Civil Engineering And Technology(IJCIET),ISSN 0976-6308,ISSN 0976-6316, Issue 2,Volume-6.
[2] Alkesh Bhalerao, S.B. Shinde, Dec. 2016:"Effect of Structural Shape on Wind Analysis of Multistoried Rcc Structures"; International Conference On Recent Trends In Engineering, Science and Management (ICRTESM-16), ISBN:978-93-86171-12-2.
[3] Abhay Guleria 2014:" Structural Analysis of a Multi-Storeyed Building using ETABS for different Plan Configurations"; International Journal of Engineering Research and Technology(IJERT),ISSN 2278-0181,Issue 05,Volume-03.
[4] IS: 875(Part 3)-1987, Indian Standard Code of Practice for Design loads (other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, New Delhi.
[5] IS: 456(2000), Indian Standard Code of Practice for Plain and Reinforcement concrete (Fourth Revisions), Bureau of Indian Standards (BIS), New Delhi.
[6] Jayant Shaligram, Dr. K.B Parikh, February 2018: "Comparative Analysis of Different Lateral Load Resisting Systems in High Rise Building for Seismic Load & Wind load: A Review", International Journal for Research in Applied Science & Engineering Technology (IJRASET**),** ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887, Issue-2, Volume-6.
[7] Megha Kalra, Purnima Bajpai and Dilpreet Singh, 2016: "Effect of Wind on Multi Storey Buildings of Different Shapes" International Journal of Science and Technology (IJST), Issue 48, pp. 1-5, Vol. 9.
[8] Potnuru Avinash, Shaik Yajdani, August 2017: "Comparative Study of Different Plan Configuration Buildings using Wind Analysis", International Journal of Science Technology & Engineering (IJSTE), ISSN (onlin e): 2349-784X, Issue-2, Volume-4.
[9] Shaikh Muffassir, L.G. Kalurkar, Jul-Aug. 2016: "Comparative Study on Wind Analysis of Multi-story RCC and Composite Structure for Different Plan Configuration" , IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684,p-ISSN: 2320-334X, Issue-4 Verve,Volume-13.
[10] Shoeb Najad N, Anjali Sudhakar, and Shiv Shankar Nair,Oct 2019: "STATIC AND DYNAMIC ANALYSIS OF WIND ENERGY BUILDING UNDER THE ACTION OF WIND LOAD USING ANSYS", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056 p-ISSN: 2395-0072, Issue-10, Volume-6.
[11] Shivendra Nath Mishra, Prof. M.C. Paliwal, Nov 2019 :"WIND LOAD ANALYSIS FOR DIFFERENT CONFIGUARTION OF STRUCTURES", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056 p-ISSN: 2395-0072 Issue-11, Volume-6.