International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 12 | Dec 2019 www.irjet.net p-ISSN: 2395-0072

Comparative Study on Seismic and Wind Performance of Multi-Storeyed Building with Plan and Vertical Irregularities - A Review

Bilal Ahmad Lone[1], Jagdish Chand[2]

[1]PG Student, UIE-Civil Engineering, Chandigarh University, Mohali, Punjab, India.
[2]Associate Professor, UIE -Civil Engineering, Chandigarh University, Mohali, Punjab, India.

Abstract*: It is a big challenge that tall buildings must withstand the various forces acting from different directions and aspects such as seismic and wind forces. While designing tall structures it is mandatory to deeply understand the seismic and wind behavior of multi-story buildings. Present study deals with the literature review on the behavior of the seismic and wind performance of regular and irregular structures by changing height and terrain category on different structures. The modeling and analysis of the previous structures were studied in perceptive of their shapes and zone-V. The buildings are modeled and analyzed by using ETABS software. Seismic analysis as per IS 1893-2016 and wind analysis as per IS 875 Part 3 was studied. Different types of parameters such as storey drift, storey displacement, base shear, overturning moment, acceleration and time period were studied. It has been found from the previous study that difference between the regular and irregular models gave variation in the displacement, drift due to the lateral forces acting on both types of buildings.*

Keywords: Multi-storey building, seismic analysis, storey displacements, storey drift, overturning moment.

Introduction

Wind load and seismic load plays an important role while designing tall structures because remaining all other loads have variations in a very small margin, the present study deals with the seismic and wind load effect of a regular and irregular multi-story building. If a building is designed with high resistance towards wind the structure will become more expensive. To keep the proper balance between the economy and safety it is compulsory to deeply understand the relation between the behavior of buildings subjected to wind force acting on the buildings.

The wind has two important components, static and dynamic. The dynamic character of wind contains mean wind velocity and varying gust velocity. It is important to consider while designing high rise buildings the resistance against wind are not too much, high rise buildings are weak in resistance against wind. Tall structures are the major projects during designing they need vailed logistics and should be well managed. Proper arrangement of structural components and the shape of structure minimize the lateral displacement and decrease the overall cost of structures.

The standard method for the design of tall buildings in the past was in the form of rectangular shape, mostly but nowadays much more complex geometries are in practice. Tall structures consider four main important factors such as stiffness, ductility, regular and simple structure, and ample lateral strength. Regular geometry structures in plan and elevation possess less damage than the irregular configuration. According to IS1893-2016, a building should be irregular when it is not symmetrical and have a discontinuity in geometry, mass, or load, these irregularities create problems in action of forces and stress distribution. Structure analysis plays a vital role to determine the behavior of the structures which are subjected to some action. Wind, waves, traffic, earthquake, and blasts are dynamic loads, if dynamic loads are applied on a structure, performance of the structure get decreased under severe seismic loading due to structure symmetry, due to asymmetry of structure member forces increased and ultimately structure collapsed

Concept of regular and irregular configuration The latest earthquake codes differentiates regular and irregular structures in terms of shape and size of the structure, assigning of the structural and non-structural components within the structure, and mass distribution of the structure.

Plan Irregularity A symmetric or plan irregular structures are both translational and torsional and results in stiffness and mass eccentricity in the structure. Because of uncertainty in the evaluation of the center of mass and stiffness, inaccuracy in the dimensions of structural elements, asymmetry may exist in a normal symmetric structure.

Vertical irregularity It is caused in the building due to the unbalance distribution of mass and stiffness along the elevation. Mass irregularity and stiffness irregularity are due to abrupt change in mass and stiffness in the vertical direction of floors

2. Literature review

Sneha b jagdale et.al conducted a study on "comparison of seismic and wind load performance of regular and irregular RC multi-story building" Regular and irregular RC structure has been selected in Zone-III and Zone-V with storey height of (g+30), these zones are selected according to IS-1893-2002, Wind load and self-weight are selected according to IS 875-2015 for analysis of the structure. Out of two buildings that are selected for analysis, one was regular and another was geometric irregular structure. It has been concluded that base shear was found 16-27 % more for regular structure concerning irregular structure for selected zones. Story drift was more in Zone -V compared to Zone-III, as wind speed increases story drift also increases in all models. Storey drift in Zone-V was found greater than Zone-IV because Zone-V is critical for high rise buildings due to a high magnitude earthquake.

Kiran Kumar's et.al conducted a study on a comparative study of wind load on buildings with different symmetry. Tall buildings have their drawbacks such as lower resistance to wind and seismicity. The shape of buildings plays an important role; some buildings shapes are weaker than others. Non-angular shapes possess greater resistance against the wind as compared to angular shapes and angular shapes which are similar to circle such as hexagon, octagon also performs well. It has been concluded that non-angular shapes are more efficient than angular shapes against the wind loads because angular shapes divert more wind with a large angle than a non-angular shape.

T. Jayakrishna k studied a multi-storey residential building against earthquake and wall loads by using a response spectrum method in Staad pro software. Dynamic analysis was carried out for regular models and irregular models to find out storey drift and storey displacement. In regular model lateral displacement was found less and base shear has remained the same for regular and irregular models.

Vinay Verma et.al analyzed by the response spectrum method for seismic analysis. This method was based on ideal pre-defined data which is not real data collected from the existing real earthquake. It was concluded that moment corrosion and deflection in regular buildings were greater than irregular buildings, but buildings with regular corner gave more deflection where model 2 possess less deflection.

Kale1, S. et.al conducted a study on earthquake & wind analysis of structures. The study deals with the generation of various models by considering different shapes of the same area and these models were tested by using ETABS software following IS 875 Part 3 and IS 1893-2002 Part 1 and different types of buildings were designed and also finding the behavior of these buildings. The response spectrum method was used for finding dynamic effects. After analysis, it has been found that wind effect was critical for 45 storey building and the seismic effect was critical at 15 storeys and 30 storey building.

Shashi Kanth h et al., Studied the wind load analysis of regular and irregular buildings by using wind load as lateral loads and compared the results of displacements, base shear, storey drift for different models. It has been concluded that base shear for regular and irregular buildings experienced same base shear but has greater inter-storey drift. In case of geometric irregular structures showed higher displacements than the other three models.

Adarsh, S. et.al conducted an analysis of wind for multi storey buildings with the regular and irregular plan and concluded that the shape of the building plays an important role for storey displacement, it was dominant for storey drift, storey displacement, time period. The shape also protected wind effects. After analysis, it has been found that due to the shear wall overall performance of the structure can be influenced because the shear wall acts as a drift control structure element. Rectangular shape structures were found more resistant against the wind as compared to normal shaped structures.

Dawood et.al Included ASCE 7-05 Quasic static analytic process for determining the wind load on high rise RC building having height to width ratio less than 4(rigid building) in Maysan province. The basic wind speed for design should be selected according to Iraqi standards. It has been concluded that designed tables were obtained and covered all possible dimensions and elevations of buildings. The results and data have been incorporated in "Mayson province" and are being used by designers, engineers and researchers and local authorities.

A.k. Roy et.al Conducted a study on wind load on high rise buildings with different configurations. The current study deals with the effect of wind for framed structures with different plan shapes and outcomes are connected concerning allowable drifts of different buildings. It has been found that wind load on buildings was grater when it has a maximum exposed area and the wind pressure coefficient has been found greater in square plan shape and it was less in circular plan shape of the building.

Ravi Kiran et.al Conducted a study on 3 different models such as regular structures, plan irregular structures and vertical irregular structures to determine the stiffness of structure. Static and dynamic earthquake analysis were conducted by taking different zones. It has been found that displacement and drift were greater in regular structure as compared to plan and vertical irregular structure in all zones by using static and dynamic analysis and also find that base shear was more for regular structures than other structures.

V. Ajay Kumar et.al Conducted study on wind load analysis of different shapes of high-rise buildings, taking buildings of 40,60 and 80 storeys should be designed for various shapes of building i.e. Rectangular building, rectangular building with rounded corners, square building, square building with rounded corners, circular building and elliptical building and analysis was carried out by Staad pro software. Wind load was estimated by IS 875 part 3, it has been concluded that rounding of corners decreases bending moment at an average of 70% than regular shape corners.

Conclusions

From the above review, it has been concluded that a lot of research work has been done on seismic and wind analysis of high rise regular and irregular structures, containing plan and vertical irregularity by using ETABS software.

Based on different journals and research papers the following conclusions were withdrawn.

1. The dynamic effect of buildings was studied by symmetrical configuration and not performed for unsymmetrical configuration,
2. Storey drift, storey displacement, overturning moment, base shear and time period are the important parameters for analysis and to interpret the results.
3. The analytical work justifies the behavior of regular structure with a plan and vertical irregularity structure.
4. The seismic and wind analysis of regular and irregular structures helps out to find the required height of the tall buildings in Zone-V.
5. As shape changes, displacement increases and lateral load-carrying capacity also changes, so the shape of the building plays an important role in the design of the stable structure.
6. Non-angular shape posse's greater resistance against the wind as compared to angular shape structures because non-angular shapes have variations in mass distribution.

References

1. Dawood Abbas Oda "Design Loads on High-Rise Reinforced Concrete Buildings in Maysan Province Southern Iraq" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 6, Issue 7, July 2017.
2. Kiran Kumar. U, Dhiyaanesh "Comparative study of wind load on buildings with different symmetry" International journal of pure and applied mathematics, Volume 119, Number 16, 2018.
3. Kale S. A, Rasal "Seismic & Wind Analysis of Multi-storey Building" International Journal of Science and Research (IJSR) ISSN, Volume 6, Issue 3, March 2017.
4. Shashiknath, Sanjithj, darshan "Analysis of vertical geometric irregularity in RC structure subjected to wind load" International Journal of Scientific Development and Research (IJSDR), Volume 2, Issue 9, September 2017.
5. Sneha Jagadale. B, Pujari A. B, "Comparison on the Effect of Earthquake and Wind Load on Performance of Regular and Irregular RC Multi-storey Building" International Journal for Scientific Research &Development. 6, Issue 05, 2018.
6. Akhil R, Aswathy S, Kumar "Seismic analysis of regular and irregular buildings with vertical irregularity using Staad.pro" International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 06, June-2017.
7. Niveditha M P, Sunil R "Seismic analysis of regular and irregular buildings with and without shear wall" International Research Journal of Engineering and Technology (IRJET) Volume 05 Issue: 07, July 2018.
8. Roy A. K, Ankur Sharma, Bijayananda Mohanty and Jagbir Singh 'Wind Load on High Rise Buildings with Different Configurations" International Conference on Emerging Trends in Engineering Innovations and Technology Management NIT Hamirpur, India. December 16-18, 2017.
9. Ajay Kumar. V, Vamsi Krishna. B, Kameswara Rao. M" Analysis of Wind Load Effects like Deflection, Bending Moment andAxial Forces on Different Shapes of High-Rise Buildings" International journal & Magazine of engineering technology, management, and research, Volume number 2, Issue number:10, October 2015.
10. Adarsh S B, Sridhar R" Study on Wind Analysis of Multi-Storied Building with Regular and Irregular Plan "International Journal of Advanced Research in Engineering & Management (IJAREM), Vol. 03, Issue 07, 2017.

11. Ali M.M and Kodmany, "Tall Buildings and Urban Habitat of the 21st Century", A Global Perspective Buildings, volume 2, No. 4, pp 384–423, 2012.
12. Cluni.F, Gusella.V, Spence S.M.J, and G. Bartoli, "Wind action on regular and irregular tall buildings" Higher-order moment statistical analysis by HFFB and SMPSS measurements, Wind Engineering journal, volume 99, No. 6–7, pp. 682–690, 2011.
13. Lin.N, Letchford.C, Tamura. Y, Liang. B, and Nakamura.O, "Characteristics of wind forces acting on tall buildings," Wind Engineering journal, vol. 93, no. 3, pp. 217–242, 2005.
14. Asghari Mooneghi.M and Kargarmoakhar.R, "Aerodynamic Mitigation and Shape Optimization of Buildings "Building Engineering journal, volume 6, pp. 225–235, 2016.
15. Revuz.J, Hargreaves.D. M, and Owen. J. S, "Domain size for the steady-state CFD modeling of a tall building," Wind and Structures an International Journal, vol 15, No. 4, pp. 313–329, 2012.
16. Yi. J and Li.Q.S, "Wind tunnel and full-scale study of wind effects on a super-tall building," Fluids Structures journal, volume 58, pp. 236–253, 2015.
17. Sevalia.J. K, Desai.A. K, and Vasanwala.S. A, "Effect of Geometric Plan Configuration of Tall Building on Wind Force Coefficient Using CFD," Advance engineering research study journal, No. 2, pp. 127–130, 2012.
18. Young-moon K.I.M, Ki-pyo.Y.O. U, and Jang-youl.Y.O. U, "Across and along-wind responses of tall building," Central south university journal, vol. 21, pp. 4404–4408, 2014.
19. Rajmani.A, Road.N, Guha.P. P, "Analysis of Wind & Earthquake Load For Different Shapes of High-Rise Building," IJCIET, vol. 6, No. 2, pp. 38–45, 2015
20. IS 875 (Part 3), Indian Standard Design Loads (Other than Earthquake) for Buildings and Structures Code of Practice, Part 3 Wind Loads, New Delhi, Bureau of Indian Standards,2015.
21. Mashalkar.B. S, Patil.G.R. and Jadhav A.S, "Effect of Plan Shapes on the Response of Buildings Subjected to Wind Vibrations," IOSR-JMCE, volume 1, pp. 80–89, 2015.
22. Saad.L and Jamkar.S.S. S, "Comparative Study of Wind Load Analysis of Buildings of Various Shapes and Sizes as per IS 875 (Part 3) and ASCE Journal," Vol. 5, No 5, pp. 3–8, 2015.
23. Dutta.S.C and Halder.L, "Wind effects on multi-storied buildings, a critical review of Indian codal provisions with special reference to the American standard," Asian Journal, volume-11, No. 3, pp. 345–370, 2010.
24. Anupam Rajmani, Priyabrata Guha," Analysis of wind & earthquake load for different shapes of high-rise building, International Journal of Civil Engineering and Technology (IJCIET), Volume 6, Issue 2, pp. 38-45, February 2015.
25. Pardeshi Sameer, Gore.N.G," Study of seismic analysis and design of multi storey symmetrical and asymmetrical building", International Research Journal of Engineering and Technology, Volume 03 Issue: 01, Jan-2016.
26. Sanhik Kar Majumder, Priyabrata Guha, "Comparison Between Wind and Seismic Load On Different Types of Structures", International Journal of Engineering Science Invention, Volume 3, Issue 4, April 2014, pp.41-54,2014.
27. Tanveer Asif Zerdi, Mohammad Tayyab Ali, Mohammed Shahid Ali Aejaz and Mudassar Jamal," Seismic Analysis of Multi-Storeyed Building (G+15) With Regular and Irregular Frame Structure", Indian Journal of applied research, Volume- 6, Issue 5, May 2016,2016.
28. Raghavendra Singh, Sumit Pahwa, Ambar Gupta, "Seismic behavior of buildings having vertical irregularities", Universe of Emerging Technologies and Science, Volume I, Issue V, October 2014.
29. Ravi Kumar.C.M, Babu Narayan.K. S, Prashanth.M.H, Manjunatha.H. B and Venkat Reddy.D," Seismic performance evaluation of RC buildings with vertical irregularity", ISET golden jubilee symposium, Paper No. E012.2012.
30. Rama Raju.K, Shereef.M. L, Nagesh R Iyer, Gopalakrishnan.S, "Analysis and design of RC tall building subjected to wind and earthquake loads", The Eighth Asia-Pacific Conference on Wind Engineering,2013.
31. Reddy.K.R.C, Sandip A. Tupat, "The effect of zone factors on wind and earthquake loads of high- rise structures", IOSR Journal of Mechanical and Civil Engineering, pp 53-58,2014.
32. Mahesh.S and Panduranga Rao.M," Comparison of analysis and design of the regular and irregular configuration of a multi-Storey building in various seismic zones and various types of soils using ETABS and STAAD", IOSR Journal of Mechanical and Civil Engineering, Volume 11, Issue 6, pp 45-52, Nov-2014.
33. Pavan Kumar.E, Naresh.A, Nagajyothi.M, Rajasekhar.M, "Earthquake Analysis of Multi Storied Residential Building - A Case Study", International. Journal of Engineering Research and Applications, Vol. 4, pp.59-64. November 2014.
34. Patil.S. S, Ghadge.S. A, Konapure.C. G, Ghadge.C. A "Seismic Analysis of High-Rise Building by Response Spectrum Method", International Journal of Computational Engineering Research, Volume 3 Issue. 3,2014.