An Analytical Study on Effect of Wind Load for Tall Building

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Abstract:- In this research paper, the effect of wind load for tall Building, Now a day's many tall structures and high rise towers and Building are being built all around the world .Wind plays an important role in design of tall structures because of its dynamic nature. Effect of wind is predominant on tall structures and Building depending on location of the structure, height of the structure. In this paper the compression of the Building with their height and its different shape onbuilding for analysis of wind loads on buildings. Considered for present study the analysis is carried out using ETABS Software 2016.

INTRODUCTION:-

Wind load for tall building can be reason multi story buildings are best choice for construction in Metro cities where a smaller amount of property is presented. As designer knows multi story structure provides large floor area in small area and it is beneficial also.Hence, it is required to assemble high rise structure. If high rise structures are constructed than many structural troubles come to pass, such as lateral load effect, lateral displacement and stiffness etc.

Normally for high rise structure wind load effects are prevailing. Therefore for high rise structure it is essential to have knowledge of different loads and its effect on structure. There is many type of effect worked on structure and causes for failure. The effect of lateral load is very important to consider such as wind loads.

Literature Review:-

After surveying various research papers which has been related wind load effect on tall buildings, the short explanation about its approach, methodology and conclusions has discussed.

1. **M. GU, Y. Quan (2004)**,In this paper, 15typical tall building models of basic cross-sections and aspect ratios from 4 to 9 are tested with high-frequency force balance technique in a wind tunnel to obtain their first-mode generalized across-wind dynamic forces. The effects of terrain condition, aspect ratio and side ratio of cross section and modified corner of the building models on the across-wind forces are investigated in detail.
2. **Guoqing Huang, Xinzhong Chen (2007**), The wind load effects of 20- and 50-story buildings in three primary directions were analyzed using detailed dynamic pressure data measured in a wind . The results of this study reconfirmed some of the findings of using simplified loading models and presented some new results that helped to better understand and quantify wind induced response of tall buildings.
3. **Michael Kasperski (2009)**, In the design process, generally more than one design task has to be met, e.g. design values have to be specified for local loads, global loads and structural loads.
4. **Aly Mousaad Aly and Srinivasa Abburu (2011)**,The paper presents practical procedure for the response prediction and reduction in high-rise buildings under wind loads. To show the applicability of the procedure, aerodynamic loads acting on a quasi-rectangular high-rise building based on an experimental approach are used with a mathematical model of the structure for the response prediction and reduction.
5. **F. Cluni , M. Gioffrè, V. Gusella (2013)**,Two equivalent shear-beam models were proposed to estimate the dynamic response of tall buildings to wind loads. The two models differ in the global elastic stiffness: the bending and shear stiffness are coupled in the first case in series and in the second case in parallel.
6. **K. Vishnu Haritha, Dr.I. Yamini Srivalli (2013)**, as the stiffness of the member increases the displacement of the frame decreases. The aspect ratio plays a major role in affecting the displacements up to certain height.
7. **Ki-PyoYou, Jang-YoulYou andYoung-MoonKim (2014)**, the optimal control technique of LQG for obtaining the reduced a long-wind responses of a tall building with ATMD has been investigated. The fluctuating a long-wind loads, acting on a tall building, was simulated numerically and using this simulated along-wind load.
8. **Umakant Arya, Aslam Hussain, Waseem Khan (2014)**, in this paper,The dynamic characteristics of an important structure under wind loading becomes a requirement in engineering design and in academic study. In the ongoing research project on tall buildings, the study of wind-induced demands is categorized as: along-wind and crosswind responses. These demands are caused by different mechanisms. Calculation of ground slope is fundamentals of many traditional Geographical Information Systems (GIS) applications. Various methods exist for calculating slope. Manual slope generation, based upon contour line information, is a long established and generally acceptable method.

9. **Vikram.M.B, Chandradhara G. P, Keerthi Gowda B.S (2014)**, Effect of wind is obtained from analysis and compared with gravity loading. Variation of axial force with storey height in all the models for gravity and wind loads at bottom storey column for different aspect ratio and different storey height. It is observed that when the aspect ratio is 0.25, the axial force is increased by 10% in dynamic analysis compared to static analysis.
10. **Aly Mousaad Aly and Srinivasa Abburu (2015),** The main objective of the current study was to further the understanding of the impact of multihazard loading, brought by wind and earthquakes, on the behavior of high rise buildings.
11. **Djamal Hissein Didane, Nurhayati Rosly, Mohd Fadhli Zulkafli, and Syariful Syafiq Shamsudin (2017)**, in this study, the monthly and yearly wind speed distribution and wind power density for thirteen meteorological stations in Chad were evaluated. The novel two-parameter Weibull distribution function was employed to analyze the five-year period data for each site.
12. **Huili Xue, Kun Lin, Yin Luo, and Hongjun Liu (2017)**, In this study, an inverse approach based on minimum variance unbiased estimation is developed for identifying the time-varying wind load from structural acceleration responses.
13. **Nicola Longarini, Luigi Cabras, Marco Zucca, Suvash Chapain and Aly Mousaad Aly (2017)**,In this paper, some limits of available design standards (Euro code & Italian design code) to evaluate wind actions on high-rise buildings (displacements and acceleration responses) are presented, pointing them out in a comparison to a more sophisticated methods (FEM of the building, HFFB technique).
14. **Rabi Akhtar, Shree Prakash, Mirza Aamir Baig (2017)**, In this paper, The Designed wind load is defined as it can be designed with parameters of wind which are given in Indian standard codes IS (875-partIII) and in high rise structures there are gust factors and wind tunnel effects have been used to determine the actual behaviour of wind on structures and the designed wind pressure should be applied on the model.
15. **A. Joseph Andrew, N Parthasarathi, S Selvi Rajan, Prakash (2018),**Mean force coefficients for Level 8 are always higher than all the other levels due to edge effect at top levels. For all other levels, values are almost same which indicates that these values are mostly governed by buffeting characteristics of approaching windflaw.
16. **Ashish Sadh, Ankit Pal (2018),** In this paper, the IS code IS 875 part III has provided certain guideline on the basis of which the building structures can be designed when subjected to wind loads. The literature survey in the performance and behaviour of building structures when subjected to wind loads suggests that the requirement of establishing a methodology for studying the response of building structure to winded loads has become essential.
17. **Fatih Topalog˘lu and Hu¨seyin Pehlivan (2018)**, in this study, average wind speed and wind direction data of Arapgir province measured at 10 m height and 10-minute intervals and taken from Automatic Meteorological Observation Station were analyzed by WAsP software.
18. **Lei Jiang , Jin-hua Li and Chun-xiang Li (2018)**, The correlation analysis of the measured wind pressure data of the upper and lower surface of the membrane structure is carried out. Most of the measuring points with negative correlation coefficients are close to the windward side.
19. **Wei Cui, Luca Caracoglia (2018**), This study examines the well-known quasi-steady theory, widely applied in wind engineering, and derives a novel generalized aerodynamic formulation for evaluating the coupled dynamic response of a tall, slender bluff body.
20. **Wei Xu, and Feng Xu (2018)**,In this study, Reynolds-averaged Navier–Stokes (RANS) simulations, large-eddy simulations (LES), and Light hill's acoustic method have been conducted to study for around high-rise buildings with external sunshade curtain wall.
21. **Yi Zhou, Yuanqi Li, Yingying Zhang and Akihito Yoshida (2018)**,In this paper simulated the wind loads of full-scale structures by the use of CFD, and the results were compared with the existing wind tunnel test.
22. **Divya Patel, Rahul Shah (2019)**, In this study, square and rectangular buildings of 30, 40 and 50 storeys are modelled and analyzed using ETABs v15.2.2 by applying wind load calculated using static and GEF method as per IS: 875 (Part 3) – 1987. The natural frequency of the structures was calculated using STAAD.Pro V8i SS6.
23. **Huili Xue, Hongjun Liu, Huayi Peng, Yin Luo, and Kun Lin (2019)**, in this paper, a time domain joint state /parameter /wind load estimation method from incomplete measurements is proposed based on modal extended unbiased minimum variance estimation.

    The recursive procedure includes four parts: time update, modal wind load estimation, measurement update, and coordinate transformation.
24. **S. Elias, R. Rupakhety, and S. Olafsson (2019)**, Results show that the wind-sensitive building is also adversely affected by earthquake ground motions. Tall buildings designed for wind forces can experience severe floor acceleration during earthquakes.
25. **Ferhat Bingol (2020)**, In this study, wind speed data in the form of 10-minute statistics from a 101 m Mast with top-mounted cup anemometers is used to compare different methods for the estimation of Weibull parameters. +e measurement period was from 27 December 2017 to 27 December 2018, that is, one full year of data with over 99% recovery rate. A high proportion of the dataset (over 20%) consisted of low wind speeds, which are known to cause difficulties in the parameter estimation.

Conclusion:-

After reviewing a lot of research papers that are based on the wind load effect on tall buildingwith various loading conditions. For further work in this the Shape of building is different and height of building is also different in the structure would createvarious type of case model and using the ETABS Software 2016 for calculating the Storey drift, Storey Displacement, Time period and Base shear.

The conclusion for the further work related to the Effect of wind load for tall Building are shown below:-

1. A lot of work has been seen in various research papers, but none of the papers can show the different shape and different height of the building frame for the wind load analysis.
2. For analysis, a structural tool such as Etabs 2016 could be used.
3. The building model will be analyzed in wind zone 47 m/s.
4. Determination of the dynamic response of the different building models.
5. After performing the comparing all the result parametric values and identify of Vulnerability frame.

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References:-

1. **M. Gu, Y. Quan(2004),"** Across-wind loads of typical tall buildings", Wind Energy and Industrial Aerodynamics , doi:10.1016/j.jweia.2004.06.004

2. **Guoqing Huang, Xinzhong Chen(2007)**," Wind load effects and equivalent static wind loads of tall buildings", Engineering Structure , doi:10.1016/j.engstruct.2007.01.011

3. **Michael Kasperski (2009),"** Specification of the design wind load", Journal of Wind Engineering and Industrial Aerodynamic, doi:10.1016/j.jweia.2009.05.002

4. **Aly Mousaad Aly and Srinivasa Abburu(2011),"** Dynamics and Control of High-Rise Buildings under Multidirectional Wind Loads", Smart Material Research, doi:10.1155/2011/549621

5. **K. Vishnu Haritha, Dr.I. Yamini Srivalli(2013),"** Effect of Wind on Tall Building Frames", International Journal of Research in Civil Engineering, ISSN Online: 2347-2855, Print: 2347-8284

6. **F. Cluni , M. Gioffrè, V. Gusella (2013),"** Dynamic response of tall buildings to wind loads by reduced order equivalent shear-beam models", Journal of Wind Engineering and Industrial Aerodynamics, http://dx.doi.org/10.1016/j.jweia.2013.09.012

7. **Ki-PyoYou, Jang-YoulYou andYoung-MoonKim(2014)**," LQG Control of Along-Wind Response of a Tall Building with an ATMD", Mathematical Problems in Engineering, http://dx.doi.org/10.1155/2014/206786

8. **Vikram.M.B, Chandradhara G. P , Keerthi Gowda B.S.(2014)**," A Study on Effect of Wind on the Static and Dynamic Analysis", International Journal of Emerging Trends in Engineering and Development, ISSN 2249-6149

9. **Umakant Arya, Aslam Hussain, Waseem Khan (2014)**," Wind Analysis of Building Frames on Sloping Ground", International Journal of Scientific and Research Publications, ISSN 2250-3153

10. **Aly Mousaad Aly and Srinivasa Abburu (2015)**," On the Design of High-Rise Buildings for Multihazard", Shok and Vibration, http://dx.doi.org/10.1155/2015/148681

11. **Djamal Hissein Didane, Nurhayati Rosly, Mohd Fadhli Zulkafli, and Syariful Syafiq Shamsudin(2017)**," Evaluation of Wind Energy Potential as a Power Generation Source in Chad", International journal of rotating machinery, https://doi.org/10.1155/2017/3121875

12. **Nicola Longarini, Luigi Cabras, Marco Zucca, Suvash Chapain, Aly Mousaad Aly(2017)**," structural Improvements for Tall Buildings under Wind Loads: Comparative Study", Shock and Vibration, https://doi.org/10.1155/2017/2031248

13. **Rabi Akhtar, Shree Prakash, Mirza Aamir Baig(2017)**," Study of compmparison between Static and Dynamic Analysis Subjected to Wind and Earthquake Load", International Research Journal of Engineering and Technology, e-ISSN: 2395-0056 , p-ISSN: 2395-0072

14. **Huili Xue, Kun Lin, Yin Luo, Hongjun Liu (2017)**," Time-Varying Wind Load Identification Based on Minimum-Variance Unbiased Estimation", Shock and Vibration, https://doi.org/10.1155/2017/9301876

15. **Ashish Sadh, Ankit Pal (2018),** "A Literature Study of Wind Analysis on High Rise Building",International Journal of Advanced Engineering Research and Science ,ISSN: 2349-6495(P) | 2456-1908(O), https://dx.doi.org/10.22161/ijaers.5.11.36

16. **A. Joseph Andrew, N Parthasarathi, S Selvi Rajan, Prakash(2018)**," Dynamic response of tall buildings to wind loads by reduced order equivalent shear-beam models", Materials Today, Materials Today: Proceeding: 5 (2018) 8923-8932

17. **Fatih Topalog lu and Hu seyin Pehlivan(2018)**," Analysis of Wind Data, Calculation of Energy Yield Potential, and Micrositing Application with WAsP", Advance in Meteorology, https://doi.org/10.1155/2018/2716868

18. **Lei Jiang , Jin-hua Li , Chun-xiang Li(2018)**," Comparative Study on Non-Gaussian Characteristics of Wind Pressure for Rigid and Flexible Structures", Shock and Vibration, https://doi.org/10.1155/2018/9213503

19. **Yi Zhou, Yuanqi Li, Yingying Zhang , Akihito Yoshida (2018)**," Characteristics of Wind Load on Spatial Structures with Typical Shapes due to Aerodynamic Geometrical Parameters and Terrain Type", Advance in Civil Engineering, https://doi.org/10.1155/2018/9738038

20. **Wei Cui, Luca Caracoglia (2018)**," A fully-coupled generalized model for multi-directional wind loads on tall buildings", Journal of Fluids and Structures, https://doi.org/10.1016/j.jfluidstructs.2017.12.008

21. **Wei Xu and Feng Xu(2018)**,"Numerical Study on Wind-Induced Noise of High-Rise Building Curtain Wall with Outside Shading Devices, Shock and Vibration, https://doi.org/10.1155/2018/5840761

22. **Divya Patel,Rahul Shah(2019)**," Effects of Gust Load on Tall Building", Journal of Emerging Technologies and Innovative Research, (ISSN-2349-5162)

23. **Huili Xue, Hongjun Liu , Huayi Peng, Yin Luo, and Kun Lin(2019)**," Wind Load and Structural Parameters Estimation from Incomplete Measurements", Shock and Vibration, https://doi.org/10.1155/2019/4862983

24. **S. Elias , R. Rupakhety , and S. Olafsson(2019)**," Analysis of a Benchmark Building Installed with Tuned Mass Dampers under Wind and Earthquake Loads", Shock and Vibration, https://doi.org/10.1155/2019/7091819

25. **Ferhat Bingol (2020)**," Comparison of Weibull Estimation Methods for Diverse Winds",Advance in Meteoroloy, https://doi.org/10.1155/2020/3638423