International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Literature Review on Analysis of Tall Buildings Subjected to Wind Loads By Using Gust Factor Method

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ABSTRACT

The considerable changes in the building techniques have tended to make tall and flexible structures more susceptible to the action of wind. Wind loadings are now assuming a greater significance in relation to the other forces imposed on the structures and have thus become an important consideration in the design of low as well as tall flexible structures. Wind causes a random time-dependent load, which can be seen as a mean plus a fluctuating component. All the structures experiences dynamic oscillations due to the fluctuating component (gustiness) of wind. In short rigid structures these oscillations are insignificant, and therefore can be satisfactorily treated as having an equivalent static pressure. This is the approach taken by most Codes and Standards. The present Indian Standard for wind loads IS 875 (Part 3) 2015 is also based on Static Method. However, Gust Factor Method is also included for computing the dynamic effects of wind on flexible structures that can oscillate in the wind. This paper presents the various such research studies which have been carried out on the subject in recent years; particularly to dynamic response of tall & slender buildings using Gust Factor Method approach.

Keywords: Tall & Flexible buildings, Dynamic oscillations, Gustiness , IS-875 (Part-3) 2015 ,Gust Factor Method, Static Method.

INTRODUCTION

As there is an economic growth there is an increasing demand for infrastructure in order to fulfill the requirement. The tall building construction has become a feasible solution to the issues related with the urban society. Structures built today are designed to withstand earthquakes, wind and blast loadings. In tall buildings, usually wind is the critical load which needs to be considered for the safety and serviceability of the structure. Wind effects on structure changes with time resulting in a dynamic problem to the structural engineer and It is necessary for us to study especially for tall buildings that are prone to wind induced oscillations hence special consideration needs to be given for analysis of these structures by considering the dynamic nature of wind. There are two components of wind namely along and across wind load components and their effect needs to be assessed for wind resistant designs. This Paper presents the various research studies which have been carried out on the subject in recent years; particularly to structural wind loading, and dynamic response of tall & slender buildings. The several of these are available in the proceedings of the conferences which are very helpful to understand the recent developments in wind engineering.

REVIEW OF LITERATURE

Er. Mayank Sharma, Er. Bhupinder Singh & Er. Ritu Goyal (2018), carried this study with the objective of critically examining the Gust Factor Method incorporated in the present IS for wind loads, IS 875 (Part 3) 1987. For the study, 25 storied steel framed building with square shape for all the four terrain categories has been chosen. The wind loads produced at various heights, base moments and base shear for the building has been computed by Peak Wind Approach as well as Mean wind Approach associated with Gust Factor. Further hourly mean wind speed as obtained reveals that the values obtained are consistently less than those obtained by the Gust Factor Method specified in the code. On comparison of results for (i) Peak Wind Approach, (ii) Mean Wind Approach associated with Gust Factor and (iii) Gust Factor Method using hourly mean wind speeds based on hourly mean wind speed data, large variations in the values are observed.

Aiswaria G. R and Dr Jisha S. V (2018), investigated along and across wind loads acting on tall buildings located in terrain category IV having height varying from 90m to 240m have been computed as per the Indian standard code IS 875(Part 3): 2015 considering the effect of interference. The across and along wind load induced maximum base shears and base moments were compared to assess the governing wind load component acting on a tall RC framed building. It was deduced that the effect of along wind force is governing for up to a height of 150m in the case of long body orientation while it is the across wind force which is governing for all the buildings in case of short body orientation.

Prakash Channappagoudar, Vineetha Palankar, R. Shanthi Vengadeshwari, Rakesh Hiremath (2018), presented a computation in which a building in Pune is taken and analysis is performed with respect to wind loads for different number of floors. Analysis is done with both codes of IS 875 (Part 3) : 1987 and IS 875 (Part 3): 2015 for different parameters affecting the stability of building. Comparisons made for Lateral Forces for Dynamic Analysis for Wind code 1987 and 2015 for 27th floor and 39th floor shows that the lateral forces in the along direction has reduced in code IS:875(Part 3)2015 when compared to previous code, the columns under consideration, steel requirement in IS: 875 (Part 3) 2015 is higher in comparison to IS:875 (Part 3) 1987. Time period also increases as there is increase in height of the structure for 27th floor and 39th floor. The base Reaction study in the IS code 875 (Part 3) 1987 should be less than that of IS code: 875 (Part 3) 2015.

Rabi Akhtar, Shree Prakash, Mirza Aamir Baig (2017), carried study on high-rise buildings which are exposed to both static and dynamic loads. Dynamic effects such as Gust factors, resonance frequencies, and accelerations are considered. The change in static results from overturning moments, deflections, reaction forces, and force distributions between concrete cores are examined considering different models. The models are analyzed by different elements and methods, to study the impact these have on the results. From the results it can be depicted that, when modeling a high-rise building in finite element software, one model is often not sufficient to cover different aspects. To see the global behavior, one model can be used, and when analyzing the detailed results another model with a fine mesh, that has converged, is needed. The same principle applies when evaluating horizontal and vertical loads, different methods or models are usually needed.

Hemanthkumar M S, Kiran.T (2017), This study concentrates on the horizontal irregularities by considering different shapes in plan of the structure. Magnitudes of wind loads are dependent on the area of exposure of the building, hence the shape of the building has to be studied with due importance as the area of exposure is dependent on shape. Different shaped building will have different responses to the applied lateral loads. Hence in this study an attempt has been made to predict the effect of different shapes of building for wind loads. In this work wind forces are calculated based on Gust effectiveness factor method. In this study a G+20 storied tall Mivan wall C-shaped, I-shaped, L-shaped and T-shaped building models are considered as a part irregularity for modeling. 700 m^2 is the Plan Area of each model. A comparative behavioral study of high rise irregular Mivan-wall structures has been done, with the aim of response optimization of the building against the wind loads

M. R. Wakchaure, Sayali Gawali (2015), In this study, analytical investigation of different shapes of buildings are taken as an example and various analytical approaches are performed on the building. These plans are modelled and wind loads are found out according to I.S 875(part 3)-1987 by taking gust factor and without taking gust factor. These models are compared in different aspects such as storey drift, storey displacement, storey shear, etc. for different shapes of buildings by using finite element software package ETAB"s 13.1.1v. Among these results, which shape of building provide sound wind loading to the structure as well as the structural efficiency would be selected.

Srikanth and B Vamsi Krishna (2014), They conducted the study on tall building frame in which 20 to 80 stories are carried for wind load analysis. Equivalent static wind loads are analyzed using the provisions of IS: 875- 1987 PART-3. Analysis is conducted by using two loading cases, i.e., vertical loads with or without wind loads. The resulting effects such as column moments, beam moments and axial forces are compared. The criticality of the wind on tall building frames is analyzed and recommendations are given. This study would lead to important recommendations for the action of critical wind loads on high rise building frames. Gust effective factor method, which is realistic and rational, should be considered for the computation of wind loads in the case of high rise frames and structures. It becomes important to study the criticality of wind forces in case of multi-storied frames particularly in serve wind zones.

Muhanad. M. Majed, Dr. P.Srinivas Rao (2013), This paper explains the steps to obtain along wind response as per (IS-875 (part-3):1987) Building of height 100, analyzed as per code. The results are compared manually and E-TABS program. This paper also explains the methods for calculating along wind response by Static Method and the gust factor method (Dynamic Method) and by considering the effects of change in terrain category, as described by the present IS-code. After comparing the results it can be seen that dynamic methods give higher value of bending moment and shear force compared to static method.

Dr. B. Dean Kumar And Dr. B.L.P Swami (2012), in this paper, the proposed draft is studied and comparison made with the existing code i.e. IS: 875(Part1)-1987. Both the static and dynamic methods described in the code used for analyzing the multi-story frames of 20 to 100 stories. The study includes the wind effects on structures situated on the costal belt of the country and in the interior part of the country. Depending on the results, important conclusions and short comings in the code and proposed draft are pointed out. Also the importance of dynamic method is studied and influenced after a comparison with the static method.

L. Halder and S. C. Dutta (2010), in this paper they carried the study of the response of low to high rise buildings with various aspect ratios (RA) under the action of wind in different terrain categories utilizing Static analysis and Gust factor based dynamic analysis as suggest in Indian wind code (IS 1989) to judge the effect of variation in building configuration under the action of wind. The study also includes an exhaustive comparison of the wind forces obtained by Force coefficient based static analysis and Gust factor based dynamic analysis interpreting where which method should be used for better protection. To investigate the effect of variation of the aspect ratio and height of building under aerodynamic load, seven different aspect ratios were chosen which were namely, 0.5, 0.75, 1, 1.25, 1.5, 1.75 and 2.The study shows that force Coefficient method gives conservative results in the terrain category 4 for all buildings with all heights, exhibiting the ratio of the base shear and the ratio of the storey shear obtained by the Gust factor method to the force coefficient method less than 1.

CONCLUSION

From the study of above literatures there is following point to be concluded-

- From the literature survey, it was observed that there is a need to analyse the along wind and across wind induced responses in order to assess which one induces a maximum response to a tall building so that an effective building design can be formulated.
- Wind direction and the building orientation play a major role in the wind responses which also needs to be assessed while designing. The IS 875 (Part 3) has been recently revised incorporating empirical formulas to estimate both along and across wind loads which is being used to assess the wind loads.
- The gust pressures are considerably higher compared to static pressure .the gust pressure are critical for design in the case of tall building .in the normal design ,designers adopt static pressure for building , which is not safe and accurate .hence gust pressures are to be adopted for a safe and exact design of building.
- The gust factor decreases with the height because as the height of the frame increases the fundamental frequency decreases.
- The gust pressures computed using draft code of IS 875 part-3 are more compared to the present IS 875 part-3 2015 because of the introducing importance factor and the change in the terrain roughness and height factor.
- The Literature study shows that force Coefficient method gives conservative results in the terrain category 4 for all buildings with all heights, exhibiting the ratio of the base shear and the ratio of the storey shear obtained by the Gust factor method to the force coefficient method less than 1.
- Short body orientation is having more across wind response.

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