A Review on Dynamic Gust Load Acting on Tall Building- Different Codal Provisions

Shivam Shridhar[1], Dr. Savita Maru[2]
[1]Dept of Civil Engineering
[2]PG Co-ordinator, Dept of Civil Engineering
[1, 2] Ujjain Engineering College, Ujjain, M.P., India

Abstract- *In the modern age of urbanization the scarcity of land has become a trouble to fulfill the residential and commercial space demand. The only solution to this problem is to build tall structures. The structural systems of high rise buildings are usually sensitive to the effects of wind. As the building height increases the effect of wind becomes more critical and static analysis does not gives satisfactory results. Gust effectiveness method takes into account the dynamic properties of structure, the wind structure interaction and then determines the wind loads as equivalent static loads. Different country codes have provides the provision of Gust Effectiveness Method. In the present work, research papers on dynamic behavior of wind and Gust Effectiveness method has been read and conclusions are made. The effect of shape, plan ratio and aspect ratio with different terrain categories has also been studied.*

Keywords- Gust Load Method, IS: 875 (Part-3), Dynamic Method, Wind Load, Tall Building.

I. INTRODUCTION

Wind is phenomenon of great complexity because of many flow situations arising from the interaction of wind with structures. Wind effects on structures continue to pose danger that continues to attract the attention of structural engineers round the world. This is because of the dynamic properties of wind i.e. its effect changes with time. The considerable changes in the techniques have tended to make tall and flexible and tall structures more susceptible to the action of wind. Wind loading on tall building is now assuming a greater significance in relation to the other forces acting on the structures. For typical tall structures, oscillation due to wind have been observed in the along wind and cross wind directions, as well as in the torsional mode. The pressure fluctuations on windward and leeward faces results in the along wind motions and generally follows fluctuations in the approach flow. Most international codes and standards utilize the Gust Effectiveness Method based on quasi-steady theory to predict the along wind response. The fluctuations in separating shear layers results in the cross wind motion of tall slender structures. The torsional motion is due to the imbalance in the instantaneous pressure distribution on each face of the building. It has been recognized that for many high-rise buildings, the cross-wind and torsional responses may exceed the along wind responses in terms of both limit state and serviceability designs.

The study presented here discusses the effect of wind on structures by using Gust Effectiveness Method by using different country codes and standards. For this purpose research papers of different authors have been studied are results are analyzed by considering the effect of shape, size, plan ratio and aspect ratio of tall buildings.

II. REVIEW OF LITERATURE

1. **Md Ahesan Md Hameed, Salman Shaikh (May 2019)** conducted a research on wind load effects on RC buildings by utilizing major codes [i.e. IS-875 (part-3):1987, IS-875 (part-3):2015, ASCE-07-05] in which buildings of different shapes such as regular plans and irregular plans was used to calculate the along wind load effect by gust factor approach. The models are created and analyzed in finite element based software package ETABS-2016. Each building is 20 storied building with storey height 4.0 m, summing upto a total height of building as 80 m. For, the purpose of analysis the plan area of regular shape like Square, Rectangular, Elliptical, Circular and Rectangle with two semicircle shapes kept same as well as the frame properties also kept equal. The results conclude that conclude that IS 875 part 3- 2015 gives mathematical equations instead of graphs. Hence new IS code is more precise than old one. Building having Circular, Elliptical and Rectangle with two half circle plan forms a smaller surface perpendicular to the wind direction, Hence the wind presser is less than the buildings having Square and Rectangular plan.

2. **Nourhan Sayed Fouad , Gamal Hussien Mahmoud, Nasr Eid Nasr (December 2018)** research aims to facilitate the necessary wind parameters for the structural design such as pressure distribution, drag coefficient for some building adopting the Computational Fluid

Dynamics (CFD) techniques. The validation of the application of CFD technique with existing wind tunnel results for some structures is investigated. Then the application of the CFD techniques performed on some structures such as single span short gable structure with mono and double slopes, trusses and domes. The basic parameters considered in the analysis of gable building including roof slops, wind direction. In addition, for gable buildings, the different roof zones coefficients of pressure assessed to compare the application of CFD technique with the international wind standards and codes of practice. The obtained results compared with each of the Euro code and ASCE10.

3. **Prakash Channappagoudar, Vineetha Palankar, R. Shanthi Vengadeshwari, Rakesh Hiremath (May 2018)** has been undertaken with the objective of critically examining the Gust Factor Method incorporated in the present Indian Standard for wind loads, IS 875 (Part 3) 1987. For the study 25 storied framed steel building having square shape in all the four terrain categories has been chosen. The wind loads induced at various heights, base shear and base moments for the building has been computed by Peak Wind Approach as well as Mean wind Approach associated with Gust Factor. There are wide variations in the values obtained by two approaches. Further hourly mean wind speed as obtained from literature was used for analyzing the building and the results were obtained. The perusal of results reveals that the values obtained are consistently less than those obtained by the Gust Factor Method incorporated in the code. On comparison of results for four terrain categories for three cases (a) Peak Wind Approach, (b) Mean Wind Approach associated with Gust Factor and (c) Gust Factor Method using hourly mean wind speeds based on hourly mean wind speed data, wide variations in the values have been observed. This emphasizes uncertainties involved in the values given in the code.

4. **Md Ahesan Md Hameed, Amit Yennawar (March 2018)** review and studied provisions of international standards and compare them with Indian standard. In this paper a comparative study of wind load analysis of RC buildings using three different codes is done as per IS 875 (Part- 3):1987, IS 875 (Part-3):2015,ASCE 7-05 and AS/NZS 1170(Part 2)-2011.Wind loads are determined based on gust factor method and critical gust loads for design are calculated. This study conclude Australian standard gives lower value of bending moment along Y-direction and displacement along X&Y direction whereas American standards give higher values as per Indian load combination and loading combinations prescribed in various codes. Also The American and Australian standard gives lower value of axial, shears forces, torsional moment and bending moment along Z-direction as per Indian load combination and loading combinations prescribed in various codes.

5. **Er. Mayank Sharma, Er. Bhupinder Singh & Er. Ritu Goyal (March 2018)** study has been undertaken with the objective of critically examining the Gust Factor Method incorporated in the present Indian Standard for wind loads, IS 875 (Part 3) 1987. For the study 25 storied framed steel building having square shape in all the four terrain categories has been chosen. The wind loads induced at various heights, base shear and base moments for the building has been computed by Peak Wind Approach as well as Mean wind Approach associated with Gust Factor. There are wide variations in the values obtained by two approaches. Further hourly mean wind speed as obtained from literature was used for analyzing the building and the results were obtained. The perusal of results reveals that the values obtained are consistently less than those obtained by the Gust Factor Method incorporated in the code. On comparison of results for four terrain categories for three cases (a) Peak Wind Approach, (b) Mean Wind Approach associated with Gust Factor and (c) Gust Factor Method using hourly mean wind speeds based on hourly mean wind speed data, wide variations in the values have been observed. This emphasizes uncertainties involved in the values given in the code.

6. **Aiswaria G.R., Dr. Jisha S.V. (2018)** analyzed the effect of across and along wind loads acting on tall building as per IS 875 (Part-3):2015 located in terrain category IV, height varying from 90 m to 240 m by considering the effect of interference. From this study, maximum base shears and base moments induced by across and along wind loads were compared to compute the governing wind load component acting on tall RC framed building. Results shows that the in case of long body orientation for upto the height of 150 effect of along wind force is governing while for short body orientation across wind force is governing for all the buildings.

7. **Shams Ahmed, Prof. S. Mandal (November 2017)** discusses a comparative study of five major international codes and standards with the latest Indian Code for wind load i.e. IS 875 Part-III(2015) for along wind loads on tall buildings and other provisions for along wind response on tall buildings by Gust Factor Method (GFM). The major international codes and standards of wind loads included within the scope of this research paper are ASCE-7-98

(United States)[3], AS1170.2-89 (Australia)[5], NBC-1995 (Canada), RLB-AIJ-1993 (Japan)[4], Eurocode 1-4 (1993)[7]. The research work is basically an inclusion of latest Indian Code IS-875 Part- III (2015) in the comparative study published by Yin Zhou, Tracy Kijewski and Ahsan Kareem. Major emphasis is put on the gust factor method approach for estimating along wind loads on tall buildings. A detailed example is also solved at the end so as to facilitate quantitative comparison.

8. **Rabi Akhtar, Shree Prakash, Mirza Amir Baig (July 2017)** compared the variations in static and dynamic results from reaction forces, overturning moments, deflections and force distribution concrete cores are investigated with different 3D models analyzed in STADD Pro. V8i(Series-4). Calculations were made according to IS 875 (Part-3), Explanatory handbook of IS 875 (Part-3)-SP64, Draft Code of IS 875 (Part-3), Thesis reference from IIT. Final results concluded that to see the global behavior, one model can be used and when studying the detailed results another model with fine mesh that has converged is often needed.

9. **H.Sarath Kumar, S. Selvi Rajan (July-2017)** research paper is concerned with the calculation of design wind loads on a rectangular building model (1:300 geometric scale) of size 10cm x 15cm x 70cm with an aspect ratio of 1:1.5:7 at eight different levels over the height under sub-urban terrain category for 0^0 angle and 90^0 angle wind incidence. The experiment id conducted in an atmospheric boundary layer wind tunnel facility of CSIR-Structural engineering Research centre, Chennai. The measured pressures are integrated to evaluate mean and RMS (Root, Mean, Square). Further the variation of above mentioned loads and response factor along the heights of the building with respect to sub-urban terrain condition are discussed and summarized in addition, the codal values of various international standards [IS-875 part-3 1987, IS-875 part-3 draft, ASCE-07] have also considered for comparison.

10. **Forrest Zhang, Alex To (October 2016)** studied the tall building with different country codes (i.e. GB50009-2012, ASCE/SEI 7-10, AS/NZS 1170.2:2011, AIJ 2004, NBC 2005, ISO 4354: 2009 and BS-EN 1991-1-1-4:2005) which includes the comparison of far field wind speed model, shape factor, aerodynamic damping, and the overall base shear force and moment of 4 typical tall buildings. The comparative results concluded that the far field wind speed modeling have large uncertainty on the design wind load which require more detailed model from full scale data, the reference wind pressure for the shape factor of leeward wall in GB 2012 is the same is the same with the windward wall which may underestimate the along-wind response and negative aerodynamic damping ratio may increase the across wind significantly for some flexible structures and wind tunnel tests shall be recommended to reduce the uncertain conservativity.

11. **Lars Morten Bardal, Lars Roar Saetran (January 2016)** results concluded that dependence of measured gust factors on various parameters of the atmospheric wind field is presented based on a 5 year dataset from Frøya. The gust factors mainly depends on turbulence intensity and averaging time for gust and mean wind speeds, and the simple linear model by Wieringa fits the measurements well for low and intermediate turbulence. The model from Greenway for the distribution of gust factors shows an overall overestimation compared to the measured data, but with a good fit for the scale parameter. Using instead the peak factor which includes the turbulence intensity the dependence on turbulence and atmospheric stability is reduced, but still present. This indicates that the “peak factor” (k_P) is a better measure for gustiness when turbulence values are available and its p_{df} follows a Gumbel distribution. An asymmetry of the measured gusts could also be observed, showing a higher fall time compared to rise time. It is important to consider the gust averaging time relevant for the specific application as this has great impact on the gust factor.

12. **Prof. M. R. Wakchaure , Sayali Gawali (August 2015)** considered different shapes of building of height 150 m having equal plan area, equal stiffness of column for wind load analysis using finite element software package ETAB’s 13.1.1v. Wind loads calculations are based on gust effectiveness factor method mentioned in IS 875 (Part-III) 1987. The critical gust loads for design are determined. After the application of calculated wind loads to the building models having different shapes are compared in various aspects such as storey displacements, storey drifts, storey shear, axial forces in column etc. Based on the results, conclusions are drawn showing the effectiveness of different shapes of the structure under the effect of wind loads. Buildings having circular or elliptical plan forms have a smaller surface perpendicular to the wind direction, the wind pressure are less than in prismatic buildings. From the above results, with the change in shape of building from square to elliptical the wind intensity, storey drifts, the lateral displacements, storey shear of the building decreased. Hence it is conclude that wind load is reduced by maximum percentage with an elliptical plan.

13. **B. S. Mashalkar, G. R. Patil, A.S.Jadhav (2015)** presents a comparative study of effect of wind on plans with different irregular shapes as I, C, T and L. The significance of this work is to estimate the design load of the structure subjected to wind in a particular region. The wind load is estimated based on basic wind speed and other factors as type of topography, terrain, and the use of building and its risk factor for that particular region. The present investigation deals with the calculation of wind loads for structural frame with different plan shapes and the results are compared with respect to permissible drifts of individual buildings. In this analysis it is found that the amount of drift is considerably changed with respect to shape of the structure. And also found that wind load on the building is maximum when it has maximum exposed area.

14. **I. Shrikanth, B Vamsi Krishna (August 2014)** studied and analyzed tall building frame 20 to 80 stories are considered for wind load analysis. Equivalent static wind loads are computed using the provisions of IS: 875-1987 (Part-3). Analysis is conducted by using the package in two loading cases, i.e. vertical loads with and without wind loads. The resulting effects like beam moments, column moments, axial forces are compared. The values of beam moments increase by 20-35% bottom to top for different multi-storied frames from 20-80 stories for dead load and live load combination. Also there is need to considered the wind effects in the case of frames having more than 20 stories particularly in severe wind climate to arrive at the critical values for design.

15. **Vikram.M.B , Chandradhara G. P 2, Keerthi Gowda B.S (May 2014)** study presents the wind effects on buildings with different aspect ratio using ETABS. All the frame models are idealized as 3D models. Variations of bending moment and axial force in columns are considered to study the behavior of frames. From the present study it can be concluded that wind effects are significant compared to gravity effect, when the aspect ratio is less and dynamic effect is not significant compared to static effect for symmetrical frames. Based on the computed results it is deduced that as the building width is increased by keeping its length fixed, the GEF goes on decreases. Gust factor is more in case of building having less width dimension. The dynamic response factor increases with height. This is because of the increase in the slowly varying background component of the fluctuating response. Wind effects are significant compared to gravity effects, when the aspect ratio is less, however its effect reduces as aspect ratio increases.

16. **Dr. B.Dean Kumar, Dr. B.L.P Swami (2012)** study includes the wind effects on structures located on the costal belt of the country as well as in the interior part of the country. Based on the study, important conclusions and short comings in the existing code and proposed draft are pointed out. Also the importance of dynamic method is studied and pointed out after a comparison with the static method. On the basis of calculations the background factor remains same for a particular frame along its height as per the code. But as per the proposed draft the background factor varies along the height of the frame. This is because the draft considers the effect at every level along the height of the frame. The background factor is independent of the breadth of the structure as per the code. As per the proposed draft the background factor decreases due to increase in the breadth of the structure. The gust energy factor increases with increase in the height of the frame as per the code. This is because the natural frequency of frame decreases with the increase in the height of the frame. Due to this the gust energy factor is increasing. Also the gust energy factor is decreasing with the increase in breadth of the structure. The resonance factor is increasing with the increase in the height of the building as per the code and draft. But as per the code the resonance factor is constant along the height of the given frame and thus is increasing with height as per the revised draft.

17. **Dr. B.Dean Kumar, Dr. B.L.P Swami (May 2010)** Gust Effectiveness Factor Method is used, which is more realistic particularly for computing the wind loads on flexible tall slender structures and tall building towers. In this paper frames of different heights are analyzed and studied. Based on the computed results this study can be concludes that in arriving at the gust effectiveness factor, it is very much necessary to investigate the resonance effects on the basis of actual computed fundamental frequency. As the height of building frame increases, the energy content in the fluctuating component of wind also increases.

18. **Rachel Bashor, Ahsan Kareem (November 2009)** A comprehensive comparison of the wind loads and their effects on tall buildings is conducted utilizing six major international codes and standards: ASCE 2005 (USA), AS/NZ 2002 (Australian and New Zealand), NBCC 2005 (Canadian), AIJ 2004 (Japanese), Eurocode 2004 (EU), and ISO 2009. The key areas of comparison include the provisions for strength design as well as the serviceability requirements in the along wind, across wind, and torsional directions. As the standards utilize a common theoretical framework, the equations are re-written in a general

format in order to compare the individual parameters. This paper examines the differences and similarities in major international wind codes/standards. Although many parameters were examined, the scope is limited to dynamically sensitive, regular-shaped buildings with flat roofs that are classified as enclosed. To accurately compare the parameters, the various equations in the codes/standards are written in a general format. While significant discrepancies are apparent in the comparison of the intermediary parameters, the overall loads are reasonably consistent. However, with a few modifications to specific parameters, the discrepancies between the standards are further reduced. The parameters contributing to the most differences in the resulting wind load are those associated with the wind velocity characteristics. Ultimately, the standardization of wind loading standards is achievable with an understanding of the similarities and differences between the major codes/standards.

19. **Dae-Kun Kwon, Ahsan Kareem (June 2009)** In comparison with atmospheric boundary layer winds, which are customarily treated as stationary, winds associated with gust fronts originating from a thunderstorm/downburst exhibit rapid changes during a short time period, which may be accompanied by changes in direction. This introduces non stationarity both in the mean and the standard deviation of wind fluctuations. In order to realistically capture characteristics of gust-front winds and their attendant load effects, a new analysis framework is presented, which is named here as the gust-front factor approach. This is akin to the gust loading factor format used in codes and standards worldwide for the treatment of conventional boundary layer winds. The gust-front factor expresses a generalized description of the genesis of the overall wind load effects on structures under both gust-front and boundary layer winds and it reduces simply to the gust loading factor for the case of conventional boundary layer winds. This approach encapsulates both the kinematic and dynamic features of gust-front induced wind effects on structures that distinguish themselves from those experienced in conventional boundary layer flows, i.e., variation in the kinematics of the velocity profile and its effects on the associated aerodynamics, dynamic effects induced by the sudden rise in wind speed, nonstationarity of turbulence in gust-front winds, and transient aerodynamics. To facilitate expeditious utilization of this framework in design practice and inclusion in codes and standards, the analysis framework and its workflow is introduced within a web-based portal. This eliminates the need for an in-depth understanding of the background within the framework and the need for associated computational effort. The portal has a user-friendly interface, which is available at http://gff.ce.nd.edu, permitting convenient analysis of several design scenarios with a host of potential loading conditions including the current ASCE 7-05 procedure in boundary layer winds for immediate comparison.

20. **P. Mendis, T. Ngo, N. Haritos, A. Hira, B. Samali, J. Cheung (2007)** Simple quasi-static treatment of wind loading, which is universally applied to design of typical low to medium-rise structures, can be unacceptably conservative for design of very tall buildings. On the other hand such simple treatment can easily lead to erroneous results and under-estimations. More importantly such a simplified treatment for deriving lateral loads does not address key design issues including dynamic response (effects of resonance, acceleration, damping, structural stiffness), interference from other structures, wind directionality, and cross wind response, which are all important factors in wind design of tall buildings. This paper provides an outline of advanced levels of wind design, in the context of the Australian Wind Code, and illustrates the exceptional benefits it offers over simplified approaches. Wind tunnel testing, which has the potential benefits of further refinement in deriving design wind loading and its effects on tall buildings, is also emphasized.

III. CONCLUSIONS

This review study on gust effectiveness method can be concluded in following points:

- The along wind and across wind generated maximum response should be assessed in order to facilitate a performance based wind resistant design.
- Building having smaller surface perpendicular to the direction of wind (i.e. circular or elliptical forms), the wind pressure is low as compared to the prismatic buildings.
- For the computation of wind loads, a rational and realistic method such as Gust Effectiveness Method must be considered for tall frames and slender structures.
- The criticality of wind force needs to be analyzed in the case of multi-storied frames particularly on more severe wind zones and cyclonic regions.
- As the building width is increased by keeping its length fixed, the Gust Effectiveness Factor goes on decreasing. The value of Gust Factor is more in case of building having less width dimensions.

- Sometimes, when the building height is very high and the structure is slender in cyclonic or windy regions then the Computational Fluid Dynamic (CFD) Analysis and wind tunnel analysis must be carried out to predict the critical effects of wind on the structures.

IV. FUTURE SCOPE

It has been established that wind causes criticality in the design of tall slender structures , which are flexible in nature. Further work may be carried out as:

- Along Wind and across wind induced responses of tall buildings of different aspect ratios with different aerodynamic modifications.
- Along Wind and across wind induced responses of tall buildings of different aspect ratios with different structural systems.
- Computation of wind force by Gust Effectiveness Method and comparison between different country codes and standards.

REFERENCES

[1] Md Ahesan Md Hameed, Salman Shaikh "Effect of Wind Loads on RC Building by using Gust Factor Approach" Journal of Emerging Technologies and Innovative Research (JETIR) Vol. 6 Issue:5, ISSN-2349-5162, PP 329-335, (May 2019)

[2] Nourhan Sayed Fouad , Gamal Hussien Mahmoud, Nasr Eid Nasr "Comparative study of international codes wind loads and CFD results for low rise buildings" Alexandria Engineering Journal (AEJ), Vol. 57, Issue: 04, PP 3623-3639 (December 2018).

[3] Prakash Channappagoudar, Vineetha Palankar, R. Shanthi Vengadeshwari, Rakesh Hiremath "Parametric Comparison Study on The Performance of Building Under Lateral Loads As Per IS 875(Part3):1987 and Revised Code of IS 875(Part 3):2015" International Research Journal of Engineering and Technology (IRJET), Vol. 05 Issue: 05, e-ISSN: 2395-0056, p-ISSN: 2395-0072, PP 621-632,(May 2018).

[4] Md Ahesan Md Hameed, Amit Yennawar, "Comparative Study on Wind Load Analysis using Different Standards - A Review", International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) Vol. 07, Special Issue: 03, ISSN(Online): 2319-8753, ISSN(Print): 2347-6710, PP 64-70, (March 2018).

[5] Er. Mayank Sharma, Er. Bhupinder Singh & Er. Ritu Goyal "Gust Factor Method for Wind Loads on Buildings and Indian Codal Provisions" International Journal of Engineering Sciences & Research Technology (IJESRT), ISSN: 2277-9655, CODEN: IJESS7, PP 621-632, (March 2018)

[6] Aiswaria G.R., Dr. Jisha S.V. "Along and Across Wind Loads Acting on tall buildings" Second International Conference on Architectural Materials and Construction Engineering (AMCE) ,PP 91-96, 2018.

[7] Shams Ahmed, Prof. S. Mandal "Comparative Study of Along-Wind Response of Major International Codes with Indian Code" International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 11, ISSN: 2278-0181, PP 256-260 (November 2017).

[8] Rabi Akhtar, Shree Prakash, Mirza Amir Baig "Study of Comparision between Static and Dynamic Analysis Subjected to Wind and Earthquake Load" International Research Journal of Engineering and Technology (IRJET) Vol. 04 Issue: 07 e-ISSN: 2395-0056, p-ISSN: 2395-0072, PP 3009-3014 (July 2017).

[9] Sarath Kumar, S. Selvi Rajan "Estimation of Gust Response Factor for tall building model with 1:1.5 Plan Ratios" International Conference on Materials, Alloys, and Experimental Mechenism, IOP Conference Series: Materials Science & Engineering, Vol. 225, (July-2017).

[10] Forrest Zhang, Alex To "Comparative Study of Along Wind and Across Wind Loads on Tall Buildings with Different Codes" The 15th International Symposium on Structural Engineering, PP 723-728 (October 2016).

[11] Lars Morten Bardal, Lars Roar Saetran "Wind gust factors in a coastal wind climate" 13th Deep Sea Offshore Wind R&D Conference, EERA DeepWind'2016, Energy Procedia 94 (2016), PP 417 – 424 (January 2016)

[12] Prof. M. R. Wakchaure , Sayali Gawali "Effects of Shape on Wind Forces of High Rise Buildings Using Gust Factor Approach" International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 8, PP 2979-2987 (August 2015).

[13] B. S. Mashalkar, G. R. Patil, A.S.Jadhav "Effect of Plan Shapes on the Response of Buildings Subjected To Wind Vibrations" National Conference on Innovation in engineering science and technology (NCIEST), International Organization of Scientific Research-Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN : 2278-1684, p-ISSN : 2320–334X, PP 80-89, (2015)

[14] I. Shrikanth, B Vamsi Krishna "Study on the Effect of Gust Loads on Tall Buildings" International Journal of Structural and Civil Engineering Research (IJSCER), Vol. 3, No. 3, ISSN 2319-6009, PP 92-106, (August 2014)

[15] Vikram.M.B , Chandradhara G. P 2, Keerthi Gowda B.S "A Study on Effect of Wind on The Static And Dynamic Analysis" International Journal of Emerging Trends in Engineering and Development (IJETED) R S.

Publication, Vol. 3, Issue: 04, ISSN 2249-6149, PP 885-890 (May 2014).

[16] Dr. B.Dean Kumar, Dr. B.L.P Swami "Critical Gust Pressures on Tall Building Frames-Review of Codal Provisions" International Journal of Advanced Technology in Civil Engineering (IJATCE), Vol. 1, Issue: 2, ISSN: 2231 –5721 (2012).

[17] Dr. B.Dean Kumar, Dr. B.L.P Swami "Wind effects on tall building frames-influence of dynamic parameters" Indian Journal of Science and Technology (IJST), Vol. 3, No. 5, ISSN 0974-6846, PP 583-587 (May 2010)

[18] Rachel Bashor, Ahsan Kareem "Comparative Study of Major International Standards" The Seventh Asia-Pacific Conference on Wind Engineering, PP (November 2009)

[19] Dae-Kun Kwon, Ahsan Kareem "Gust-Front Factor: New Framework for Wind Load Effects on Structures" Journal of Structural Engineering, American Society of Civil Engineer (JSE-ASCE), (June 2009)

[20] P. Mendis, T. Ngo, N. Haritos, A. Hira, B. Samali, J. Cheung "Wind Loading on Tall Buildings" Electronic Journal of Structural Engineering (EJSE) Special Issue: Loading on Structures, PP 41-54 (2007)