REVIEW ON PERFORMANCE BASED WIND ANALYSIS AND DESIGN

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Abstract - *The purpose of the project was to study the performance-based wind analysis of RCC and steel structure We can more effectively design structures assess to the performance-based wind design approach. Wind effects are considering for high-rise structures and steel structure. Performance based wind design gives the different wind load patterns for checking the performance of structure against wind. In this paper, a brief review is based on performance-based wind design of tall structure, steel structure with non-linear analysis. In this project work, an attempt is made to fully understand the method and process used in performance-based wind design and nonlinear design of the building.*

***Key Words*:** Performance-based Wind design, Performance objective, Non-linear static analysis.

1. INTRODUCTION

The performance-based engineering concept was developed and used in the seismic engineering field. It is used in professional practice for seismic design and devaluation. For performing PBWD of wind-excited buildings, it is necessary to have a understanding of structural responses in the nonlinear inelastic range. Performance-based wind design requires performance-objectives, analysis methods such as nonlinear static pushover and nonlinear time history analysis under wind loads, and mechanisms to reduce and, if possible, to eliminate damage accumulation.

As the wind flows against a building, the resulting force acting on the elevations is called the 'wind load'. The building's structural design resist wind forces and efficiently and transfer them to the foundations in order to avoid structural collapse.

The structural response of typical, roof pitch, gable-end, industrial buildings, in a wind storm is dependent on the wind loads used in the design of cladding and the frame structure. Building codes and guidelines define the required performance via the specification of minimum structural performance requirements under wind load. Since this approach intends to keep the structural system elastic, the more efficient design may be achievable by allowing controlled inelasticity in structural components. However, recent studies in earthquake and wind engineering highlighted the conceptual and practical limitations of the Code oriented design methods. All these facts are using liable wind design and assessment approach evidently describing the performance of high-rise building to wind loads beyond the current design wind loads. Hence, philosophically logical extension of the current wind design is performance-based wind design. Performance-based engineering is a modern engineering process through which a new structure is designed, or an existing building is evaluated more efficiently and economically by requiring the structure to meet certain performance requirements at various levels of demand. Comparing to the current perspective approach, utilizing the performance-based approach results in more informative and transparent output .

The Structural Engineering Institute of the American Society of Civil Engineers published a pre-standard for PBWD of tall buildings (ASCE2019). The pre-set and are outlines an alternative and comprehensive approach to building design for wind loading, which explicitly evaluate occupant comfort, building drift and extreme wind event behaviour. While PBSD methodologies used worldwide for over 25 years, the development of similar techniques for the design of building for wind hazards has lagged behind. Several concerns have slowed the application of wind design, including duration and directionality of loading, element fatigue, conceptual methods, wind tunnel techniques, and dynamic response. The Pre standard was created to address these concerns and chart a path forward for implementation of PBWD.

The Pre standard used for detailed evaluation of building response requires detailed understanding of their leant wind environment. Therefore, the building analysis and design arepshows a result on conducting wind tunnel testing to calculate structural loads. These structural loads calculate by using one of three methods of linear or nonlinear response history analysis. In this work, a similar type of concept will be used to analysis and design of tall building for performance-based wind design nonlinear response history analysis.

2. LITERATURE REVIEW

Jeong S.Y, Alinezad H. and Thomas H. K. [1] They are investigating benefits of performance-based wind design by comparing wind loads with seismic loads for various return periods. They analyzed tall building of 300m height in along-wind and across-wind directions for various wind speeds that corresponded from weekly to 10,000- year return period wind speeds in Washington. For the comparison, seismic loads were also estimated of response spectrum according to ASCE. They found that, there is potential efficiency of PBWD in optimizing the levels of serviceability and strength levels, by calculating building drifts explicitly as well as considering the effects of supplemental dampers in structural design.

Xiaoye Li1,2, Cong Wang1, Yingchun Jiang3 & Yikui Bai1 [2] They are investigating the safety of steel frame steel greenhouses under wind loads are still limited. In this study, a 10 m span whole steel frame solar greenhouse was taken as the research objective. They were taking davenport spectrum as the target spectrum; the time history of the wind speed was simulated by the harmonic superposition method. The finite element model of the greenhouse structure was established using ANSYS software. The simulated wind pressure was applied on the greenhouse structure for dynamic response analysis. The compare dynamic response results with the static analysis results under average wind load.

Azin Ghaffary [3] studied the advancement of nonlinear wind design methods. They check the necessity of performance-based wind design and nonlinear design of the building. Check the advantages in nonlinear analysis of the building consider their economy and safety. They check the wind flow response when some uncertainty in the building design. They give the difference in between nonlinear structure and linear elastic structure. For that study they use linear and nonlinear response of the 20-story SAC steel frame. They finding from this is study is that incorporating uncertainties when they conducting performance- based assessment for wind-induced response of buildings is found to be crucial especially for nonlinear response prediction that could be later used for collapse and safety consideration.

Bezabeh M. A, Bitsuamlak G. T and Tesfamariam S. [4] studied the limitations of conventional code design and overcome it by performance-based wind design. Also introduced mechanisms to reduce damage accumulation in the building. They used the existing 18-story Brock Commons mass-timber building in Vancouver, Canada for their study. Analysis is done by nonlinear time history for inelastic range and also introducing to the use of self-centering systems in eliminating the possible damage accumulation in structural systems subjected to long-duration wind loads. Use of TMD' s to reduce wind induced vibrations in tall building. They found that the provision of the linear-elastic.

Sandeep Kumar and Anjali Rai [5] presented a study that the structural performance of a steel building with different braced systems. They designed and analyzed G+44 story residential steel building under wind loads conditions. They use wind loads analysis according to Indian standards code IS875:2015(part 3) by diaphragm analysis method. They conclude that the Chevron Bracing design is the best structural performance of any kind of design considered in other conditions.

Suchana S. Telrandhe and A.M. Pande [6] In the current study, the high-rise building, wind is critical load and needs to be considered for safety and serviceability of structures. They use Indian standard IS 875(part 3) is revised in 2015, in that is code many modifications are carried out in sections related to dynamic wind effects. In this paper they consider wind effect along shorter and longer direction located in category IV. it has different base dimensions with same width along shorter direction with varying height of building from 42 to 60 m have been computed as per Indian Standard code IS 875(part 3): 2015 by the Gust Factor Method. Base dimension plays critical role, with the increase in dimension in the direction of wind, the response of building reduces.

Megha Jadhav and Nandkumar Patil [7] studied performance- based design optimization of tall steel framed structure exposed to wind loads of various levels by using E Tab software. They studied the design of a steel framed structure with an expectable and tolerable performance at four level wind at the time of building. Done the inelastic drift behavior of steel building by non-linear static pushover analysis. They done the study on the Performance Based design optimization of Tall steel framed structures which is subjected to wind excitation in wind load zone VI.

Mutthu Meena M, Mr. Kamalakannan P. [8] investigated about the comparative study of total steel take off for both the frames along different bay spacing of about 4m,6m and 8m and 12m for same area. This is achieved by using STAAD pro.v8i software is designed for static and dynamic force which include wind load and earthquake loads according to IS code. The deflection is controlled by cross bracing. The result of this study shows that the weight of structure depends on the bay spacing. The weight of PEB reduces. PEB with bay spacing 6m is found to be most economical.

Ulan Dakeev [9] In this paper wind tunnel apparatus is used to improve the efficiency of power output by a small-scale wind turbine. In their study they indicate power output versus wind velocity for that they do experimental wind turbine at variable wind velocity values with and without the proposed wind tunnel. They also study The statistical t-Test and One-way ANOVA analyses were performed to suggest whether or not the proposed approach would be useful for wind turbine manufacturers to evaluate the degree that contributes to the variability of renewable energy production.

Khallaf M. and Juppa J. [10] investigate performance-based tall building design and the development of a combined architectural urban design method focusing on the effects of wind loads on- and wind flows around tall buildings. The flexible relations between geometries, wind load and wind flow performance can be analyzed. A relational diagram is applied in mapping the relationships between the different parameters. Autodesk Robot Structural/ CFD Analysis and Autodesk Flow Design are selected as the performance simulation tools. They get the optimized design solution to one that satisfies competing criteria while meeting building standards and city development guidelines.

Mohammadi A. [11] studied the nonlinear dynamic responses of the buildings to different wind hazard levels, and development of wind performance-based engineering approach. He used the three different story steel moment frame high rise buildings. 3D nonlinear finite element models are used for nonlinear dynamic response. Three types of wind performance were evaluated as structural component performance; cladding performance to wind induced shear deformation; and service ability motion comfort performance. He suggests that Rayleigh damping methods with excluding nonlinear members from providing stiffness proportional damping regardless of the type of stiffness matrix (initial, tangent or current stiffness matrix) results in more reliable viscous damping simulation for the 47-story building model.

Jamaluddeen and Rajiv Banerjee [12] presented a paper effect of wind load on tall building. For study they consider two symmetrical buildings. They studied on displacement, time period, base shear and base moment coefficients of different shape of tall building. Because of dynamic reason wind is imp for study. In that paper location of the structure, height of the structure are considered for studying wind effects. 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 building with their height. Building different shape on building for analysis of wind loads.

Petrini F. and Ciampoli M. [13] presented a paper the adequacy of the structure through the probabilistic description of a set of decision variables (DVs). Here DV' s are the collapse or serviceability, the discomfort of the occupants, the length of the out of service time. The 74-story high rise steel building is taken for study purpose. The structural analysis has been carried out on a finite element (FE) model of the building implemented in ANSYS V 11. The dynamic response of the building has been evaluated by linear dynamic analyses carried out both in time and frequency domains, assuming rigid diaphragms. They found that the across-wind acceleration at the top of the building is a measure of the occupant comfort, that is, of the motion perception of building vibrations due to wind and performance-based design of structures under wind actions is feasible and fruitful.

Willford M. and Smith R. [14] In the current study, the comparison of high-rise building design by performance-based method to the conventionally code-based method. For study they used the 60 story RCC twin towers. Non-linear response history analysis was chosen as the only appropriate method to determine the response of the building for the MCE ground motions. The software used for non-liner analysis was LS-DYNA, and the element strength is taken at expected value level. They found that high rise building designed by performance-based method not only perform better than conventional design once, but are less expansive to construct, and suggest the use of a robust non-tuned supplementary damping system can substantially reduce wind load effects, permitting more economical structural design a dun certain in transit damping.

3. CONCLUSIONS

After going through all the literature, the several researchers have studied the performance based seismic design for buildings. There is less information available about the analysis and design of industrial building using performance-based wind design. In addition, the PBWD formulations, which are directly extended from earthquake engineering methodologies, may suffer from the lack of accuracy due to the inherent differences between earthquake and wind loads, primarily in load duration, frequency content, and damage mechanisms. It is very difficult to define wind load pattern for analysis using nonlinear response history analysis. Therefore, there is need to investigate defined method and steps for design and analysis of industrial steel building for performance-based wind design, with taking wind tunnel test for wind load pattern. Also it is required to find out difference in response of building between conventional code based design and performance based design.

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