TECH-CHRONICLE
AN INTERNATIONAL E-JOURNAL ON
EMERGING TRENDS IN SCIENCE, TECHNOLOGY AND MANAGEMENT

# *Analytical Study of a High Rise Building Subjected to Wind Loading Using Different Bracing System*

[1]Mr. A. S. Rajas
M.E. Structural Engineering Student, Dr. D Y Patil School of Engineering and Technology, Charoli, Pune. (India)
Email: amolrajas9@gmail.com

-

**Abstract:** The focus of this study is on the wind analysis of high rise steel building with different bracing systems .This study will evaluate the efficiency of different bracing systems at different locations of steel building. In the recent past many high rise buildings or towers are being constructed in India. The impact of wind loads are to be considered for the analysis and design of steel towers or tall multi-storied building towers. We can minimize the storey drift and failure of these structures subjected to wind loading by using some retrofitting techniques such as different bracing systems. Tall structures are more flexible and susceptible to vibrations by wind induced forces. In the analysis and design of high-rise structures estimation of wind loads and the inter storey drifts are the two main criteria to be positively ascertained for the safe and comfortable living of the inhabitants .Inter storey drift can be controlled through suitable structural bracing system. Comparison of different bracing models with respect to deflection, Bending moment, Shear Forces, Axial forces in the different members will be done in this analytical study.

***Keyword:*** ***High rise steel structure, wind loading, storey drift, different bracing systems***

## I. INTRODUCTION

High rise buildings have always been a dominant landmark in the townscape; at the same time has been preferred due to scarcity of land and to meet the increasing demand for space for residential and commercial purposes. These tall structures being slender light weight and with low structural damping undergo oscillations due to earthquake and wind loads. Wind is the term used for air in motion and is usually applied to the natural horizontal motion of the atmosphere. The horizontal motion of air, particularly the gradual retardation of wind speed and the high turbulence that occurs near the ground surface are of importance in building engineering. In urban areas, this zone of turbulence extends to a height of approximately one-quarter of a mile above ground, and is called the surface boundary layer. Above this height is called the gradient wind speed, and it is precisely in this boundary layer where most human activity is conducted. Therefore how wind effects are felt within this zone is of great concern.

**Types of wind**

Winds that are of interest in the design of buildings can be classified into three major types i.e. prevailing winds, seasonal winds, and local winds.

*1. Prevailing winds*

Surface air moving toward the low-pressure equatorial belts is called prevailing winds or trade winds. In the northern hemisphere, the northerly wind blowing towards the q\equator is deflected by the rotation of the earth to become north easterly and is known as the northeast trade wind. The corresponding wind in the southern hemisphere is called the southeast trade wind.

*2. Seasonal winds*

The air over the land is warmer in summer and colder in winter than the air adjacent to oceans during the same seasons. During summer, the continents become seats of low pressure, with wind blowing in from the colder oceans. In winter, the continents experience high pressure with winds directed towards the warmer oceans. These movements of air caused by variations in pressure difference are called seasonal winds. The monsoons of the China Sea and the Indian Ocean are an example.

*3. Local winds*

Local winds are those associated with the regional phenomena and include whirlwinds and thunderstorms. These are caused by daily changes in temperature and pressure, generating local effect in winds. The daily variations in temperature and pressure may occur over irregular terrain, causing valley and mountain breezes.

All three types of wind are of equal importance in design. However, for the purpose of evaluating wind loads, the characteristics of the prevailing and seasonal winds are analytically studied together, whereas those of local winds are studied separately

**Characteristics of Wind**

The flow of wind is complex because many flow situations arise from the interaction of wind with structures. Following are the characteristics of wind

1. Variation of wind velocity with height.
2. Wind turbulence.
3. Statistical probability.
4. Vortex shedding phenomenon.
5. Dynamic nature of wind- structure interaction
6. From a structural engineer's point of view tall building or multi-storeyed building is one that, by virtue of its height, is affected by lateral forces to an extent that they play an important role in the structural design
7. Multi-storeyed buildings provide a large floor area in a relatively small area of land in urban centre

**Bracing System:-**

A bracing system can be defined as a structural system capable of resisting horizontal actions and limiting horizontal deformations. The main purpose of a bracing system is to provide the lateral stability of the entire structure. It has to resist, therefore, all lateral loading due to external forces, e.g. wind, imposed deformation, e.g. temperature, earthquake and the effects of imperfections on the simple bracing. For a non-sway frame, the bracing system must, in addition, be stiff enough so that second order effects need not be taken into account in the analysis.

Many types of bracing systems such as V, K or Chevron and X-type, Diagonal type bracings have been developed in order to comply with structural design requirements as well as architectural demands.

*X-Braces* as shown in figure (a) can increase the lateral stiffness of buildings and decrease the lateral displacements.

*Diagonal or shear bracing* as shown in figure (b) helps prevent buildings from "racking" or swaying.

*Chevron-bracing* as shown in figure (c) frames have been also developed in order to resist transverse dynamic loads.

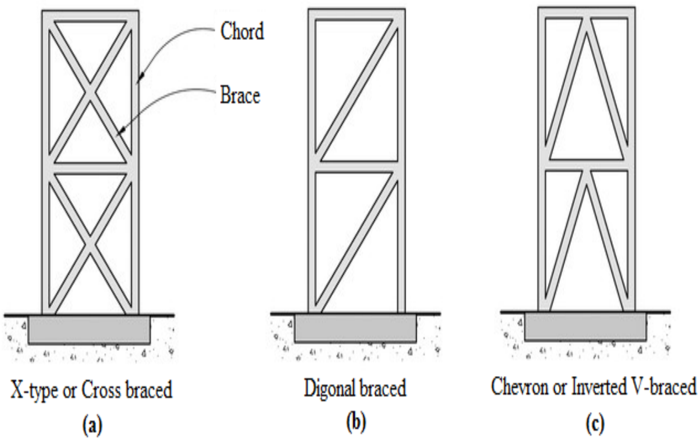


**Figure 1: Different types of bracing system**

## II. PREVIOUS WORK

P. Suresh, B. Panduranga Rao, Kalyana Rama (2012), have analytically calculated the wind load using static and gust factor method for a sixteen storey high rise building and results were compared with respect to drift and it has concluded that in high rise buildings the stability can be achieved by suitably adding the dimensions of the corner columns with corner diagonal X-bracings. Provision of X-bracings reduces the amount of drift and bending moments in the structure. Provision of corner bracings can also be used as a retrofitting technique to strengthen the existing structure as X- bracings will act more like shear walls.

Daniel Christopher Berding (2006) studied literature and taken a comprehensive review which covers all pertinent aspects of wind drift in steel framed buildings. Next an analytical study of the variations in modeling parameters is performed to demonstrate how simple assumptions can affect the overall buildings stiffness and lateral displacements. This was investigated these sources of discrepancy through a thorough review of the literature, an analytical study of a typical 10 story office building, an analytical study on the sources of member deformations, and by developing a survey to assess the current state of the professional practice. In other words, this thesis was undertaken and written with the intention of suggesting and establishing a comprehensive, performance based approach to the wind drift design of steel framed buildings.

B. Dean Kumar and B.L.P. Swami, (2010), have calculated the wind loads using Gust Effectiveness Factor Method, which is more realistic particularly for computing the wind loads on flexible tall slender structures and tall building towers. In their work they have taken the frames of different heights of building are considered for analysis and study purpose and after analyzed the building frames It conclude that as the height of building frame increases, the energy content in the fluctuating component of wind also increases and the wind pressures computed by the gust effectiveness factor method are not only safer for design but also they are more rational and realistic.

Shahrzad Eghtesadi, Danesh Nourzadeh, Khosrow Bargi (2011), carried out the investigation and comparison with various types of bracing systems. For this reason, they have chosen four types of bracing systems include X-bracing, Diagonal bracing, Inverted chevron CBF and Inverted chevron EBF, in four different height levels, are modeled and analyzed in the STAAD pro software. After comparison of results. it stated that Application of the inverted chevron concentric bracing system may be proper and economical for the steel braced frames.

## III. PROPOSED METHODOLOGY

For this study, a steel building of fifteen storey subjected to wind load in wind zone-III will be considered. A wind load will be calculated by Gust factor method using IS 875(PART 3):1987 as estimation of wind load by gust factor method is more precise. Shear forces, bending moment, storey drifts and axial forces will be computed. There will be different bracing systems, e.g.- X-bracing, Diagonal bracing and Chevron Bracing system will be used and placed at different location such as At corner, At middle and Alternately. All the results obtained will be compared. In this regard STAAD Pro 2007 software package will be considered to perform analysis and Design.

## IV. EXPECTED RESULTS

From most of the research papers referred it can be seen that 'X-bracing' is more efficient in reducing lateral displacement of structure and will have minimum possible bending moments in comparison to other types of bracing systems. When X-brace is used it gives the highest capacity but comparatively less ductility. The chevron type of brace gives moderate performance during an earthquake, since the capacity and ductility both are achieved. The location of brace member has significant effect on the seismic response of the braced frame structures. The central locations of brace member are favorable as they are effective in reducing actions induced in frame with less horizontal deflection and drift. Comparison of static effect and wind effect on the structure in all the parameters can be found based on the above study. From this study, most efficient type and location of bracing system can be found out for the typical structure considered.

## *References*


[1] P. Suresh, B. Panduranga Rao, J. Kalyana Rama (2012), "Influence of diagonal braces in RCC multi-storied frames under wind loads: A case study", International Journal of Civil and Structural Engineering, Vol.3, No.1, pp 214-226.

[2] D. Berding, (2006), "Wind Drift Design of Steel Framed Buildings: An Analytical Study and a Survey of the Practice", Proceedings of International Conference on Structural Engineering, Organized by Virginia Polytechnic Institute and State University, Virginia, pp 1-156.

[3] B. Dean Kumar and B. Swami (2010), "Wind effects on tall building frames-influence of dynamic parameters", Indian Journal of Science and Technology, Vol. 3, No. 5, pp 583-587.

[4] S. Eghtesadi, D. Nourzadeh and K. Bargi (2011), "Comparative Study on Different Types of Bracing Systems in Steel Structures", Proceedings of International Conference on Modeling & Simulation, World Academy of Science, Engineering and Technology, Dubai, pp 1863-1867.