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ANALYSIS AND DESIGN OF WIND AND EARTHQUAKE LOADS ON TALL BUILDINGS

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ABSTRACT:

Now a day's many tall structures and high rise towers are being built all around the globe .Wind plays a critical position in design of tall structures because of its dynamic nature. The effect of wind is predominant on tall structures depending on location of the structure, height of the structure. In this paper equivalent static method is used for evaluation of wind loads on buildings with various ratios. The aspect ratio may be various with the aid of changing number of bays. Aspect ratio 1, 2, 3 were considered for present research. The analysis is accomplished the usage of STAAD PRO. The high rise building with a long lifetime may be exposed to one or more extreme peril. Traditionally; specifications individually treated the multiple extreme hazards according to controlling load case. Thus, the ability of high rise buildings designed by the current codes to face the combined threats of earthquake and wind is rather imprecise. This paper presents a multihazard-based framework to assess the damage risk of high rise buildings which can be broken into three parts: the modelling of hazards and the damage probability computation. Modern tall buildings have efficient structural systems, and utilize high-strength materials, resulting in reduced building height, and thus, become more slender and flexible with low damping. These flexible buildings are very sensitive to wind excitation and earthquake load causing discomfort to the building occupants.

Keywords: Tall building, STAAD Pro, Damage, earthquake, multiple loads.

1. INTRODUCTION:

Tall buildings, which are usually designed for office or commercial use, are among the most distinguished space definitions in the Structural Engineers history of Indian urbanism in the twentieth century. They are primarily a reaction to the rapid

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growth of the urban population and the demand by business activities to be as close to each other as possible. Structural Engineers reinterpretations of the building type, the high cost of land in urban areas, the desire to prevent the disorganized expansion, the need to preserve agricultural production, the concept of skyscraper, influence of cultural significance and prestige, have all contributed to force buildings upward. Today, it is virtually impossible to imagine a major city without tall buildings. The importance of tall buildings in the contemporary urban development is without doubt ever increasing despite their several undeniable negative effects on the quality of urban life.

The first high-rise buildings were constructed in the United States in the 1880s. They arose in urban areas where increased land prices and great population densities created a demand for buildings that rose vertically rather than spread horizontally, thus occupying less precious land area. High-rise buildings were made practicable by the use of steel structural frames and glass exterior sheathing. By the mid-20th century, such buildings had become a standard feature of the architectural landscape in most countries in the world. The foundations of high-rise buildings must sometimes support very heavy gravity loads, and they usually consist of concrete piers, piles, or caissons that are sunk into the ground. Beds of solid rock are the most desirable base, but ways have been found to distribute loads evenly even on relatively soft ground. The most important factor in the design of high-rise buildings, however, is the building’s need to withstand the lateral forces imposed by winds and potential earthquake. Most high-rises have frames made of steel or steel and concrete. Their frames are constructed of columns (vertical-support members) and beams (horizontal-support members). Cross-bracing or shear walls may be used to provide a structural frame with greater lateral rigidity in order to withstand wind stresses. Even more stable frames use closely spaced columns at the building’s perimeter, or they use the bundled-tube system, in which a number of framing tubes are bundled together to form exceptionally rigid columns.

OBJECTIVE:

The wind is the most powerful and unpredictable force affecting tall buildings. Tall building can be defined as a mast

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anchored in the ground, bending and swaying in the wind. This movement, known as wind drift, should be kept within acceptable limits. Moreover, for a well-designed tall building, the wind drift should not surpass the height of the building divided by 500. Wind loads on buildings increase considerably with the increase in building heights. Furthermore, the speed of wind increases with height, and the wind pressures increase as the square of the wind speed. Thus, wind effects on a tall building are compounded as its height increases. Besides this, with innovations in architectural treatment, increase in the strengths of materials, and advances in methods of analysis, tall building have become more efficient and lighter, and so, more vulnerable to deflection, and even to swaying under wind loading. Despite all the engineering sophistication performed with computers, wind is still a complex phenomenon, mainly owing to two major problems. Unlike dead loads and live loads, wind loads change rapidly and even abruptly, creating effects much larger than when the same loads were applied gradually, and that they limit building accelerations below human perception. Although the true complexity of the wind and the acceptable human tolerance to it have just begun to be understood, there is still a need to understand more the nature of wind and its interaction with a tall building, with particular reference to allowable defections and comfort of occupants.

2. LITERATURE SURVEY:

Xiao –Wei zheng, Hong-Nan Li,Yeong –Bin Yang, Gang Li,(2019)(1)In this paper they studied about multihazard based framework to access the damage risk of high rise building subjected to earthquake and wind hazard separately and simultaneously .Numerical values indicate that the damage probability and contribution of each hazard conditions are sensitive to damage severity .the extensive application highlight the necessity of examining the responses of high rise buildings subjected to multihazard.

Ferrareto A.Johann (2018)(2) In this paper they studied about accessing tall building oscillations due to wind – induced motion is a multidisciplinary task that involve knowledge from several fields of study ,including structural engineering ,wind engineering ,reliability ,and even human physiology .

Alfonso Vulcano ,(1998)(3)this paper presented a study about based isolation is a very effective technic for reducing the seismic forces trough a de coupling of the structure option from that of the soil. With regard to the earthquake, the insertion of very flexible based isolation system is generally favorable, particularly for reducing the ductility demand .main purpose of this paper is to conclude the dynamic response of base isolated structures subjected to strong earthquakes and wind loads in order to achieve an optimal design of the base isolation system.

Siu-Kui Au, Feng-Liang zhang ,ping To ,(2011)(4)This paper describes observation on the identified model properties of two tall buildings using ambient vibration data collected during strong wind moments. The approach views model identification as an inference problem where probability is used as a measure for the relative possibility of outcome given in a model of the structure and measured data .identification of the identified natural frequencies and damping ratios verses the model root – mean-square value indicate a significant trend that is statistically repeatable across events .

Dat Duthinh1 and Emil Simiu2,(2010)(5)In accordance with the ASCE Standard 7-05, in regions subjected to wind and earthquakes, structures are designed for loads induced by wind and, separately, by earthquakes, and the final design is based on the more demanding of these two loading conditions. Implicit in this approach is the belief that the standard assures risks of exceedance of the specified limit states that are essentially identical to the risks inherent in the provisions for regions where only wind or earthquakes occur. We draw the attention of designers, code writers, and insurers to the fact that this belief is, in general, unwarranted, and that ASCE 7 provisions are not risk consistent, i.e., in regions with significant wind and seismic hazards, risks of exceedance of limit states can be up to twice as high as those for regions where one hazard dominates.

Azlan Adnan, Suhana Suradi,(2008)(6) This study addresses the performance of reinforced concrete buildings with the comparison on the effect of earthquake and wind loads for existing buildings in Malaysia, so that the adequacy of the design capacity can be checked. This study investigated seven existing buildings from West and East

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Malaysia. The buildings were categorized as medium and high-rise reinforced concrete moment resisting frames.

Sanchita hirde (et.al) (7) The paper presented a study on the severity of earthquake verses against wind forces or multy story RCC building the main aim is to analyze the multi-storeyed structure situated in wind zone vi and compare its performance to the buildings situated in zone v the analysis is carried out using the software ETABS .he observed that the effect of both earthquake forces and wind forces on multistory building increases with increase in height of a building.

3. PROPOSED SYSTEM:

As earthquakes can happen almost anywhere, some measure of earthquake resistance in the form of reserve ductility and redundancy should be built into the design of all structures to prevent catastrophic failures. Moreover, during the life of a building in a seismically active zone, it is usually expected that the building will be subjected to many small earthquakes, including some moderate ones, one or more large ones, and possibly a very severe one. Building massing, shape and proportion, ground acceleration, and the dynamic response of the structure, influences the magnitude and distribution of earthquake forces. On the other hand, if irregular forms are inevitable, special design considerations are necessary to account for load transfer at abrupt changes in structural resistance. Therefore, two general approaches are utilized to determine the seismic loading, which take into consideration the properties of the structure, and the past record of earthquakes in the region. When compared to the wind loads, earthquake loads have stronger intensity and shorter duration.

Load analysis:

Live load	=3 KN/m^2 (all over slabs)
Floor finish load	=1 KN/m^2 (all over slabs)
Location	= Vijayawada
Wind load	= As per IS875-1987
Earthquake load	=As per IS-1893 (part-1)–2002
Depth of foundation below ground	= 1.5 m
Type of soil	= Type II, Medium as per IS:1893
Allowable bearing pressure	= 200KN/m^2
Minimum thickness of footing	= 0.305 m, Assume Isolated footing
Height of building	=GF:3+5storied@3m+lift&stair height (3m)=21m
Leength in x-axis	= 30.78m
Length in z-axix	= 19.35m
External Wall thickness of Brick	= 0.23 m
Internal wall thickness of AAC block	= 0.15 m
Paraphet wall thickness of AAC block	= 0.15 m
Praphet wall height	= 1m
Columns	= 0.225 x 0.450 m & 0.225 x 0.525m
Beams	= 0.225 x 0.225 m, 0.300 x 0.225m & 0.375 x 0.225m
All slabs	= 0.120m thick
Terracing	= 0.120m thick avg.
Grade of concrete	= Used M25 concrete
Gade of steel	= Used Fe 415 steel

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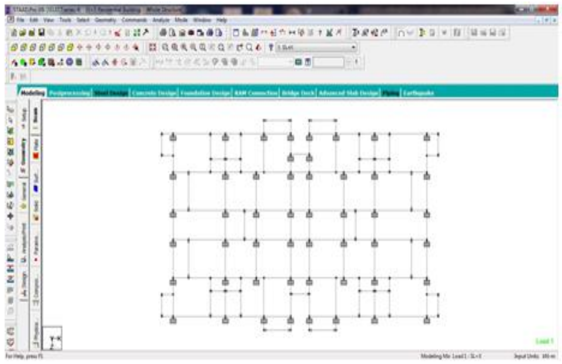

Fig.3.1. Plan of the G+5 storey building.

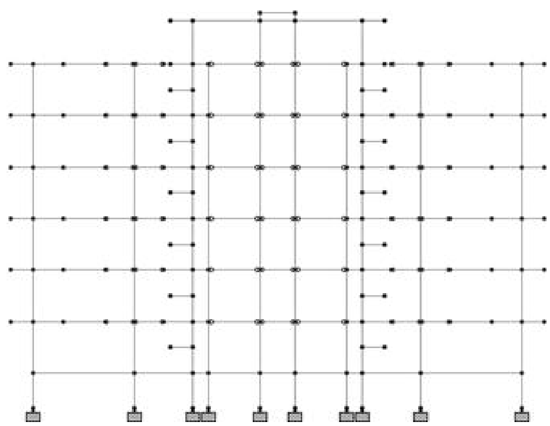

Fig.3.2. Elevation of the G+5 storey building.

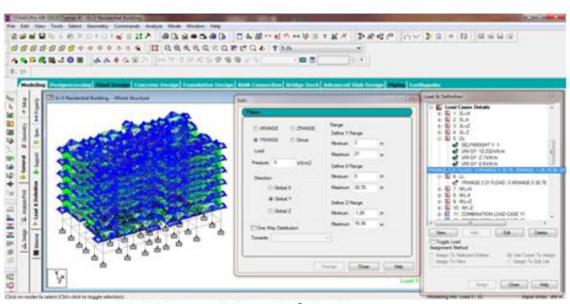

Fig.3.3. Input window of floor load generator.

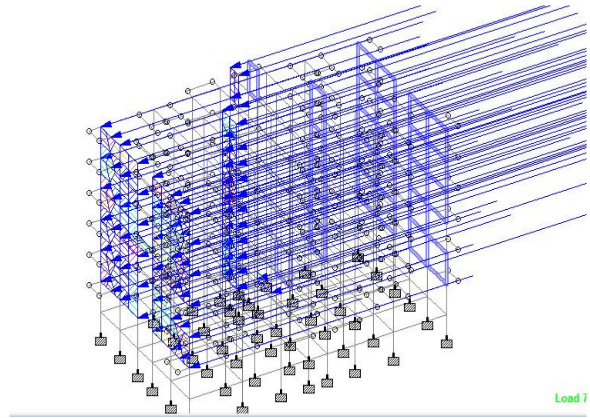

Fig.3.4. Assigning wind load in WL+X direction.

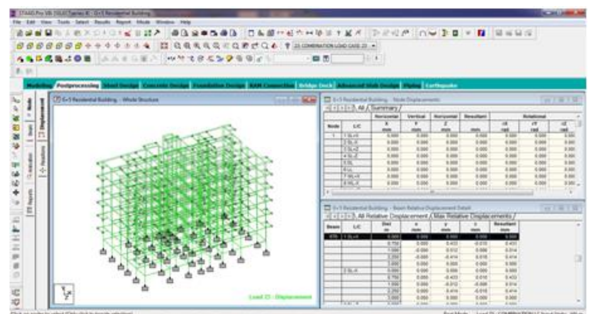

Fig.3.5. Post processsing mode in STAAD.Pro

4. CONCLUSION:

STAAD PRO has the capability to calculate the reinforcement needed for any concrete section. The program contains a number of parameters which are designed as per IS 456(2000). Beams are designed for flexure, shear and torsion.

Design for Flexure:

Maximum sagging (creating tensile stress at the bottom face of the beam) and hogging(creating tensile stress at the top face moments are calculated for all active load cases at each of the above mentioned sections. Each of these sections are designed

to resist both of these critical sagging and hogging moments. Where ever the rectangular section is inadequate as singly reinforced section, doubly reinforced section is tried.

Design for Shear:

Shear reinforcement is calculated to resist both shear forces and tensional moments. Shear capacity calculation at different sections without the shear reinforcement is based on the actual tensile reinforcement provided by STAAD program. Two-legged stirrups are provided to take care of the balance shear forces acting on these sections.

Beam Design Output:

The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

Column Design:

Columns are designed for axial forces and biaxial moments at the ends. All active load cases are tested to calculate reinforcement. The loading which yield maximum reinforcement is called the critical load. Column design is done for rectangular section. Rectangle columns are designed with reinforcement distributed on each two side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under bi-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design of STTAD.

STAAD. foundation:

STAAD. Foundation can automatically absorb the geometry, load and reactions from a STAAD.Pro module and accurately design isolated, pile cap, strip footing, true mat foundation and even perform pile arrangements for a pile cap.

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