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A REVIEW ON VERTICAL IRREGULARITY OF BUILDING WITH SHEAR WALL FRAMED STRUCTURES AND ITS EFFECTS DUE TO WIND FORCES

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Abstract : Now daily, the multi-storey building will be for the purpose of the general, industrial and commercial, etc. for the design of these high structures as well as wind loads and earthquake charges for their consideration for analysis. Structures that exhibit this discontinuity in physical property or geometry are referred to as irregular structures. In the present study the verification of the modeling and analysis of vertical irregular structures using different structural software is shown and many of the standard codes are used for the design of all elements and for the designed and final wind loads of this review article with the comparison of the structure behavior like displacement, drift etc .of these irregular vertical buildings with symmetrical regular ones.

***IndexTerms* - Geometry, Vertical irregularity, wind analysis, shear wall, Multi-storey**

I. INTRODUCTION

Because congested land promotes high rise buildings, high rise or multi-story buildings are a necessary part of urban locality and also a part of developed country. Since the last decade, people's demands and changes in lifestyle have outpaced their expectations. For example, in the 1800s, the design of buildings and other structures was very simple, with symmetric geometry. However, as a result of the increased architectural demand, building plans are becoming asymmetric and irregular in both horizontal and vertical geometry. This irregularity causes a discontinuity in the structure's mass and stiffness. In addition to this, the height of the building is taken into account when analysing the structure's stability. Multi-story buildings, also known as skyscrapers, are currently popular. And it is the structural designer who is tasked with solving the problem of high-rise buildings and irregular geometry. Because structural failure begins at the points of weakness, and these points of weakness arise as a result of separation in mass, stiffness, and an instant change in the vertical plan of the structure. Irregular structures are those that have a discontinuity in physical property or geometry. Plan irregularity and vertical geometric irregularity are the two types of irregularity. If a plan has different plan configurations, this is referred to as plan irregularity, and the seismic response is not only translational but also rotational, this causes eccentricity in the structure's mass and stiffness. Vertical Geometric Irregularity is defined as the horizontal dimension of the lateral force resisting system in a storey being greater than 150 percent of that in its adjacent storey. If the building is located in a severe zone with lateral forces such as wind and seismic, stability becomes critical. At this stage, structural software such as STAAD PRO, ETABS, SAP2000, SAFE, and others are used to analyse and design these structures. This paper is based on software wind analysis of tall buildings with vertical irregularity.

LATERAL FORCE EFFECT ON VERTICAL IRREGULARITY

Vertical irregularity is the most important factor to consider when analysing a multi-story building. The behaviour of structures with these irregularities in the event of an earthquake must be investigated. Adequate safeguards will be put in place. An in-depth examination of the structural behaviour of buildings with irregularities required for design and behaviour. Multi-story structures are primarily intended to withstand static loads. Typically, the outcome of dynamic masses acting on structure is ignored. This characteristic of ignoring dynamic forces is frequently the cause of disaster. Over the last 20 years, wind engineering has become increasingly focused on modest low rise and high rise structures, as a large portion of the damage and loss associated with extreme wind events occurs to those minimally designed buildings such as low rise buildings, as well as large loss if encountered by high rise buildings. In a vertical irregular structure, the mass, stiffness, and geometry of the structure separate, and this separation or sudden change in geometry causes the structure to fail. Vertical irregularity is the primary cause of sudden collapse and overturning of structures; thus, structural irregularity is a critical parameter for structural engineers to consider when designing. A strong wind blows against a building. The mean wind force is derived from the mean wind speed and, as a result, the unsteady wind force produced by the unsteady flow field. The effect of an unsteady wind force on a building or a portion of a building is determined not only by the characteristics of the unsteady wind force, but also by the dimensions and vibration characteristics of the building. As a result, in order to estimate the planning wind load. It is necessary to assess the characteristics of unsteady wind forces and, as a result, the dynamic properties of the building. The following factors are commonly considered in determining the unsteady wind force: 1) Turbulence in the wind (temporal and special fluctuation of wind) 2) Vortex formation in the wake of a building 3) For many buildings, the result of unsteady wind force generated by wind turbulence dominates the interaction between building vibration and encompassing air flow. As a result, wind load is required to be considered in high-rise buildings or buildings with a height greater than 10 metres, with some factors varying depending on the type of structure, zone, topography, terrain category, and so on

II. LITERATURE REVIEW

1. **A.Pavan Kumar et al. (2017)** performed analysis of high rise building about G+30 framed structure building situated in zone four and zone five in soil type 2 (medium soils) and analysis were done by ETABS. Gravity and Lateral loads were considered as per Indian standards with guidelines of IS 1893:2002 for (Earthquake load) and IS 875:1983 for (Wind load). The plan area was taken as 24.14m×20.627m and height of each storey was 3m. Modelling and analysis were done in ETABS 2013 software. The results of each zone were compared by displacement characteristics, shear at base and storey drift values. And conclude that storey drift is gradually increases from top storey to bottom storey in both zones specially zone 5 has higher value of drift and storey shear.

2. **Rupesh R.Pawade et al. (2017)** Performed (Non-linear static) pushover analysis on G+16 storied building having vertical irregularity. Five types of buildings are modelled in which one model is regular and other four is vertical irregular. SAP 2000 software is used for analysis and concluded regular building having more capacity to resist lateral forces with minimum deformation as compared to vertical irregular setback buildings.

3. **Shashikanth et al. (2017)** shows the demand of vertical irregular structure and need of lateral loads considerations in analysis of tall buildings. Describe the weakness in irregular structure which tends to sudden failure or rupture caused by uneven separation in mass, change in stiffness and vertical geometry of structure. Describe the difference in regular and irregular structure according to analysis. Also defined the termed "irregularity" with its two types namely Plan irregularity and Vertical irregularity. Vertical irregularity is said to be when in a storey the horizontal area of wind force resisting surface is 150% more than its adjacent storey. Three models were prepared for analysis. In which one model is regular (same geometry till top storey i.e. 15th storey) and other two was irregular having setbacks at different levels (one sided vertical setback at 4th storey and 8th storey respectively) and two sided vertical setbacks at 4th storey. All models having 900 meter square area and 45m height each. ETABS was used for modelling and analysis of all structure. All loads are taken as per Indian code. For wind load IS 875-1987 were used. Conclude that i) irregular geometric structure poses same base shear but gives higher value of inter storey drift values. ii) In case of irregular structure having setbacks at lower level shows the maximum displacement values as compared to other irregular structure having setbacks at high level. iii) Regular Structure without setbacks proved safest structure with little amount of displacement value.

4. **Piyush mandloi et. al (2017)** Analysed four different building models which are vertically irregular as well as each model is analysed for mass irregularity and the results were compared with regular building in geometry and mass. The seismic analysis was done to study storey deflection, storey drift, overturning moment and base reaction in all four models by considering different time histories which are chichi(1999), petrolia(1992), friuli(1976), northridge(1994) and sylmar respectively. Result showed that the designs worked for seismic zones must consider time history data while designing vertical and mass irregular building.

5. **K.divya et al. (2016)** Explain the types of structure with respect to regular structure and irregular structure and effects of wind force of 50m/sec on tall structures such as it exerts lateral forces and moments in structure. This paper is depend upon Indian standard codes and followed IS 875 part 3-1987 for wind load. In this paper four models (G+10) was prepared having total height of 37.5m with the plan area of 35.77m x 24.42m. Four models was prepared for different irregularity the models are Regular, vertical irregular, stiffness irregular and vertical and stiffness irregular buildings. Showed the detailed calculations of gravity and lateral load. Analysis was done by using Staad pro software. At the end conclude that bending moments and shear forces gives minimum values with its increasing height in regular and stiffness irregular buildings. Models having irregularities shows maximum amount of displacement and deformation as compared to regular building.

6. **Shaikh Muffassir et al (2016)** This study shows The high rise structure or building is the necessity of metro cities. The multi-story high rise RC building is larger and less elastic in nature as judge against to compound structures. This study investigates the similarity or comparison between RCC and composite structure under the effect of wind, additional to it compound structure also includes unlike plan configurations. this study has total 15 number of building model are arranged and analysis for wind load by using ETABS 2015software. The various software are work on wind and earthquake analysis but we goes for software ETABS 2015.The wind analysis is performed for unlike heights such 20m, 50m and 80m respectively. In adding together, the comparative study concludes that the compound structure are bigger elas tic in nature and more at risk as compare to RCC structure and the compound option is better than RCC for multi story structure..In addition, the comparison of unlike plan configuration shows that the response of parameter such as story displacement, story stiffness, base reaction and time period under effect of wind. The reason of this analysis is to conclude the most efficient shape of construction in horizontal zone.

7. **Md. Mahmud et al. (2015)** has worked on building shapes and elaborates the effects on each shape under wind and earthquake. Three different complex shaped buildings are taken and compared with each other under critical wind and earthquake loads. Designing procedure is done by using (BNBC) 2006 that is standard national code from Bangladesh. Shows the effects on different building shapes through displacement of building by considering L-Shaped, hollow rectangle shaped and rectangle with more corners having ideal plan area of 600sq.m and 18m height. There are two highlighted and more convenient methods are available to analyse the wind forces namely „surface area method‟ and „projected area method‟. In this study „projected area method, were used. For seismic analysis „Equivalent static force‟ method is used. Conclude that maximum displacement is occur due to wind pressure in L-shaped building in axis having small area because the system of resisting wind pressure is depend upon wind contact surface area. The weakest node in case of earthquake load is not weak for wind load. Also maximum storey drift have been seen in the same model.

8. **Anju Krishna et al. (2015)** the architectural demand arises and it becomes necessary to take lateral loads consideration in tall buildings. Explained lateral forces resisting systems in structure such as shear wall, rigid frame wall frame, braced tube system, and diagrid system. The diagonal members as a beam are used in this system with the angle of inclination 74.5 degree. In this study 36 storied building is modelled having 130m height with plan area of 36m ×36m. Three models were prepared having vertical irregularity with the setbacks at 25% 50% 75% total height of building. Steel sections were used as members of diagrid and columns of structure. Same ideal models were prepared in tubular system and compared with diagrid system structure. Wind speed was taken as 30m/sec. After analysis of all models conclude that the diagrid system having vertical irregularity shows little amount of displacement and storey drift value as compared to tubular system. Diagrid system gives more attractive architectural appearance and better interior space as compared to conventional systems. Diagrid system proved more efficient system in high-rise building with vertical irregularity under maximum wind loads.

9. **N.Anvesh et al. (2015)** Wind engineering has more focused over last two decades on high rise as well as modest height buildings. Worked on analysis of G+10 storied building under lateral loads and compared regular building with mass irregular building having same configuration but change in load in 3rd and 6th storey (mass irregular). Shows effect on structure due to mass irregularity. E-tabs software is used for analysis and resulted that in refuse area beam gives more value of bending moment and shear force with 67% more in mass irregular building. Displacement and sizes of structural members increases in mass irregular building.

10. **Ramesh Konakalla et al. (2014)** Shows impact of vertical irregularity in multi storied buildings when dynamic loading is subjected. In this linear static analysis considering four forms of 20- Storied 3D frames. Found for regular frame, there's no torsional impact within the frame within the symmetry. The response for vertically irregular buildings is totally different for the columns that are situated within the plane perpendicular to the action of force. This is often because of the torsional rotation within the structure.

11. **Abhay guleria et al. (2014)** Describe the advantages of ETABS software using for analysis of multi storey and different plan configuration buildings. Shows the structural behaviour of multi storied structure with rectangular, L, I and C-shaped plan buildings. The 15 storied building were considered in each case and after analysis of all cases are compared with each other for individual structural behaviour in terms of maximum shear force, bending moment and storey displacement. The plan area of 32m×24m considered with each storey height of 3m. Buildings are situated in zone 5. ETABS is used because of its simplicity and accuracy. And conclude that L-shaped and I-shaped plan structure shows the nearly same in result. Asymmetric plans undergo more deformations hence symmetrical plan should be adopted.

12. **Sanhik et al (2014):** Presented the comparison between wind and seismic load on different types of structures. In this study, the effect of wind and seismic both will be considered and compared them according to IS 875(Part 3)-1987 and IS 1893(Part 1)- 2002. The modeling and analysis of (G+5) structures are done by using STAAD Pro. They compare results of bending moment due to wind and earthquake loads. After analysis and result they conclude that, the bending moment due to earthquake loads are greater than bending moment due to wind loads.

13. **Poonam et al. (2012)** Results of the numerical analysis showed that any storey, especially the first storey, must not be softer/weaker than the storeys above or below. Irregularity in mass distribution also contributes to the increased response of the buildings. The irregularities, if required to be provided, need to be provided by appropriate and extensive analysis and design processes. Although the above researchers and few others have given useful insights into the topic of vertical irregularities and their effects on structural response against seismic analysis, but these studies are not carried out against wind analysis. For that reason, in this thesis work an attempt is made to determine the percentage variation of displacements in frames with vertical discontinuity and without vertical discontinuity at variable wind speeds for different zones in India.

14. **Syed Fahad Ali et al** presented the work on seismic analysis of RCC and steel concrete composite structure. The modeling and analysis of RCC and composite buildings has done by finite element based software ETABS 2015 and also buildings are categorized with number of stories. In addition, they also presented the cost comparison of RCC and composite structure with different support condition. From overall view of analysis and result, they suggest that the composite structures are more economical than RCC structure and the composite structures are better option for multi-story buildings to resist the seismic loads.

15. **Sarkar et al. (2010)** had worked on stepped building frames having vertical irregularity. Gives the examples of stepped building in Delhi India. Proposed alternative process for estimating the irregularity present in building frames to know well about dynamic characteristics of the same building such as mass of structure and stiffness also proposed the equation to determine the fundamental time period for irregular stepped buildings. This formula is valid for all types of stepped buildings having vertical irregularity.

III. CONCULSION

Many papers were reviewed in this study, and we are now aware that there are two types of structural irregularity: plan irregularity and vertical irregularity. And vertical irregularity causes structural weakness and failure due to mass separation and stiffness when subjected to lateral loads (wind and seismic). However, in the case of multistory buildings, wind analysis is more important than seismic analysis. There are numerous standard codes available for various countries. Many of the researchers used ETABS structural software to assign wind loads. It provides analytical results and structure behaviour with less effort. According to the findings of this study, the value of drift increases from top to bottom storey with sudden fluctuation at irregular floor. In the case of a vertical irregular structure subjected to lateral loads, higher values of drift, axial force, bending moment, and base shear were obtained. In the irregular structure, the amount of joint displacement for lateral loads was observed to be greater than in the regular structure. ETABS reduces effort and time, and the software used for analysis, particularly lateral loads, is simple to use. Details on each and every member can be obtained. Vertical irregular structures require lateral force resisting systems that are modern and effective, such as the tubular and diagrid systems.

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