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A Review on Effect of Wind and Seismic Forces on Vertical Irregular Structure

Dr. A. R. Gupta[1], Mr. V. P. Dhawale[2]
[1]*Guide and ME coordinator, Department of structural Engineering, C.O.E.T. Akola, S.G.B.A.U. Amravati (India)*
[2]*ME Student, Department of structural Engineering, C.O.E.T. Akola, S.G.B.A.U. Amravati (India)*

Abstract: ***From last few decades, The number of tall structures and skyscrapers around the world has increased drastically which is serving many purpose like residential, offices etc. and many other commercial requirements. Beautiful aesthetic appearance and eye catching shapes and projections of the structures has increased the demand of tall structure. In the perspective of structural engineer designing such eye catching shapes and the projections in a high rise structures is a challenging job to study the behaviour of structure. In vertically irregular structure, failure of structure starts at a point of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. When wind forces and earthquake waves comes in contact with structure it harms more to irregular structure because of its change in sudden stiffness results in more excitation of structure as compare to regular.***

Keywords: High Rise Structure, Vertical Irregularity, Mass Irregularity, Shape Irregularity

I. INTRODUCTION

Earthquake is the most devastating and destructive of all the natural calamities. Earthquake is distinctive shaking of the earth surface which results in damage of the structures and causes several hundreds of causalities or loss of life. The earthquake is caused due to the energy released at the movement of faulty rocks. There will be continuous movement of the rock. The earthquake occurred in past days proves that effect on the building Structures, loss of human lives, damage on the ancient structures, flyovers bridges etc. this will directly affect the growth of the country. Many researches are carried out to design an earthquake resistant structure, but still it is not been possible to design the earthquake resistant structure without causing damage. Vertical irregular structures constitute a large portion of the modern urban infrastructure.

The group of people involved in constructing the building facilities, including owner, architect, structural engineer, contractor and local authorities, contribute to the overall planning, selection of structural system, and to its configuration. This may lead to building structures with irregular distributions in their mass, stiffness and strength along the height of building. When such structures are located in a high wind zone and seismic zone, the safety of the structure becomes more challenging. So to acquire safety against additional deformations there is need to study of detailed considerations to design earthquake resistance structures as well as wind resistance structure.

II. LITERATURE REVIEWS

G. Guruprasad et. al (1) Evaluated G+15 storey building by considering irregularity in plan. The dynamic analysis by using ETABS software was done to study story drift, story shear, support reactions, building mode section cut forces of RC building with plan irregularity in terms of performance point and the effect of earthquake forces on the multi storey building frame with the help of dynamic analysis in zone v according to IS 1893:2002.The irregularity in terms of plan L and C shapes are taken into consideration. It was observed that the maximum value of storey shear was observed for L- shape plan than regular building and C-shape building. From evaluation it was concluded that rectangular and L-shape buildings in plan perform better in case of dynamic analysis as compared to C-shape buildings.

Piyush mandloi et. al (2) Analyzed four different building models which are vertically irregular as well as each model is analyzed 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.

Nonika. N et. al (3) Performed seismic analysis on 16 storey building, symmetrical in plan and irregular in elevation for seismic zone II, III, IV and V. The Response Spectrum Method was used to find maximum displacement, storey drift, base shear and natural time period. Results shows, The base shear and lateral displacement gradually increased with increase in zone factors for both the

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models, However lateral displacement is less in regular model as compared to vertical irregular model.

Anupam Rajmani et. al (4) Performed wind and earthquake analysis for a different shapes of high rise buildings such as rectangular, triangular, square and circular. The buildings are planed such that base area of each model is same. Apart from different shapes the models were also analyzed by considering three different storey height such as 15 storey, 30 storey and 45 storey. Results shows, For 15 storey building the most stable structure is circular and triangular shape for maximum earthquake and maximum wind load respectively. Similarly for 30 storey building rectangular shape is most stable for maximum earthquake and wind load and for 45 storey building circular and rectangular shape is most stable for maximum earthquake and wind load respectively.

Albert Philip et. al (5) Performed Response Spectrum Analysis on a 13 storey buildings, irregular in plan by using ETABS-2015 software for seismic zone III in India, also to carryout ductility based design using IS 13920. The analysis was done to compare parameters such as storey displacement, storey drift, storey shear and stiffness with each other and with respect to floors. Results shows, Storey displacement increases linearly with height of the building; maximum storey drift is observed at second floor for irregular structure and at fourth floor for regular structure; maximum storey shear force was observed between ground floor and second floor for regular structure and at ground floor for irregular structure and the value decreases linearly with height; storey stiffness varies non-linearly for both the structures with maximum value at ground floor.

Vidhya Purushothaman et. al (6) Evaluated fifteen storey building, irregular in plan configuration such as Rectangular, C-shape, L-shape and H-shape along with two different composite columns made of concrete and steel sections. Seismic response spectrum analysis was done for seismic zone three by using ETABS-2015 and the results of base shear, storey displacement and storey drift are compared with each other. It was observed that rectangular plan building shows better base shear resistance for both type of composite columns, However L-shape building has lesser resistance to base shear in either composite column section. The values of storey drift are more in rectangular building in case of concrete filled steel tube column and it is more in L- shape building in case of encased I section column. However, storey displacements are more in rectangular and L-shape plan in both composite column section.

V. Guruprasad et. al (7) Studied effect of P-DELTA on structural irregularities in high rise buildings. There are two types of irregularities such as plan irregularity and vertical irregularity considered, In case of plan irregularity C, L, H and T shape plans and In case of vertical irregularity stiffness, geometric and mass irregularity are taken and the results were compared with a regular rectangular structure. Apart from irregularity five different storey height are also consider for analysis. From the results of storey displacement, moment and storey drift; it was observed that structures with irregularity configuration are 40% more prone to destabilizing stresses when compared to conventional rectangular non-irregular structure.

Mr. Pathan Irfan Khan et. al (8) Reviewed data of different vertical irregular RCC structure having mass irregularity at a different floors. The response spectrum analysis of a vertical irregular structure was performed by using STAAD Pro and the results of storey drift, storey displacement and base shear are compared with conventional regular structure. It was observed that lateral displacement of the building is reduced as the percentage of irregularity increase.

Shashiknath H. et. al (9) Analyzed fifteen storey vertical geometric irregular RC structure subjected to wind load according to IS 456-2000 and IS 875-1987 by using ETABS software package. The results of storey displacement, storey drift and base shear were compared with regular structure.

Mr. Sagar B. Patil et. al (10) Studied behavior of plan and vertical irregularity of a structure by time history analysis and response spectrum analysis using ETABS according to IS 1893-2002. From the results of response spectrum analysis it was noted that the storey drift and storey displacement is maximum in both irregular plan and vertical irregular structure.

III. DETAIL STUDY

A. Study on Concept of High Rise Structure

A high-rise structure is a multi-story structure between 35- 100 meters tall, or a building of unknown height having more than 12 floors used mainly as a residential and/or office building. Advances in construction technology, materials, structural systems and analytical methods for analysis and design facilitated the growth of high rise structures. High-risestructures became possible with the invention of the elevator and cheaper, more abundant building materials. The materials used for the structural system of high-rise structure are reinforced concrete and steel. A building with fifty or more stories is generally considered as a skyscraper. High-rise structures pose particular design challenges for structural engineers, particularly if situated in a seismically active region or if the structure is exposed to high wind forces. Meanwhile high-rise structures have technical and economic advantages in areas of high population density and in regions where horizontal development is restricted or not possible and hence have become a distinctive feature of housing accommodation in virtually all densely populated urban areas around the world.

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B. Vertical Irregularities and Its Seismic Effect

Vertical Irregularities are mainly of five types

1) *Stiffness Irregularity:*

a) Soft Story: A soft story is one in which the lateral stiffness is less than 70 per-cent of the story above or less than 80 per-cent of the average lateral stiffness of the three stories above.

b) Extreme Soft Story: It is one in which the lateral stiffness is less than 60 per-cent of that in the story above or less than 70 per-cent of the average stiffness of the three Story's above.

2) *Mass Irregularity:* When the weight of any story is more than 200 percent of the adjacent story, then it considered as mass irregularity.

3) *Vertical Geometric Irregularity:* A structure is considered to be Vertical geometric irregular when the horizontal dimension of the lateral force resisting system in any story is more than 150 percent of that in its adjacent story.

4) *In-Plane Discontinuity in Vertical Elements Resisting Lateral Force:* An in-plane offset of the lateral force resisting elements greater than the length of those elements.

5) *Discontinuity in Capacity:* Weak Story-A weak story is one in which the story lateral strength is less than 80 per-cent of that in the story above Vertical irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with setbacks and step backs are the remarkable structures which collapsed. So, the effect of vertically irregularities in the seismic performance of structures becomes really important. The dynamic characteristics of buildings with vertically irregular configuration differ from the regular building. When such buildings are constructed in high seismic regions the analysis and design becomes more complicated. Hence structural engineer needs to have a thorough understanding of the seismic response of structures having vertical irregularities.

IV. CONCLUSION

Study reveals that the effect of seismic forces are more vulnerable in terms of Displacement , Drift values , Member end forces and Moments developed. The wind and seismic forces affects more at where irregularity introduced and damage elements at great extent as compare to other portion of structure.

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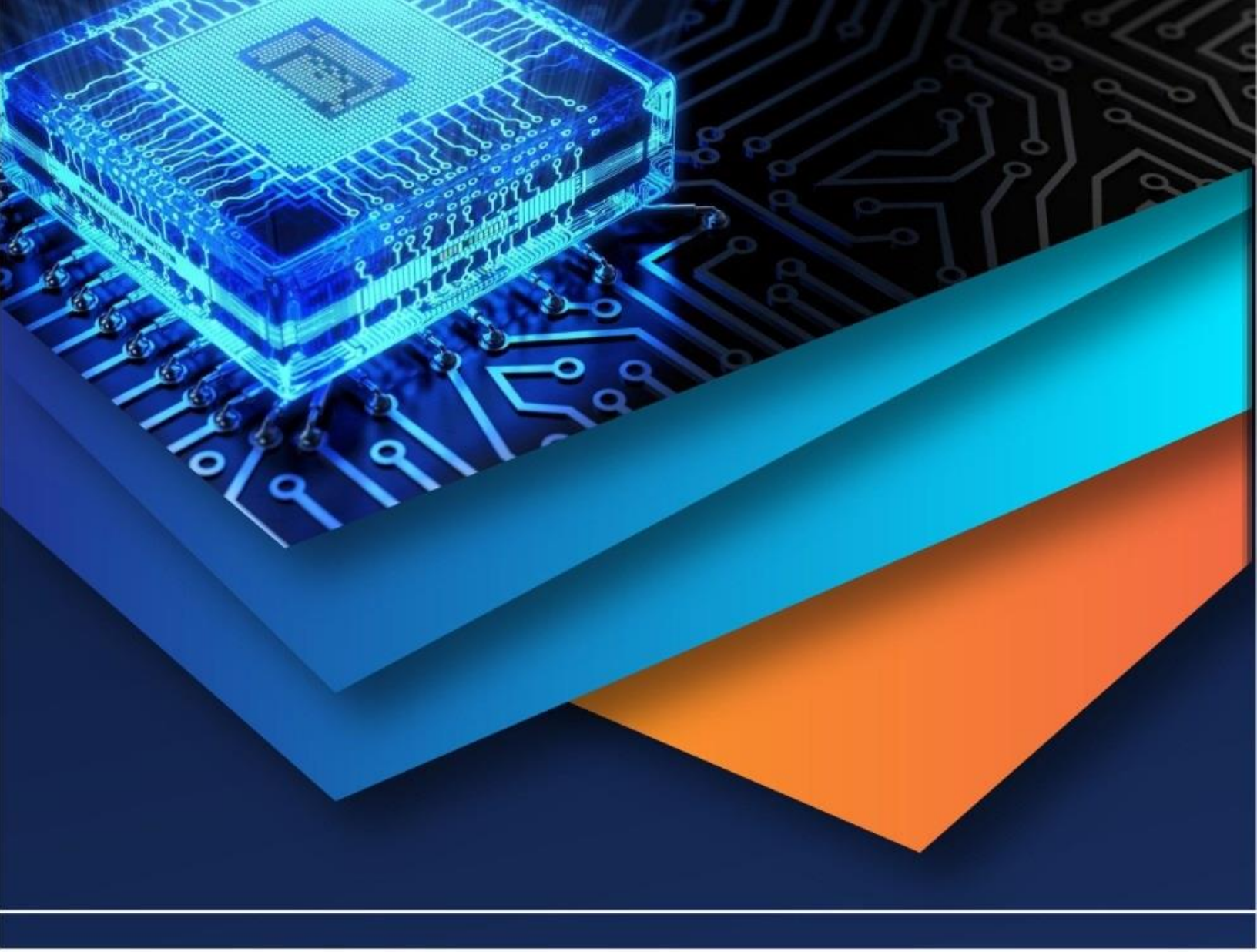
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