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Vertical Irregularity of Building: A Review

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ABSTRACT:

Building designs are becoming more and more well-known every day. There are numerous types of construction utilized, in buildings the distribution of mass, stiffness, and strength in both vertical and horizontal directions determines how well a high-rise building performs during powerful seismic events. Buildings that exhibit discontinuities in mass, stiffness, or strength between adjacent floors are classified as irregular buildings. This review examines numerous studies that examine vertical irregularities in buildings utilizing varying load conditions, building types, and software, as well as the behavior of buildings with respect to strength and seismic activity.

I. INTRODUCTION

Structure failure begins in weak spots during an earthquake. The discontinuity in mass, stiffness, and structure geometry are the causes of this weakness. Irregular structures are those that exhibit this discontinuity. During earthquakes, vertical abnormalities are a primary cause of structural failures. These buildings differ from "regular" buildings in terms of their dynamic characteristics due to variations in stiffness and mass with height. Vertically irregular structure defined by IS 1893: The irregularities observed in the building constructions could perhaps be attributed to the uneven distribution of mass, strength, and stiffness over the building's height. Two categories of abnormalities exist: first is Horizontal irregularities The second irregularity is vertical.

II. VERTICAL IRREGULARITIES OF BUILDING

Significant variations in stiffness, strength, mass, size, or a discontinuity in the buildings could be the cause of the vertical irregularity. The list of four varieties of vertical irregularity is- They are: (a) In-plane discontinuity in lateral-force-resisting vertical parts; (b) Mass irregularity; (c) Vertical geometric irregularity (set-back); and (d) Stiffness irregularity (soft story).

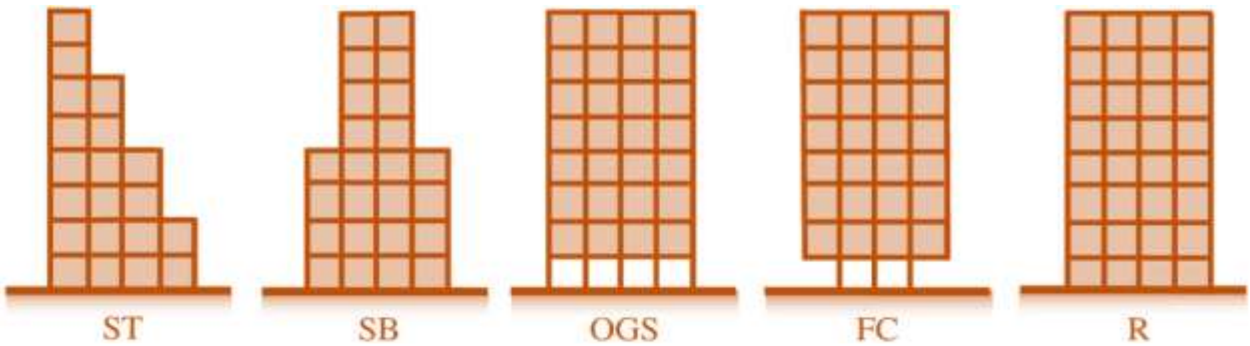

Figure 1 Vertical irregularity of building

III. LITERATURE REVIEW

On the vertical irregularities of buildings, several works are presented. which, when summed together, are as follows: -

Jack P. Moehle (1984) Using techniques from static analysis, the seismic response of four irregular reinforced concrete test structures is interpreted. The four test buildings were scaled-down replicas of multi-story building frames made up of frame wall and frames. blends. The structural walls were interrupted at different levels, resulting in discontinuities in the vertical plane of the constructions. It is discovered that under significant earthquake motions, standard limit analysis and static inelastic analysis offer reliable measurements of strength and deformation properties.

Devesh P. Soni (2006) This article compiles the most recent studies on the seismic response of vertically unequal building frames. What is considered vertical irregularity under current construction rules has been explored. An overview of the studies conducted on how vertically unequal constructions behave during earthquakes is given, along with the findings. It has been observed that building codes provide guidelines for classifying projects that are vertically unequal and suggest using dynamic analysis to ascertain the lateral stresses of the design. Most studies agree that buildings with discontinuous mass, stiffness, and strength distributions are more seismically demanding, and that the tower component of set-back structures requires more drift.

Himanshu Bansal (2012) Response spectrum analysis (RSA) and time history analysis (THA) of vertically uneven reinforced concrete building frames are the main goals of this research. Additionally, ductility-based design employing IS 13920, which stands for equivalent static analysis and time history analysis, is carried out. Three different kinds of abnormalities were taken into consideration: irregularities related to mass, stiffness, and vertical geometry. Our observations show that the storey shear force is always at its lowest in the top storey and reaches its highest in the first storey. It was found that the base shear of the mass irregular structures was greater than that of comparable regular structures. The rigidity uneven structure has larger inter-storey drifts and less base shear.

Nonika, N. (2015) A five-bay by five-bay, sixteen-story building with lift core walls, each storey height of 3.2 metres, and uneven elevation is regarded as the soft storey three-dimensional structure in this study. It is presumed that an irregular building exists in every zone. utilising a conventional and practical FE software programme, the irregular building's linear dynamic analysis utilising the Response Spectrum approach is completed. All of the structures are examined in order to calculate the impact of varying degrees of abnormalities. Furthermore, the conducted study facilitates an understanding of the behaviour that occurs in irregular buildings relative to regular buildings. The behaviour characteristics taken into consideration for this are: 1) Maximum displacement 2. Shear at the base

Abdul Rahman, Shaikh Abdul Aijaj (2016) Here, they examine how variations in the mass and stiffness of the frame on vertically uneven structures affect the proportional distribution of lateral forces that are generated by seismic action at each story level. Software based on the finite element approach is used to study the influence of mass and stiffness irregularity of G + 10-storeyed vertical geometric irregular architecture. Storey shear, storey displacement, and storey drift are three ways that the structure's response is assessed: linear static analysis and linear dynamic analysis. Plots and comparisons of the responses have led to the drawing of conclusions.

Aijaz Shaikh (2016) This study's primary goals are to comprehend the many irregularity responses resulting from plan and vertical irregularity, to analyse "geometric irregular"-shaped buildings during the action of seismic forces, and to compute column deflection. It is important to take into account further increases in deflection because they lead to the collapse of columns. Therefore, this additional deflection needs to be included in design techniques.

Ravindra N. Shelke (2017) Response spectrum analysis (RSA) of vertically uneven RC buildings is the project's main goal. The analysis and design outcomes of irregular structures were compared to those of regular structures. Three different kinds of abnormalities were taken into consideration: irregularities related to mass, stiffness, and vertical geometry. It was found that the base shear of the mass irregular structures was greater than that of comparable regular structures. The rigidity uneven structure has larger inter-storey drifts and less base shear. For upper levels, the absolute displacements discovered by time history analysis of the geometric irregular structure at the corresponding nodes were found to be larger than those found in the case of the regular structure; nevertheless, as we descended to lower stories, displacements in both structures eventually tended to

Oman Sayyed (2017) The distribution of stiffness, strength, and mass in both the vertical and horizontal planes affects how well a high-rise building performs during powerful earthquake events. Buildings that exhibit discontinuities in mass, stiffness, or strength between adjacent floors are classified as irregular buildings. The performance and behaviour of regular and vertical irregular G+10 reinforced concrete (RC) buildings under seismic loading is the main topic of this study. This study examines stiffness and setback, two different forms of vertical abnormalities. Response spectrum analysis (RSA) is used to do seismic analysis on a total of eight regular and irregular buildings that have been modelled.

Kolukula Sai Kiran (2018) Response spectrum analysis (RSA) and time history analysis (THA) of vertically uneven reinforced concrete building frames are the main goals of this research. Additionally, ductility-based design employing IS 13920, which stands for equivalent static analysis and time history analysis, is carried out. Three different kinds of abnormalities were taken into consideration: irregularities related to mass, stiffness, and vertical geometry. Our observations indicate that the storey shear force is highest in the first storey and, in all cases, lowest in the top storey. It was found that the base shear of the mass irregular structures was greater than that of comparable regular structures. Three different kinds of abnormalities were taken into consideration: irregularities related to mass, stiffness, and vertical geometry.

Kumar R (2018) The most deadly natural disasters that result in significant loss of life and livelihood are earthquakes. Since building collapses or damages account for the majority of losses, it is crucial that structures be designed in compliance with codal specifications. Since the majority of the physical processes we observe on a daily basis are nonlinear, we cannot ignore them. Pushover analysis thus aids in our comprehension of the nonlinear behaviour of the structure under gravity loads and the monotonic increase in lateral load. The pushover analysis approach is used in this study in accordance with IS 1893 (part 1):2002 criteria, and ETABS version 15.2.2 was used for the analysis.

Shridhar Chandrakant Dubule (2018) The impact of different vertical abnormalities on a structure's seismic response is the subject of the study. Response spectrum analysis (RSA) of vertically uneven reinforced concrete building frames and ductility-based design using IS 13920, which corresponds to RSA, are the project's goals. The outcomes of the examination of irregular structures are compared to those of regular structures. Three different kinds of abnormalities were taken into consideration: mass irregularity, stiffness irregularity, and stiffness &mass irregularity. Our observations show that the storey shear force is always at its lowest in the top storey and reaches its highest in the first storey.

Latip Kumar Sharma (2019) According to the needs for both functionality and aesthetics, the construction of vertically uneven buildings is almost inevitable in this study. Nevertheless, post-earthquake damage assessment reveals that structural irregularity is critical to the buildings' seismic performance. Sudden change in the strength, stiffness as well as load path discontinuities raise the seismic demand of the building which increase the susceptibility of the buildings. A specific geographic area's seismic risk assessment necessitates the use of fragility models for various structure types.

Sujan Mondal (2021) Three of the seven models in this study—mass irregularity, stiffness, and vertical setbacks—were taken into consideration. All of the aforementioned abnormalities are combined in the other three variants. The factors selected for evaluating the seismic reactions are in terms of the basic time period, Capacity Curve, Displacement Profile, and Inter-Storey drift Ratio. These choices are based on the analysis results of each configuration. The findings show that setback buildings' reaction amounts are significantly higher than those of conventional buildings. It is discovered while comparing the analysis results that pushover analysis exaggerated the number of responses. The irregularity has an impact on the seismic reaction as well.

Prit B Sathwara (2021) For the seismic zone V described in IS 1893 (Part I): 2016, linear static dynamic analysis, such as response spectrum analysis, has been performed in order to comprehend the performance characteristics of the irregular frame in comparison with regular RC frame. ETABS 2018 software is used to model and analyse every building frame. The maximum value of base shear is shown by a regular frame with a shear wall. Among all the models, the conventional frame with basement exhibits the longest duration. Step frames with basements exhibit the highest storey drift values, whilst step frames without shear walls have the highest top storey displacement values. The total structure, including the basement, provides a greater storey stiffness value.

Somya Diwan (2021) Five frameworks with a single irregularity and one with a combination of irregularities are formed when a ten-story conventional building frame is altered and integrated with different vertical irregularities in elevation. Additionally, numerical testing of the frameworks with a shear wall present has been done. Seismic loading is applied to all structures, and the outcomes are shown quantitatively. Response spectrum analysis, utilising STAAD PRO V8i in the form of maximum nodal displacements, base shear reactions, mode shapes, and storey drifts, is performed.

Basu Dhakal (2022) The primary objective of earthquake engineering is to plan and build a structure so that, by implementing the appropriate precautions, the building's and its structural components' damage is minimised during an earthquake. There is a broad range of damage that seismic excitations can do to buildings. Even when the same location, earthquake, and structural structure are taken into account, the system's damages are not uniform nor consistent.This study compares the seismic performance of structures with regular and irregular floor designs as its main objective. The current study examines models of RCC structures with both regular and irregular floor designs and G+9 stories. We perform a dynamic study of the model using the ETABS application.

Khare Basant (2020) This review's primary goals are to oversee the construction in high seismic zone IV and to evaluate the design horizontal powers, story toppling second, story drift, and lateral displacement. For this reason, a 10-story building with four astonishing shapes—a rectangular, C-shaped, H-shaped, and one without a shear divider—as well as an optional shear divider with a glass outline are used as an experiment. The STAAD.Pro 2015 form was used to analyse all of the models. Comparative Dynamic Analysis has been used in the current evaluation to evaluate how much the design has been distorted for each of the four examples. Findings and Recommendations: divider

IV. CONCLUSION

After reviewing every study mentioned above, Most research has simply assessed the elastic response. The majority of research has looked into two different kinds of irregularities: those in soft, weak, and/or set-back structures. Although there have been differing findings on set-back buildings, most research concur that the tower portion of the set-back structures has shown an increase in drift demand. In comparison to conventional structures, there has been a reported increase in seismic demand for first-story soft and weak structures. The effect of strength irregularity is greater than the effect of stiffness irregularity for buildings with discontinuous distributions of mass, stiffness, and strength (either separately or in combination). The largest effect is found when the irregularities in stiffness and strength are combined.

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