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Discussion on Recent and Past Development in the Field of Seismic Analysis on Symmetry and Asymmetry Shaped Building Frames

Anmol Deep Bagde[1], Umank Mishra[2]
[1]PG Scholar, [2]Associate Professor, Department of Civil Engineering, Shri Shankaracharya Technical Campus, Bhilai

Abstract: This paper highlights the detail discussion of past researcher by categorizing the review on seismic analysis based on regular and irregular shape building. The review concludes that after careful observation there are lot of experimental and numerical investigation may be done on different shape of building and many researchers has already been done work on regular building but not given remedies hence there is need of application of retrofitting such as shear wall, bracing in structure as building material by the structural engineers.
Keywords: Regular, Irregular, Shear wall, Bracing

I. INTRODUCTION

Earthquake-prone areas in the country have been identified using statistical knowledge on seismicity, historical earthquakes, and the region's tectonic setup. Based on these inputs, the Bureau of Indian Standards [IS 1893 (Part I):2002] classified India into 4 seismic zones: Zones II, III, IV, and V. The most seismically active region is Zone-V, and the least active is Zone-II. Zone - V includes the entire northeastern India, including parts of J.K, HP, Uttaranchal, the Rann of Kutch in Gujarat, a portion of North Bihar, and the Andaman and Nicobar Islands. Zone IV contains the remaining parts of JK and HP, as well as Sikkim, Northern Uttar Pradesh, Bihar, and West Bengal, as well as parts of Gujarat and small portions of Maharashtra near the west coast and Rajasthan. Kerala, Goa, the Lakshadweep islands, the remaining parts of UP, Gujarat, and WB, and parts of Punjab, Rajasthan, MP, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Orissa, AP, Tamil Nadu, and Karnataka were included in the Zone III. Zone II incorporates the remainder of the country.

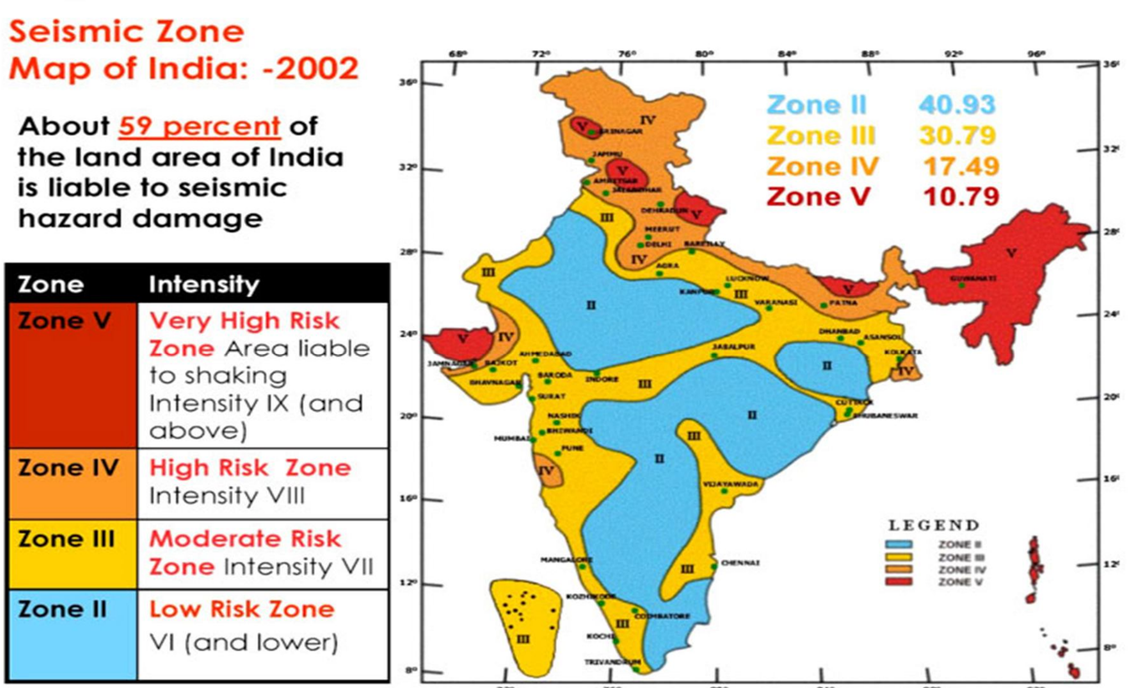

Fig. 1 Map of Seismic Zones in India

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II. REVIEWS

The following are the review of the past researchers for the different cases of Seismic analysis-

A. *Review Based on Regular Shaped Building*

According to (Akash Panchal, 2017), worked on a structure in such a way that it reduces damage during an earthquake makes the structure inefficient, as the seismic action may takes place or may not occur in its lifetime and is an erratic phenomenon. STAAD Pro V8i was used to analyze and design a G+6 existing RCC framed structure in this paper. The building was designed in accordance with IS 1893(Part 1):2002 for earthquake forces in various seismic zones. The primary goal of this paper is to compare the variation in steel percentage, force along X-direction, moment along shear direction, and deformation in various seismic zones. Variations increase dramatically from zone II - zone V. From zone II to zone V, the steel percentage, maximum shear force, maximum bending moment, and maximum deflection increase.

(Balaji.U. A1, 2016) studied about that the ancient time we know earthquake is a disaster causing occasion. Up to date days constructions are fitting increasingly narrow and extra inclined to sway and consequently detrimental within the earthquake. In the past, researchers and engineers worked to make buildings more earthquake resistant. Following numerous functional reports, it has been demonstrated that the use of lateral load resisting methods in the constructing configuration has significantly increased the performance of the structure in earthquake by using ETABS 9.7.4, the work has been carried out for the various instances utilizing shear wall and bracings for the exceptional heights, and the maximum top regarded for the reward gain knowledge of is 93.5m. The modelling is finished in order to investigate the effects of special circumstances as well as specific heights on seismic parameters such as base shear, lateral displacements, and lateral drifts. The learning has been implemented for Zone IV and Zone V in Soil Type II (medium soils), as specified in IS 1893-2002.

(Mahesh Rao, 2014) studied the behavior of G+11 multi-story buildings with symmetry and asymmetry configurations under earth quake load, and wind loads are assumed to act concurrently with earth quake loads. In this paper, a multi-story commercial building is studied for both seismic and wind load using CSI product software. Assuming that the material property is linear-elastic, static and dynamic response spectrum analyses are carried out by taking into account seismic zones, and the behavior of all zone is measured by using three different types of soils, namely Hard, Medium, and Soft. Different responses, such as storey drift and displacements base shear, are plotted for different zones and soil types.

(Piyush Tiwari, P.J.Salunke, 2014) investigated the performance of a multi-story framed building by strong earthquake motions and evaluated by the affect by the distribution of mass, stiffness, and strength in the building's horizontal and vertical planes. In multi-story framed buildings, ground motion generally causes smash up at locations of structural weaknesses in the lateral load resisting frames.

This paper examines the performance and behavior of a regular and vertical geometric irregular RCC-framed structure subjected to seismic motion. This project employs five types of building geometry: one regular frame and four irregular frames. A comparison study is conducted between all of these building configurations in terms of height and bay. The building frames are modelled and analyzed using the software. The seismic responses such as shear force, bending moment, storey drift, storey deformation are obtained. The seismic analysis is done according to (IS 1893 (Part 1), 2002) Seismic zone IV & medium soil strata are taken for all the cases. The change in the different seismic response is observed along height of building.

In year 2016, (Mohaiminul Haque, Sourav Ray , Amit Chakraborty, Mohammad Elias, 2016) studied that the ETABS v9.7.1 and SAP 2000 v14.0.0 are used to analyses four different shaped (W-shape, L-shape, Rectangle, Square) ten-story RCC building frames for seismic zone 3 (Sylhet) in Bangladesh. The deformation of various shaped buildings due to static loading and the nonlinear dynamic spectrum have been investigated in a comparative study.

(Kakpure & Mundhada, 2017) in their paper, they studied that the present paper uses nonlinear static pushover analysis to conduct an analytical investigation of both regular and irregular shaped buildings. It is used to study and identify the seismic behavior of buildings with G+5, G+10, and G+15 storeys. According to the findings of the study, as the number of storeys increases, lateral load carrying capacity does not increase, but corresponding displacement does. As the irregularities of the building increase, shear decreases to 10-13 percent in G+5, 15-18 percent in G+10, and 15-20 percent in G+15, but displacement remains constant. Plastic hinge performance levels and location are observed in all regular and plan irregular building models. It was discovered that during the subsequent push to the building, hinges formed first in the beams. Initially, hinges were in the B-IO stage before progressing to the IO-LS and LS-CP stages.

(Vishwakarma & Rai, 2017) discovered seismic activity in hilly areas of north east India in their paper. Because of the scarcity of flat land in hilly areas, buildings must be built on sloping ground.

Because buildings are irregularly situated on hilly slopes in earthquake zones, many damages occur when earthquakes occur, which may cause a lot of human disaster and also affect the economic growth of these areas and has studied that the hilly areas in north east India contained seismic activity. Because of the scarcity of flat land in hilly areas, buildings must be built on sloping ground. Because buildings are irregularly situated on hilly slopes in earthquake areas, many damages occur when earthquakes occur, causing a lot of human disaster and affecting the economic growth of these areas. In this paper, we used Staad Pro to compare sloping ground with different slopes and plain ground buildings using the Response Spectrum Method as defined by IS 1893-2000. The dynamic response and maximum displacement in columns are investigated using various sloping ground configurations.

(Gorle et al., 2018) In their paper, they investigated how structural design necessitates structural analysis as well as earthquake or seismic analysis of any structure prior to construction. Earthquake or seismic analysis is the calculation of a structure's response to earthquake excitation. To carry out the seismic analysis of the structures, various seismic data are required. The seismic analysis of a structural system is used in this study to determine the deformations and forces induced by applied loads on a residential G+8 RC frame building using STAAD PRO V8i designing software in seismic Zone II, Zone III, Zone IV, and Zone V. The response of structures to earthquake excitation is investigated in terms of member forces, joint displacement, and support reaction. Base shear, displacement, axial load, moments in Y and Z directions in columns and shear forces, maximum bending moments, and maximum Torsion in beams are all analyzed. The current work aims to comprehend that structures must have suitable Earthquake resisting features in order to safely withstand large lateral forces imposed on them during earthquakes in various seismic zones, as well as construction material, cost, and effectiveness in minimizing Earthquake damage in structures.

(Patil & Sonawane, 2015) In their paper, they discovered that the effective design and construction of earthquake-resistant structures is becoming increasingly important throughout the world. The earthquake response of a symmetric multistory building is investigated in this paper using manual calculations and the ETABS 9.7.1 software. The method incorporates the seismic coefficient method, which is recommended by IS 1893:2002. The results of both manual analysis and soft computing are compared. This paper provides a comprehensive guideline for both manual and software analysis of the seismic coefficient method.

(Imranullahkhan, 2017) has examined the dynamics of a g+9 storey asymmetrical in plan building under earthquake load using linear dynamic analysis. (Response spectrum method) is used to evaluate storey drift and displacements. The current research is restricted to reinforced concrete (RC) multi-story apartment complexes of various shapes such as Regular, L-shape, and T-shape.

(Patel & Abdulla, 2016) examined the L-shaped high-rise building with different locations of shear walls and different shapes of shear walls is considered for analysis in their study. The ETABS software is used to analyses the high-rise building in order to determine various parameters such as Time period, Base shear, Storey drift, and Storey displacement. The analysis results on various parameters are presented in tabular and graphical form, and the results of various parameters are compared using different seismic analysis methods such as ESA RSA and Time history analysis.

B. Review Based on Irregular Shaped Building

(Krishna, 2014) concerns research into the optimal placement of shear walls in an asymmetry high-rise building. They examined high-rise buildings with varying shear wall areas and shapes (L, U, box, H, T, W).

(Mohod, 2015) Buildings with irregular geometry respond differently to seismic action, according to research. Plan geometry is the parameter that determines its performance under various loading conditions. The structural analysis software STAAD Pro. V8i was used to investigate the effect of irregularity on structure. There are several factors that influence building behavior, with storey drift and lateral displacement playing an important role in understanding structure behavior. The findings are reported in graphs and bar charts. According to the research, a simple plan and configuration must be used during the planning stage to decrease the impact of an earthquake.

(Raul et al., 2019) presented the paper based on numerical analysis to compare the structural analyses of solid rectangular and hollow rectangular high-rise buildings. Shear, drift, and displacement were the parameters tested for building analysis using the response spectrum method.

(Ramchandani & Mangulkar, 2016) studied the response spectrum analysis on two different shapes of structure, namely, regular and irregular shapes, using STAAD PRO. And the comparison results are studied and compared while taking earthquake characteristics and structure dynamic characteristics into account. According to the findings, the earthquake response peak values and main response frequencies are very close and comparable.

(Santhosh & Mathew, 2017) states that the study of enhancing the shape of shear walls in symmetrical high-rise buildings. The shear walls are placed symmetrically in symmetrical buildings because the centers of gravity and rigidity coincide. In this article, a high-rise building with various shear wall shapes is analyzed.

ETABS software is used to analyze the storey drift and base shear of a multi-story building with G+14 and G+29 storey. For the seismic loading analysis of the building, two different Zones (Zone-III & Zone-V) are considered. The dynamic method is used to analyze the building (Response spectrum analysis).

(Sachdeva et al., 2018) investigate the behavior of column shapes This work considers two shapes: circular and rectangular. The height and cross-sectional area of both column shapes are kept constant, and OMRF is used. Seismic forces are taken into account when determining the realistic behavior of structures. The analytical strategy is built on two models. The dimensions of columns and beams are determined by construction practice. The work's conclusion is presented, which is based on the variation of floor-wise shear forces and the development of equations for the same.

(Guleria, 2014) investigated for various plan configurations such as rectangular, C, L, and I-shape. The ETABS software is used to model a 15-story R.C.C. framed building for analysis. Following structure analysis, maximum shear forces, bending moments, and maximum storey displacement are computed and compared for all analyzed cases.

(Harshitha & Vasudev, 2018) studied that Since earthquakes are one of the most devastating natural disasters known to mankind, earthquake engineers have made significant contributions to the structural safety. Adopting structural steel bracings in the structure is one option for reducing the damage caused by the earthquake. These members can be used as a horizontal load resisting system in the building to improve the stiffness of the frame for seismic forces. The current study is based on an analysis of an RC-framed structure with structural steel braces conducted with the ETABS software. This work is being carried out to learn about the behavior of various bracing systems for various arrangements. G+10 building in zone IV is chosen and analyzed with various braces. The effectiveness of braces is investigated using 16 different models, one of which is the bare frame model. The building's performance is investigated in terms of lateral displacement, base shear, and time period. The analysis values were compared, and it was discovered that the seismic behavior of braced framed buildings is preferable to unbraced framed buildings. It was also discovered that the various bracing system arrangements have a significant impact on the seismic performance of the building.

(Babu et al., 2018) presented in their study that impact of retrofitting such as X, V-bracing on reinforced structures. The reinforced concrete framed building (G+9) was modelled and analyzed in three parts for the purposes of this study such as without L-shape shear wall and X-bracing, model with X, V-bracing retrofit, and shear wall modelling in RCC frames. The walls are located in the middle of the frame and bracing is placed at the same location. were analyzed for seismic forces at various seismic zones using software. Lateral deformation, peak storey shear, and relative drift examined to evaluate the seismic performance of retrofitted RCC building.

III. CONCLUSIONS

According to the literature, the majority of research is numerical based software analysis for different zones, change in soil type and shape of building. There is still a need for numerical research to identify the behavior of building frames. Furthermore, because the effect of different shaped building frame plays a significant role in improving deformation. Extensive research must be conducted based on the loading and different regions for the different shape of frames. Furthermore, because the Bureau of Indian Standard Code has not provided any specifications for exception in building shape, more research in that field is required to incorporate codal provisions.

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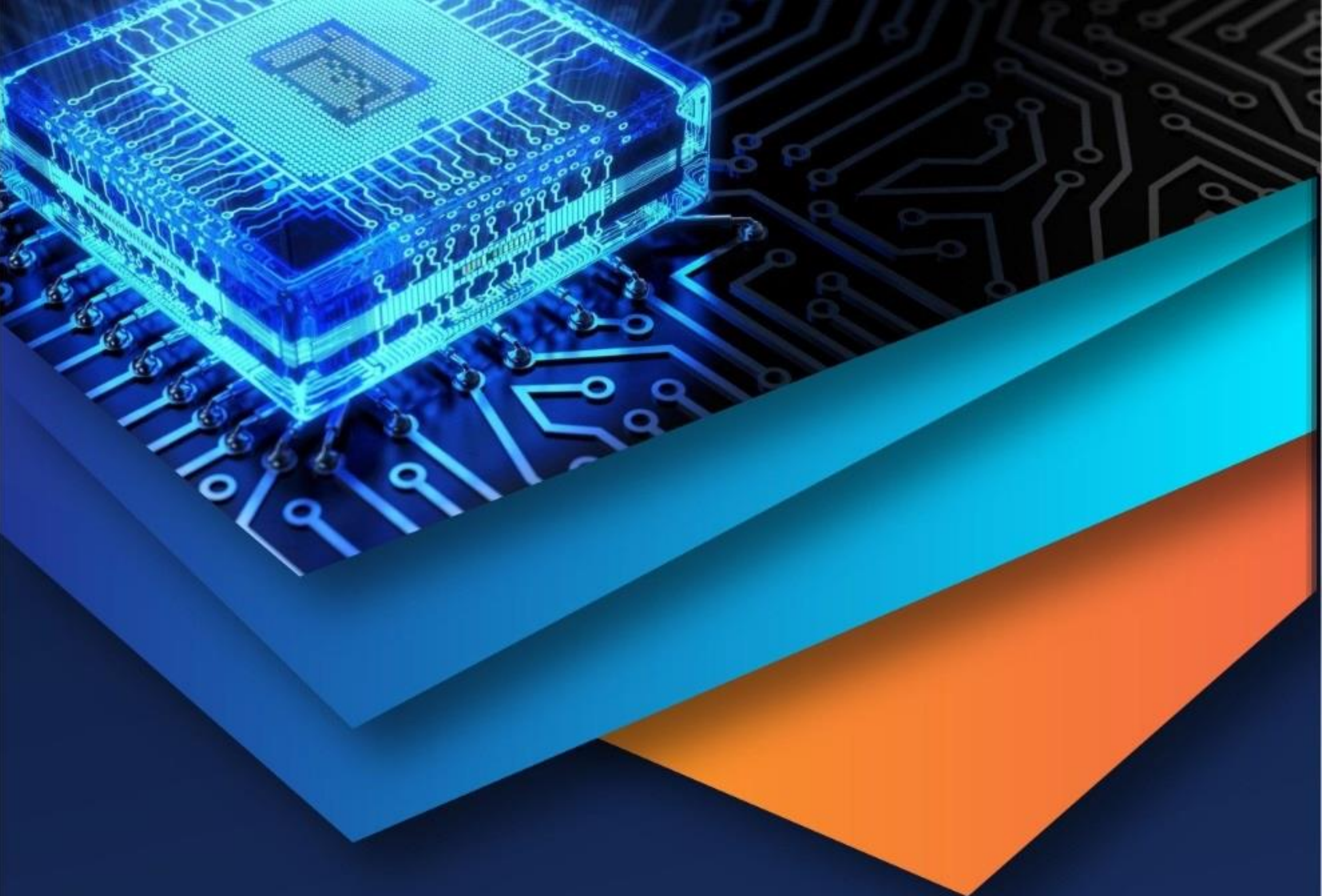

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