International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 06 | Jun 2024 www.irjet.net p-ISSN: 2395-0072

A Review on Pushover Analysis of Irregularity Structure at Different zone

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Abstract – Earthquake is the one of the most dangerous natural hazards to damage structure in the world. Now a day construction space is very less, So tall structures are more introduce on field. Irregular structure cannot analysis by seismic method (linear static method) for this analysis we use nonlinear static method. For the analysis E-tabs software is Using for Pushover analysis we can understand that at which joint beam or column is first damage when earthquake occur. Pushover analysis method we cannot design structure but ductile detailing make structure safer. This study help to improve structure performance in earthquake.

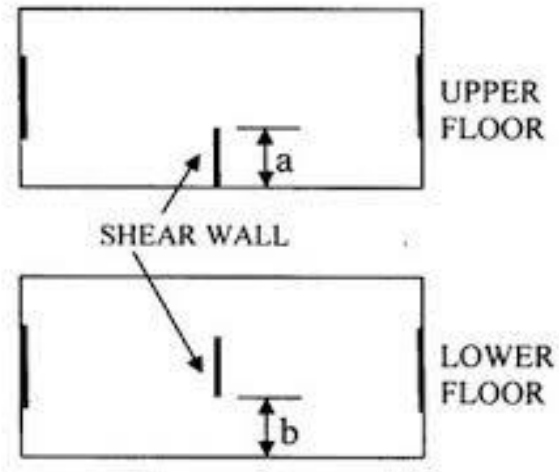
***Key Words*: Irregular Structure, pushover analysis, E-tabs.**

1.INTRODUCTION

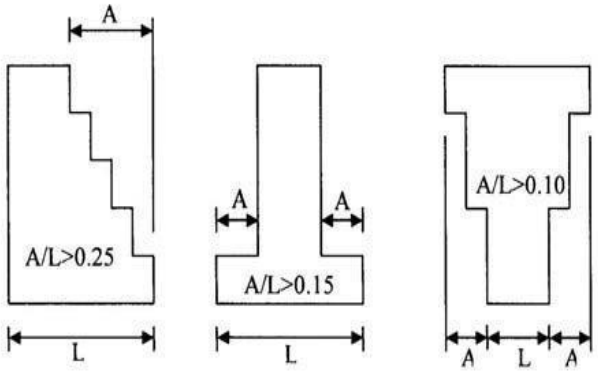
In the event of an earthquake, structure damage typically begins at the weakest point within a building. A structure is classified as regular when its design displays nearly symmetrical configuration around the axis, while irregularity emerges from the absence of symmetry and disruption in geometry, mass distribution or load bearing components. In urban setting with limited construction space, irregularities manifest more frequently, necessitating structural engineers to possess comprehensive knowledge of irregular structure response to seismic activity.

Irregularities within building structure often stem from uneven mass, strength, and stiffness distribution along their height. Constructing such building in high seismic zones complicates analysis and design. Two primary irregularity type are recognized.

1. Plan irregularities



2. Vertical irregularities

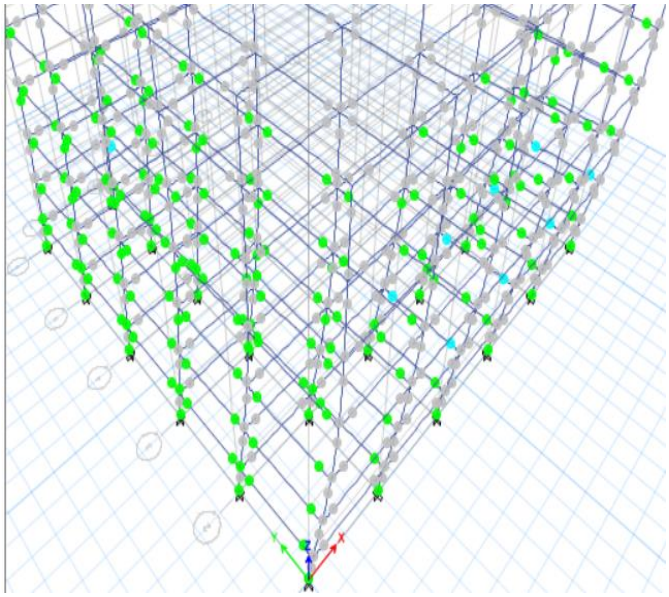


Plan or vertical irregularities render structures susceptible to seismic forces. Torsional irregularity and sudden increases in overturning moment are consequences of structural irregularities. Therefore, addressing irregularity becomes a critical aspect in the design phase, especially when considering stiffness irregularity resulting from abrupt stiffness changes between adjacent floors, like setback in a building's elevation.

Using nonlinear static analysis, also known as pushover analysis, assesses a structure ability to bear ultimate load and deflection. It modals local nonlinear effects like flexural

hinges at joins, deforming the structure until enough hinges form a collapse mechanism or reach the plastic deformation limit. The analysis generates a static pushover curve plotting a strength based parameter against deflection. For instance, it correlates strength levels in parts of the structure with lateral displacement or plots bending moments against plastic hinges.

These results offer insights into the structural system's ductile capacity, indicating failure mechanisms, load levels and deflections leading to failure. When analysing frame objects, material nonlinearity is assigned to specific hinge location based on criteria like FEMA-356 or user-defined standards.



Hing location can see like this FEMA-356 and ASCE 41-13. various software features like strength drop, displacement control, p-delta effect, staged construction, and link assignments are available for use in static pushover analysis.

1.2 Objective

- To investigate the seismic loading of structure with plan irregularity and vertical irregularity.
- To determine the progressive failure in building.
- Predict potential weak areas in the structure, by tracking the sequence of damages of every member in the structure.
- To investigate the differences in structural response caused by the earthquake motions in various Indian seismic zones.
- The primary goal of designing an earthquake-resistant structure is to ensure that the structure has enough ductility to withstand lateral loads.
- To analyse structure using E-tabs software.

1.3 Aim of Study

- To study structure behaviour in earthquake by using pushover method.
- For the understanding of structure component and which one is fail first.
- Using IS code and ASCE 41-13 this both code is use in this analysis method.

1.4 Scope of work

This study help to design earthquake resist building in different zone and different irregularity in verticaly by Indian code and American code by using ETABS software fore this analysis. This analysis help to design structure at which point structure collapse start, so we can that place design more ductail. After that we can built safe structure for us.

2. Literature Review

[1] Kangle, S. R., and D. S. Yerudkar. "Response Spectrum Analysis for Regular Multistory Structure in Seismic Zone III." ***International Journal of Engineering Research & Technology (IJERT)***

RCC structure is analyse by the computer software are used for the structure configuration like bending moment, stress, strain and deformation or deflection. Main purpose of this research is the comparative study of building G+15 story by STAADPRO and ETABS. They analyzed the structure through the response spectrum analysis to design economic structure. Structure design in STAADPRO and ETABS similar loading is use in both software and analyzed the result. IS 1893 (Part1) for seismic design use to perform dynamic analysis.

After analysis of response spectrum we can concluded that the dynamic analysis must carried done for the tall structure. Through this analysis we can conclude that small earthquake are not impacting structure of manor magnitude and intensity. In this research both software result like base reaction, modal participation factor, periods and frequencies, story displacement are different up to 5%-10% and modal mass is higher then 75%, so structure is stiff in earthquake.

[2] Rathod, Kaushal Vijay, and Sumit Gupta. "A nonlinear time history analysis of ten storey RCC building." ***International Research Journal of Engineering and Technology*** **7 (2020)**

The paper talks about studying how a ten-story building handles earthquake. It shows how important it is to construct strong building to keep them from falling earthquake. They used a method called time history analysis to see how the

building moves during an earthquake. Use a specific earthquake data from EL centro earthquake 1940 and computer software ETABS to simulate it. They looked at different things like how much weight the building can hold, its flexibility, and how it moves during the earthquake. After that compare these result to safety standards to make sure the building is safe enough.

Due to structure weight and length different in x direction base rection is max at 5.6 sec with base force 664.1KN and In y direction at 3.5 sec with 566 KN. similarly, story drift in X and Y direction with time, 4 story at 5.24mm and 6 story at 7mm. displacement in X and Y direction at top floor Is 42.34mm and 53.15mm. simply analysis of nonlinear time history analysis of ten story building and get the result to see structure system and function.

[3 Mahmoud, Sayed, Magdy Genidy, and Hesham Tahoon. "Time-history analysis of reinforced concrete frame buildings with soft storeys." ***Arabian Journal for Science and Engineering*** **42 (2017)**

The study looks at how reinforced concrete building behave with and without full infill walls. It examines different models, like bare frames and those with infill walls at various levels. They used a method to consider infill panels' impact, did dynamic analysis using ground, scaled for cairo's conditions, in two direction ETABS software helped develop and analyze models. Results show notable differences in how floors respond between bare frame and those with full or partial infill walls. location of soft story at base level, 3rd story level, 6th story level 9th story level, 12th story level. They present simulation results for comparison of forces, deflections, drift ratios, and moments across different setups.

Analyzed two deferent ground motion record from near point EL centro(1940) and far region Loma prieta(1989) take for Time History analysis. Analysis of shear force, lateral force, drift ratios, over turning moment in ETABS software. Wall reduce story displacement and also increase base shear. In EL centro story shear is max t ground and loma prieta at 9th, 12th story shear max. over turning moment in El centro at soft story at base, for loma prieta in infill wall.

[4] Firoj, M., and S. K. Singh. "Response spectrum analysis for irregular multi-storey structure in seismic zone V." ***16th Symposium on Earthquake Engineering, IIT Roorkee, India*****. 2018.**

An earthquake causes massive destruction to livea and buildings. Seismic forces from earthquake can severely damage or even collapse structures. So studying how buildings handle lateral forces is crucial. In this research, a 10 story building was examined using ETABS, STAAD PRO and SAP2000 software. They cheched joint displacements, forces, time, and mass participation. They used IS:1893(part 1) design spectrum for analysis. The study showed the building is robust against earthquakes, with over 75% participation in handling with quake force. More joint displacement occurred in the X-direction because the earthquake's motion was applied that way.

Conducting dynamic analysis is crucial for tall structures with vertical irregularities over 40M in height. The structure considered is earthquake resistant, being stiff with a modal mass participation factor above 75% in higher. The frequencies are different 0.44 Hz to 0.57 Hz. Comparative study of three software are like axial load higher in ETABS and joint displacement in STAAD PRO is max. all through mass participation factor is max in ETABS.

[5] Dadawala, Saunil, and N. R. Chandak. "Response spectrum analysis of multi storied buildings: A review." ***2018 Advances in Science and Engineering Technology International Conferences (ASET)*****. IEEE, 2018.**

The impact of earthquake on structures is severe, making it crucial to factor in earthquake forces during the design phase.joints within structures suffer the most, necessitating their reinforcement. Different computational methods like response spectrum and time history are employed to compute earthquake effects. This paper focuses on these seismic analysis methods, discussing their constraints and showcasing a case study of the Gujrat earthquake, illustrating its effects on diverse structures.

In this research paper they study all analysis method pushover analysis, response spectrum analysis, time history analysis on case study on bhuj earthquake 26th Jan 2001 and due to this earthquake damages of different place like rudra matha bridge, navalakhi port, low rise residential buildings ext.design of structure should be proper as per ductail detailing an seismic code must be use, detailing of reinforcement should ne done carefully.

[6] Keerthigowda, B. S., and Syed Tajoddeen. "Seismic analysis of multistorey building with floating columns." ***IEEE Trans. Power System*** **19.1 (2014):**

Global earthquake expose risks in weak structures, notably in urban india's modern high-rises with floating columns, inadequate leads to poor performance in seismic zones. A recent study investigated the drawback of floating column in building. Were compared those with and without floating column analysis natural period, base shear, and horizontal displacement during seismic activity. Results indicate that adding lateral bracing decreases deformation, enhancing seismic performance. Subsequent analysis of RC building with floating columns, post-bracing, significantly improved seismic resilience compared to initial modal in ETABS software.

The study aimed to assess the performance of an RC building with floating columns during seismic events and the effect of adding lateral bracings. Through response spectrum analysis on three modal, it evaluated story drift, shear, time period, and displacement. Results indicated weaker performance of multistory buildings with floating column in earthquakes. Introducing lateral bracing notably improved seismic strength, enhancing story drift, shear, time period and displacement by 10%-30% in multi-story RC building.

3. CONCLUSIONS

Effect of stiffness irregularities on seismic performance of building has been performed using ETABS software. Through the pushover analysis we can understand the structure performance in different zone.

- Compare to regular structure irregular structure need more attention .
- In irregular structure more heingies form and continuty brake, so structure behave unpredict table.
- In irregular structure stiffness regularity base shear is max.
- Vertically irregular building are harmful and the effect of stiffness irregularity on the structure is also dangerous in seismic zone.
- Possible if irregularities in a building must be avoided. If irregularities have to be introduced for any reason such building should be designed properly as per IS codes.
- Pushover analysis give the location at which member is first fail during earthquake. So we can design that member as per ductaile detailing

REFERENCES

[1] Kangle, S. R., and D. S. Yerudkar. "Response Spectrum Analysis for Regular Multistory Structure in Seismic Zone III." *International Journal of Engineering Research & Technology (IJERT), ISSN* (2020): 2278-0181.

[2] Rathod, Kaushal Vijay, and Sumit Gupta. "A nonlinear time history analysis of ten storey RCC building." *International Research Journal of Engineering and Technology* 7 (2020): 7153-7160.

[3] Mahmoud, Sayed, Magdy Genidy, and Hesham Tahoon. "Time-history analysis of reinforced concrete frame buildings with soft storeys." *Arabian Journal for Science and Engineering* 42 (2017): 1201-1217.

[4] Firoj, M., and S. K. Singh. "Response spectrum analysis for irregular multi-storey structure in seismic zone V." *16th Symposium on Earthquake Engineering, IIT Roorkee, India*. 2018.

[5] Dadawala, Saunil, and N. R. Chandak. "Response spectrum analysis of multi storied buildings: A review." *2018 Advances in Science and Engineering Technology International Conferences (ASET)*. IEEE, 2018.

[6] Keerthigowda, B. S., and Syed Tajoddeen. "Seismic analysis of multistorey building with floating columns." *IEEE Trans. Power System* 19.1 (2014): 356-365.

[7] https://home.iitk.ac.in/~vinaykg/Iset_43_tn1.pdf

[8] https://www.researchgate.net/figure/ertical-Geometric-Irregularity-or-Set-back_fig1_321481090