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Review on Push over Analysis of RCC Building with Soft Stories at Different Levels

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Abstract: *The increase in population, parking spaces is a major problem for the apartments of the cities. Hence fresh trend is making use of the open ground storey for parking. Also, for office, shop spaces, or conference hall etc., soft story at different levels of structure is construction. In the beyond (past) earthquake has shown that the buildings with simple (unsophisticated) and uniform configurations are subjected to less damage. The regularity and continuity of stiffness in the horizontal planes as well as in vertical direction is very important from earthquake safety point of view. A building with discontinuity is subjected to concentrated of forces and deformations at dot of the discontinuity which may leads to the failure of members at the junction and collapse of building. Open first storey is a typical feature in the modern multi-storey constructions in metro city India. Such as the features highly unacceptable of the buildings built in seismically active areas; as a been verified of numerous experiences the strong shaking during the past earthquakes. It is the thought of multi-storey buildings with soft ground floor are inherently vulnerable to breakdown due to earthquake load, their construction is still widespread in the developing nations like India. It is the social and functional demand to provide car parking space at ground level and for offices open stories at other level of structure away out-weighs the warning against such buildings from engineering community. The ground soft story for office space open floor is required on other levels of building. In present work we are concentrating on finding the best place for soft stories in high rise buildings.*

Keywords: *Population Increase, Parking Problem, Open Ground Storey, Office Space, Earthquake, Structural Safety*

I. INTRODUCTION

Recently there has been a considerable increase in the tall buildings both residential and commercial and the modern trend is toward more tall and slender structures. Thus, the effects of lateral loads like wind loads, earthquake loads and blast forces are attaining increasing importance and almost every designer is faced with the problems of providing adequate strength and stability against lateral loads. This is the new development as the earlier building designed the buildings for vertical loads and as an afterthought checked the final design for lateral loads as well, Now the situation id quite different and a clear understanding of effect of the lateral loads on the building and the behavior of various components under these loads in essential.

Structural design of building for seismic loading primarily concerned with structural safety during major earthquakes, but serviceability and the potential for economic loss are also of concern. Seismic loading requires an understanding of the structural behavior under large inelastic deformations. Behavior under this loading is fundamentally different from wind or gravity loading, requiring much more detailed analysis to assure acceptable seismic performance beyond the elastic range. Some structural damage can be expected when the building experiences design ground motions because almost all building codes allow inelastic energy dissipation in structural system.

The January 26 earthquake in Kutch region of Gujarat brought into focus earthquake science and our preparedness for such natural disasters. India has had three major quakes during the past few decades. This time the situation is particularly grim because of the huge loss of life and widespread destruction in a relatively prosperous region of the country. Not only have urban and rural buildings been razed to the ground, the quake has caused great local and national financial loss.

Most of the loss of life in past earthquakes has occurred due to the collapse of buildings, constructed in traditional materials like stone, brick, adobe and wood, which were not particularly engineered to be earthquake resistant. In view of the continued use of such buildings in most countries of the world, it is essential to introduce earthquake resistance features in their construction.

Earthquakes are natural hazards under which disasters are mainly caused by damage or collapse of buildings and other man-made structures. Experience has shown that for new constructions, establishing earthquake resistant regulations and their implementation is the critical safeguard against earthquake-induced damage.

As regards existing structures, it is necessary to evaluate and strength them based on evaluation criteria before an earthquake. Earthquake damage depends on many parameters, including intensity, duration and frequency content of ground motion, geologic and soil condition, quality of construction, etc. Building design must be such as to ensure that the building has adequate strength, high ductility, and will remain as one unit, even while subjected to very large deformation. Observation of structural performance of buildings during an earthquake can clearly identify the strong and weak aspects of the design, as well as the desirable qualities of materials and techniques of construction, and site selection. The study of damage therefore provides an important step in the evolution of strengthening measures for different type of buildings.

In the event of an earthquake, it is generally seen that different buildings behave and respond differently. For example, one building which is properly designed and detailed to resist the seismic forces remains the seismic forces remains intact whereas, an adjoining building which may be designed to perform poorly in the event of an earthquake may be rigorously damaged or may even collapse. If such a thing happens, the building which is intact may not be approachable because of the debris of the adjoining building. Further usage of the intact building may be hampered because of the reconstruction or retrofitting of the damaged building.

To avoid such a scenario, it desirable to go for performance-based engineering and performance-based design as far as seismic risk is concerned. Using the static pushover analysis, the structural and nonstructural performance may be restricted to a predefined level say Immediate Occupancy, Life safety or Collapse Prevention. Hence, it is desirable to divide the newly planned city into zones having a specific seismic performance. Thus, a zone of the city may be reserved for all the buildings meeting the requirement of immediate occupancy as per push over analysis. Thus, in the event of an earthquake, all the buildings in that.

II. LITERATURE REVIEW

1) *Pushover Analysis of Building Using Soft Storey at Different Levels*

This project uses pushover analysis in ETABS to evaluate the seismic performance of G+13 RCC frames in India, focusing on the impact of shear and structural walls on lateral displacement and base shear. Both soft storey regular L-shaped buildings are analyzed to identify weak zones and improve earthquake resistance.

2) *Review on Pushover Analysis of Building Using Soft Storey at Different Level*

This study analyzes three G+15 RCC building models with different shear wall positions in seismic Zone V with medium-II soil, using ETABS. Both linear static and nonlinear static (Pushover) analysis are performed under the same earthquake loading to evaluate seismic behavior. The paper focuses on pushover analysis, including performance levels, pushover curves, and the analysis procedure to assess structural performance.

Finally, the development of performance-based seismic design methods for elevated water tanks remains an important area for future research.

3) *Comparative Study on Reducing Soft Storey Effect in RC Structures*

This study evaluates the seismic performance of G+7 soft-story RCC buildings with open ground floors, using ETABS for pushover analysis. Various configurations were tested-bare frame, soft-story, with shear walls, and with steel bracings. Results show that shear walls significantly improve seismic performance, reducing storey drift by 96% and increasing ground-floor stiffness by 10.6 times. Steel bracings also enhanced performance but were less effective than shear walls. The findings highlight the effectiveness of shear walls and bracings in making soft-story buildings safer in earthquake-prone areas.

4) *A Review on Seismic Analysis of RCC Building with Soft Storey at Different Level*

Soft-Storey Buildings, Common in developing countries for parking needs, are highly vulnerable to earthquakes due to reduced stiffness at the open ground floor. This study analyzes various models with shear walls and steel bracings to improve seismic performance, Indian earthquakes have shown that such vertical irregularities lead to collapse, Nonlinear analysis is essential to accurately assess and improve the behavior of these structures under seismic loads.

5) *Design and Analysis of High-Rise Buildings using ETABS*

This study focuses on the use of ETABS software in civil engineering for efficient planning and design of High-Rise Buildings. It highlights how ETABS helps analyze structural loads (static and dynamic) to support safe and cost-effective construction, especially in densely populated areas like Ernakulam.

6) *Analysis of RCC Building with Multiple Soft Story Using ETABS*

This paper focuses on the seismic vulnerability of soft-storey buildings, especially those with open ground floors used for parking (stilt floors). Such structures face high risk during earthquakes due to sudden stiffness changes. The study uses software like ETABS, along with methods like time history, response spectrum, and pushover analysis to evaluate their behavior.

7) *Preventing Soft Storey Irregularity in RC Building by Pushover Analysis*

This study examines the seismic risks soft storeys, typically found in entrance floors used for parking or commercial spaces. These storeys have reduced lateral rigidity, making building vulnerable during earthquakes. To address this, a 7-storey RC building is analyzed using ETABS, applying pushover analysis with strengthened beam-column sizes and added walls to improve stability.

8) *Pushover Analysis of Reinforced Concrete Frames*

This paper presents the seismic design and analysis of a reinforced concrete frame using modern seismic codes. The design reduces elastic seismic forces using a reduction factor while ensuring sufficient ductility in critical areas. To evaluate the structure's load capacity and ductility, a nonlinear method is necessary. The study uses a static nonlinear "pushover" analysis to estimate seismic forces and building behavior, with the model developed in Abaqus incorporating geometric nonlinearity.

9) *Nonlinear Static Pushover Analysis of Medium Rise and High-Rise Building*

This paper presents a nonlinear static pushover analysis of medium-rise bare RC frames and high-rise infilled RC structures with soft stories at various levels using ETABS. The study finds that placing soft stories at higher levels reduces hinge formation but increases displacement and base shear, impacting the building's seismic performance.

10) *Comparative Study Nonlinear Static Pushover Static Pushover Analysis and Displacement Based Adaptive Pushover Analysis Method*

This paper explores the Displacement-Based Adaptive Pushover (DAP) method as a more accurate alternative to conventional static pushover analysis for evaluating seismic performance. RC moment-resisting frames of 6,9,12 and 15 stories are analyzed for Zone V using IS codes. The study finds that DAP better captures inelastic behavior and provides more reliable seismic demand estimates than traditional pushover methods.

III. CONCLUSION

In the present study, non-linear response of RC frame high rise building with soft story at different level in addition ground floor using ETABS under the loading has been carried out. The objective of this study is to see the variation of load- displacement graph and check the maximum base shear and displacement of the frame with soft stories at different levels.

- 1) Plastic hinge formation for ground floor soft story and ground plus different level soft story have been obtained at different displacements levels.
- 2) In actual well-planned building without soft story building hinge formation starts with beam ends and base columns of lower stories, then propagates to upper stories and continue with yielding of interior intermediate columns in the upper stories. formation in this manner.
- 3) Comparison of the reveals that the patterns of plastic hinge formation for the different level soft story is quite different, as we shift soft story to higher level the intensity of hinge formation becomes lower and lower in soft story.
- 4) In this study our building model is very stiff so we cannot more and more hinges. We can see some hinges. But our hinges only up to LS level.
- 5) In case structure is not much stiff Hinges propagates up to CP or may be Above CP level.
- 6) Or in low stiff structure seen those changes in hinges severity.
- 7) When soft story at bottom level of building then hinges may be higher severity can be seen. When soft story at bottom level severity of hinges is high compare to when soft story at top level of building severity will be less compare to soft story at bottom level.
- 8) Also, numbers of hinges are more when soft story at lower level of structure. When we shift the soft story at upper floor of the structure number of hinges will also decrease. And it will be good for structure.
- 9) As we shift soft story lower level to higher level displacement of structure also it decreases.
- 10) At same time base shear of the structure also decrease.

- 11) In terms of effective damping of the structure, when soft story shift from lower level to higher level effective damping of the structure would be decrease. Means that less damage of structure when damping ratio is less. So, when soft story at lower level of structure damage will be maximum and we shift the soft story at higher level of the structure damages will be less compared to lower-level case.
- 12) It is advisable to provide soft story at higher levels in structure.

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