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Analysis of A High Rise Building Frame Considering Seismic Load Using ETABS

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ABSTRACT

Buildings must be able to safely withstand any significant ground motions that could happen during construction or regular operation in order to be considered earthquake resistant. The impacts that ground motions have on structural reactions, however, are special. The timehistory analysis is the analytical method that is most accurate for structures that are subjected to severe ground vibrations. For this analysis, a stepwise solution is used to integrate the pushover analysis of a multi-degree-of-freedom system, or MDOF, in the time domain in order to depict the real reaction of a structure. Although it can be applied to all practical uses, this method takes time. The pushover analysis was developed because it was necessary to develop quicker techniques that would nevertheless provide a trustworthy structural assessment or design of structures subjected to seismic loading. The foundation of pushover analysis is the presumption that during a seismic event, structures vibrate primarily in the first mode or in the lower modes. As a result, the multi-degree-offreedom system is reduced to a single-degree-of-freedom system that has attributes that are predicted by the nonlinear static analysis of the multi-degree-of-freedom system, or SDOF system. The ESDOF system is then subjected to a response spectrum analysis with constantductility spectra, or damped spectra, or a nonlinear time history analysis. Through modal connections, the seismic demands for the MDOF system are converted from the ESDOF system's computed seismic demands.

Keywords: RCC frame, Irregular building, FEMA hinge, capacity spectrum, pushover analysis, seismic reaction.

I. INTRODUCTION

Modern high rise building construction began to address a variety of objectives, including the need to accommodate a growing population, the high cost of land, and even to demonstrate the state of the economy in the case of corporate structures. Earlier, these structures were regular in shape, but with modern technology and materials, it is now feasible to build structures with a variety of plans, shapes, and sizes. Due to their practical and aesthetically pleasing qualities, these atypical structures are quite prevalent all over the world. Different story heights, excess mass in one or more storeys that may be caused by the presence of public meeting areas like gyms, halls, etc., abrupt changes in stiffness made in accordance with architectural considerations, and other factors can all contribute to irregularity. The majority of apartments favour soft-storey structures with sizable parking areas. Irregular buildings are those that have discontinuities in their bulk and rigidity in their layout or elevation. Performance level describes the state of the building's damage, providing information on whether it is safe for occupants to occupy it or how much repair work will be required, as well as its serviceability following an earthquake. Different design requirements are needed at various performance levels. Therefore, it is impossible for a single design parameter to achieve all performance goals. Even though these performance goals could place competing demands on stiffness and strength, one shouldn't sacrifice life safety.

Objectives of the Research

- To study the effect of vertical geometric irregularity in G+20 3D buildings.
- To analyse the buildings using Pushover Analysis.
- To calculate the maximum Monitered Displacement of the different buildings.

LITERATURE REVIEW

D J Zavala et.al (2022) author analyzed the influence of the stiffness irregularity and the p-delta effect on the structural behavior of a reinforced concrete building. The main objective was to determine the impact of the stiffness irregularity and the p-delta effect on the structural behavior in regular and irregular buildings. The linear dynamic analysis procedure was performed in order to determine the structural response in terms of drifts, shear force and moments per floor. A comparative analysis of the responses from the linear and nonlinear analysis was carried out to determine the percentage variation of the results

Thokala Brahmendra Rao et.al (2022) in the research paper, p- delta (P-Δ) effect on high- rise building was investigated for the analysis of G+29 RCC framed building and models were done by ETABS2016. Seismic and wind loads were applied to model as per IS-1893 (2002) and IS-875 (PART-III). The displacements, storey drifts, Bending Moments and Shear Forces are compared to the different models by considering with and without P-delta effect and by providing shear walls at different locations. Results stated that displacements of conventional building models (without p-delta) is less when compare to building with p- delta. The storey drifts in building models with p-delta effect are more when comparing with models analysed using equivalent static analysis method(without p-delta effect). The bending moment (BM) in shearwall 18% increases after p-delta effect. Shearwall placed at centre of frame shows more effectiveness when comparing with shear wall placed at corner and without shear wall of the structure.

II. METHODOLOGY

Step 1: Research paper from different authors was summarized in this section who have focused towards analyzing multi storey high rise structures considering seismic loads with different zones and soil condition

Step 2: In order to initiate the modelling of the case study, firstly their's need to initialize the model on the basis of defining display units on metric SI on region India as STAAD.Pro supports the building codes of different nations. The steel code was considered as per IS 800:2007 and concrete design code as per IS 456:2000.

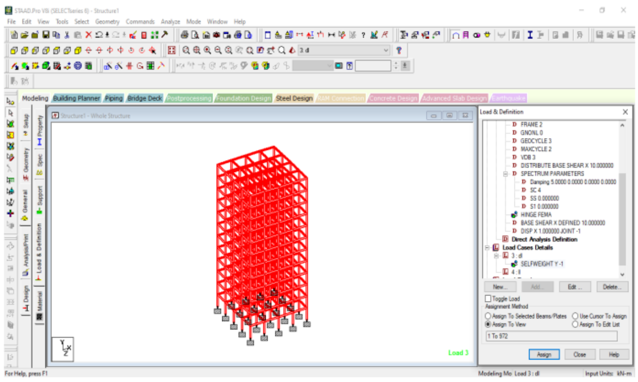
Step 3: STAAD.Pro provides the option of modelling the structure with an easy option of Quick Template where the grids can be defined in X, Y and Z direction. Here in this case, 6 bays in considered in both X and Y direction with a constant spacing of 3.5m making the model symmetrical in nature. G+11 storey structure is considered with typical storey height of 3.2 m and Bottom storey height of 2 m.

Step 4: Next step is to define the material properties of concrete and steel. Here in this case study, M30 concrete and rebar HYSD 550 is considered and its predefined properties are available in the STAAD.Pro application considering section properties for Beam, Column and Slab.

Step 5: Assigning Fixed Support at bottom of the structure in X, Y and Z direction in both the considered cases

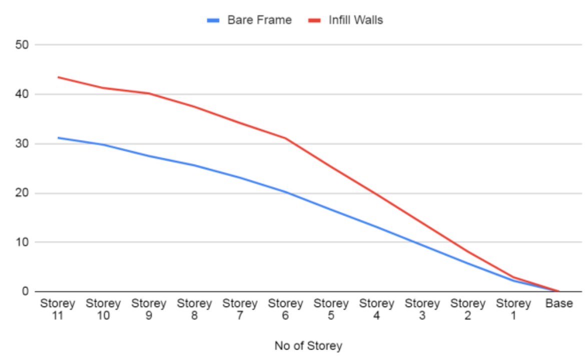
Step 6: Defining Load cases for dead load, live load and seismic analysis for X and Y Direction.

Step 7: Analyzing the structure for dead load, stress analysis and displacement.

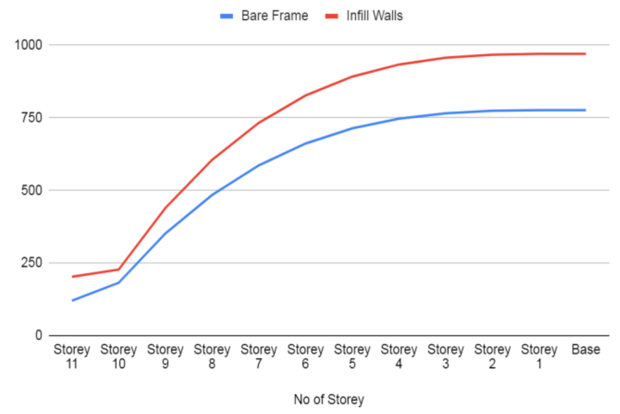


III. ANALYSIS RESULT

DISPLACEMENT:



STOREY SHEAR:



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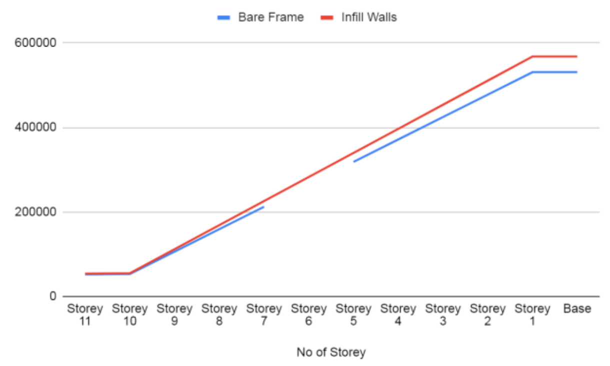

IV. CONCLUSION

This chapter presents the major conclusions and future scope of the assessment of Pdelta effect for high rise buildings. Based on the second order analysis using STAAD.Pro and verification with other authors following conclusions can be drawn.

Base Shear Base shear is a calculation of the greatest lateral stress that seismic activity is likely to exert on the foundation of the structure. It is determined using the lateral force formulae for the seismic zone, soil type, and building code.

Base shear is the maximum expected lateral force that will occur due to seismic ground acceleration at the base of the structure. The base shear was found to be 96004.672 kN for Infill structure whereas 43533.575 kN for bare frame structure.

Storey Displacement Story displacement is the lateral displacement of the story relative to the base. The lateral force-resisting system can limit the excessive lateral displacement of the building. The acceptance lateral displacement limit for wind load case could be taken as H/500 (some may take H/400). Displacement was minimum at the bottom of the structure but maximum comparison between the results were visible by 8.2% at the top of the structure in bare frame structure and infill wall.

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