SEISMIC ANALYSIS USING STAAD Pro FOR L-SHAPED RCC FRAMED BUILDING

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Abstract - In this paper P-delta analysis of building structures is performed, the methods reviewed include the amplification factor method, the direct method, the iterative method, the negative property member method, and the second-order computer program method. The influence of asymmetry of building on the P-delta effect in elastic ranges of behaviour is evaluated. The result indicated that the effect of the P-delta is quite sensitive to characteristics of ground motion such as the frequency content of earthquakes. Under the P-Delta effect, displacement varies exponentially with an increase in height or increment in stories. The axial forces also vary with the height of the structure. Because of the wide variation in displacement with an increase in slenderness, P-Delta analysis is required for structures taller than 7 stories. the P-Delta effect will be substantial when lateral forces exist on the structure and this increases with an increase in the number of stories. The P-Delta effect is not predominant in buildings up to seven stories and it is very negligible when only gravity loading exists on the structure.

Key Words: P-Delta Analysis, Elastic Ranges, L-shaped building, Axial force, Gravity Loading, Lateral Forces.

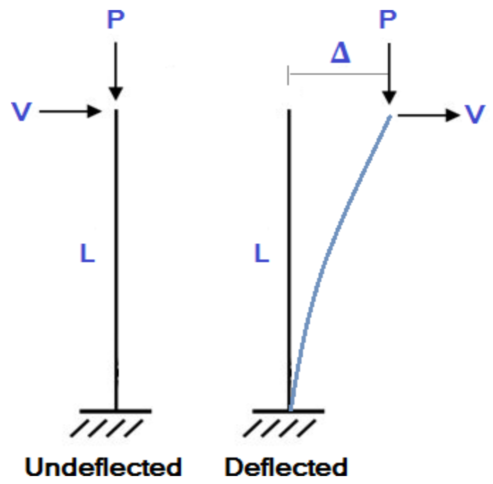
1.INTRODUCTION

1.1 P-Delta Analysis

The term "P-Δ analysis" itself explains the meaning, when a structural member is loaded, then its shape changes, and due to this additional forces & moments are induced. It is a second-order analysis. P-Delta Analysis is a type of analysis that is particularly important for laterally displacing multi-story building structures experiencing a gravity load.

1.2 P- Delta Effects

When subjected to lateral displacements, the building structure will deform which in turn produces second-order over-turning moments and usually, these are not taken into consideration in the case of dynamic and static analysis.



1.3 Need for P-Delta Analysis

P-Delta effects usually become prevalent in tall structures that are experiencing gravity loads and lateral displacement due to wind or other forces. If the lateral displacement and/or the vertical axial loads through the structure are significant, a P-Delta Analysis should be performed to account for the non-linearities. In many cases, a linear static analysis can severely underestimate displacement (among other results) in comparison with a P- Delta (Non-Linear) Analysis.

1.4 Reason for taking L-shaped Building

Sometimes the plot area is having an irregular shape. In that situation, there is a need to construct a building according to the shape of the plot area. If the plot area is in L-shape, so to make complete use of the plot area we have constructed an L-shape building. Recently, most structures of architectural importance have been highly unfeasible to plan with regular shapes. With such complex configuration irregularities, the structural design and the prediction of the potential structural collapse of irregular buildings under earthquakes become very challenging. Moreover, torsional effects could significantly amplify the seismic response of buildings. L-shaped buildings have the potential of re-entrant corners and torsional irregularities, which causes stress concentration.

1.5 Significance of Seismic Analysis

Seismic analysis is a tool for the estimation of structural response in the process of designing earthquake-resistant structures and/or retrofitting vulnerable existing structures. In principle, the problem is difficult because the structural response to strong earthquakes is dynamic, nonlinear, and random. All three characteristics are unusual in structural engineering, where the great majority of problems are (or at least can be adequately approximated as) static, linear and deterministic. Consequently, special skills and data are needed for seismic design, which an average designer does not necessarily have.

2. LITERATURE REVIEW

For the purpose of understanding the significance of the various design parameters and efficacy of this study, it is necessary to review the literature of past research.

Bharat and Hemchandra (2020) aimed to compare the seismic response demands of the different L-shaped buildings with the reference regular model by varying the seismic angle of incidence. The second part is to determine the response of the different models when subjected to the varying angle of the input response spectrum. Hence it can be concluded that code-defined load combination rules are insufficient to achieve the response for the irregular structures. [1]

Shehata et. Al.(2018) investigated structural seismic response demands for the class of L-shaped buildings by evaluating the plan configuration irregularity of re-entrant corners and lateral–torsion coupling effects on measured seismic response demands. The measured responses include story drift, inter-story drift, story shear force, overturning moment, torsion moment at the base and over-building height, and torsional irregularity ratio. [2]

Vijayalakshmi et. Al. (2017) considered the effect of lateral load on the structural system for the P-Delta effect. The drift ratio is found for both, earthquake and wind loading, considering with and without the P-Delta effect for a different number of stories such as G+10, G+20, G+30, and G+40 stories. [3]

Raheem et. Al. (2016) grasped the seismic behavior of the buildings with an irregular plan of L-shape floor plans through the evaluation of the configuration irregularity of re-entrant corners effects on measured seismic response demands. The measured responses include inter-story drift; story shear force; overturning moment; torsion moment at the base and along the building height; top floor displacement; and torsional Irregularity Ratio. [4]

Kabir et. Al. (2015) assessed the seismic vulnerability and response of regular and irregularly shaped multi-story buildings of identical weight in the context of Bangladesh. Both static and dynamic (response spectrum) analysis has been performed to study the influence of the shape of a building on its response to various loading. [5]

Mallikarjuna and Ranjith(2014) described seismic analysis for an 18-story steel-framed structure using STAAD Pro V8i software. A comparison of P-Delta analysis with linear static analysis has been attempted. [6]

Dinar and Rahi (2013) evaluated the deflection of high-rise steel structures under the P- Delta effect. Linear static analysis was done to observe the severity of the P-Delta phenomenon. The analysis was done by using STAAD Pro v8i software. They found that because of the wide variation in displacement with an increase in slenderness, P-Delta analysis is required for structures taller than 7 stories. [7]

Mahdi and Gharaie (2011) evaluated the seismic behavior of three intermediate moment-resisting concrete space frames with an asymmetrical plan in five, seven, and ten stories by using pushover analysis. In each of these frames, both projections of the structure beyond a reentrant corner are greater than 33 percent of the plan dimension of the structure in the given direction. [8]

Sood and Naveen (2010) outlined and compared the three methods, and discuss them in the context of traditional force-based seismic design and earlier design approaches which contained some elements of performance-based design. Factors defining different performance states will be discussed, including the need, not yet achieved, to include residual displacement as a key performance limit. [9]

Federal Emergency Management Agency (2005) proposed the evaluation and improvement of the nonlinear static procedures (NSPs) contained in the Pre-standard and Commentary for the Seismic Rehabilitation of Buildings, and the Capacity Spectrum Method, as detailed are in the ATC-40 Report, Seismic Evaluation, and Retrofit of Concrete Buildings. [10]

3. OBJECTIVES

The objectives of this study are:

- To analyze the seismic performance of L-shaped buildings with and without P-Delta analysis.
- To compare the results obtained from linear analysis and P-Delta analysis.

The different parameters such as forces, story displacement, time period, frequency, torsion moment responses, and story drift in different seismic zones in different models are compared to achieve the above objectives.

4. PROPOSED METHODOLOGY

- Prepare the plan for L-shaped Building.

- Design of buildings using E-Tabs 2015
- Linear analysis of 10, 20, 30, 40 & 50 stories of L-Shaped buildings for various parameters using STAADPro V8i.
- P-Delta analysis of 10, 20, 30, 40 & 50 L-Shaped buildings for various parameters using STAADPro V8i.
- Compare the result of linear analysis & P-Delta analysis.

5. CONCLUSION

- It was concluded that due to the non-linear relationship between deflection and the gravity loads, it is necessary that loads corresponding to the failure state under consideration be used in P-Delta analysis.
- The characteristics of a lateral load-resisting system have far more important compared with the number of stories in the building.
- Both linear static and P-Delta analyses are necessary for tall RC structures.
- The building response values on P-Delta analysis were twice that on static analysis. The X bracing in the continuous bracing pattern is proven to be more effective under both static and P-Delta analyses.
- Because of the wide variation in displacement with an increase in slenderness, P-Delta analysis is required for structures taller than 7 stories.
- The P-Delta effect will be substantial when lateral forces exist on the structure and this increases with an increase in the number of stories. The P-Delta effect is not predominant in buildings up to seven stories and it is very negligible when only gravity loading exists on the structure.
- The effect of P-Delta increases as the height of the building increases, and it can be reduced up to a certain extent by the construction of shear walls.
- The structures with irregularity configurations are 40% more prone to destabilizing stresses i.e., 1.4 times more when compared to conventional rectangular non-irregularity structures and dynamic stresses are 1.7 times more than the linear static method of wind analysis.
- The impacts of P-Delta are quite sensitive to ground movement, for example, the frequency content of quakes. The affectability is still vital but not exactly the dynamic cases. All in all, the affectability to ground motion increases, as the eccentricity increases. The impact of "P-Delta" analyses is discovered higher in static and dynamic analyses and the impact of "P-Delta" analyses is much higher when the plan of the building is asymmetric with respect to a symmetric building.

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