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Effect Of Abrupt Changes In Ground Shear On Building Structures Considering Linear Static

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Abstract: In the modern era the demands of high-rise are greater than earlier due to the provision that the number of satisfactory people can be accommodated in that but the inappropriate design may lead to catastrophic demolition or destruction of the structure which is obvious from the earlier few decades. When horizontal loading acts on a building, causing it to deflect, the resulting eccentricity of the gravity loading from the inclined axes of the structure's vertical members causes the lateral displacements of the structure and the moments in the members to increase. This second-order effect is termed the P-delta effect. In heavily clad low- and medium-rise structures, the P-delta effects are small enough to be neglected. However, with the trend toward taller and lightly clad buildings with greater lateral flexibility, the P-delta effects become more significant. In some cases, the P-delta effects are large enough to require an increase in the designed member sizes. In an extreme case of a very flexible structure with a large gravity loading, the P-delta effects could, if not accounted for, be severe enough to initiate collapse. Thus, in the design of any high-rise building, it is important to assess whether these second-order effects are significant and, if so, to account for them in the analysis and design.

Index Terms - P-delta effect, High Rise Structure, lateral displacements.

I. INTRODUCTION

In the traditional first order analysis of structures, the effects of change in the structure actions due to structure deformations are ignored. However, when a structure deforms, the applied loads may cause additional actions in the structure that are called second order or P-Delta effects. P-Δ effect in structure mainly arises from the direct action of lateral forces and expiry the structure in a state of equilibrium where the deformed structure shape is a more determining factor. This kind of effect is made in the analysis of second order, where the geometry of the elements is come from their warped condition. Gravitational loads (especially in high buildings, they reach a very high order of their values) on their way through the construction elements, where this one are deformed they produce additional forces, which are not taken into account during calculations of structures in unreformed shape as shown in fig1.1. The given gravitational loads are the loads, more precisely defined, in the group of action forces in a structure, we cannot say that their change from project values, will be the determining factor in the effect of P-Δ, but in defining order remains the geometry of the structure. More precise the geometry is defined as the correct second order effects could be considered in structures.

For the analysis of a structure to be complete and correct, an appropriate model must be chosen to represent the structure and an adequate analysis procedure must be chosen to reflect the system's response to applied loads. In the modern era the demands of high-rise are greater than earlier due to the provision that the number of satisfactory people can be accommodated in that but the incorrect design may lead to catastrophic demolition or destruction of the structure which is obvious from the earlier few decades. A first-order analysis, in which equilibrium and kinematic relationships are taken with respect to the undeformed geometry of the structure, is simple to perform but is not a thorough analysis since it neglects additional loading caused by the deflection of the structure. For most structures, a second-order analysis, which imposes equilibrium and kinematic relationships on the deformed geometry of the structure, is required for stability design.

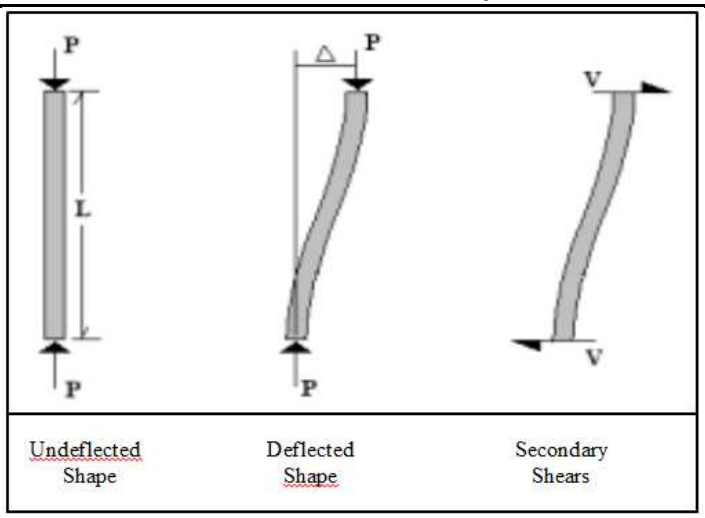

Figure 1: P-Delta Analysis

II. OBJECTIVE

The primary objectives of this study can be summarized as follows:

- To study, review different methods of P Delta analysis
- To compare the result of P-Delta analysis by amplification factor method, the direct method, the iterative method in terms of their efficiency and accuracy.
- To recognize in what way the P Delta effects influence the variation of responses of structure
- To study different parameter like bending moments, displacements and shear forces against linear static analysis.

III. METHODOLOGY

The static analysis of multistory buildings for the gravity loads or vertical loads and horizontal loads can be done as followings:

1. Portal frame method
2. Substitute frame method
3. Cantilever method
4. Kani's method

1. Portal frame method: The portal method is one of the common approximate methods in the analysis of statically indeterminate structures. This method is used to analyze the frames which subjected to lateral loadings such as wind, earthquake, and blast loadings.

2. Substitute frame method: In this method only a part of the frame is considered, called a substitute frame. The moment's for each floor is separately computed. It will be assumed that the moment transferred from one floor to another is small. Each floor will be taken as connected to columns above and below with their far end fixed. The frame taken this way is analyzed for the moments and shears in the beams and columns. The moment distribution for the substitute frame is analyze only for two cycles and hence the method is sometimes referred to as the two cycle method.

3. Cantilever method: It is assumed that a point of contra flexure occur at the middle points of the members of the frame and horizontal shear taken by each interior columns is double the horizontal shear taken by each of the external columns. Thus by making the above two assumptions, the structure can be easily analyzed. It is also assumed that the horizontal force on each storey height is equally divided and transmitted to the top and bottom of the storey. In this method the minor difference in assumption in considering the moments and shear force in load bearings members.

4. Kani's method: In this method can be considered by taking a beam "AB" represent one of the spans of a frame or continuous structure and after it's loading it will deform. As per Kani's method- moments at the near end of a member will be sum of

i. The fixed end moments at the near end due to this loading on the member.
ii. Twice the rotations contribution of the near end.
iii. The rotation contribution of the far end.

IV. MODEL DESCRIPTION

In this study the method of P-Delta (structure deformation) effect in multi-storied structures are identified floor wise. Thus the significance of building responses like displacement, column moment, beam moment, column shear and beam shear are studied in detail. Seismic analysis is perform as per IS-1893 (Part-I) 2002 guidelines. In present study six different storey cases is taken where storey variation starts from storey 5 to storey 30, Making 5 storey intervals from each makes a gradual but less time consuming analysis. Storey cases are: 5, 10, 15, 20, 25 and 30. Each of the storey case is analysed for Linear Static and P-Delta analysis separately with appropriate command. Each storey is 3 meter in height makes Storey 5, Storey 10, Storey 15, Storey 20, Storey 25 and Storey 30 in total height of 15, 30, 45, 60, 75 and 90 respectively. As storey increases so the slenderness increases. In both direction bay length of buildings is 5 m.

Table 1 : Model Details

Sr. No.	Particular	RCC Structure
1.	Plan Dimension	20 x 20 m
2.	Height of each storey	3.0 m
3.	Size of Beam	0.3 x 0.45 m
4.	Size of Column	0.45 x 0.45 m
5.	Thickness of slab	0.125 m
6.	Seismic zone	III
7.	Earthquake load	As per IS:- 1893-2002
8.	Type of soil	Type II medium as per IS:-1893-2002
9.	Live load	2 kN/m2 at typical floor 1.5 kN/m2 at terrace.
10.	Floor finish	1.25 kN/m2
11.	Walls	0.23 m thick
12.	Support at base	Fixed

IV. RESULTS AND DISCUSSION

The trend towards slender and more efficient building structures has resulted in more significant P-delta effects, which has led to the demand for simple and accurate methods of P-delta analysis. In present study P-Delta and Linear Static analysis of 12 cases, in total 12 models reveals that P-Delta effects significantly influence the axial, moment and displacement of the structural components and has higher value than the Linear Static analysis. The variation mainly identified when the slenderness ratio is comparatively increasing by increasing the storey. Variation is observed in several sections: variation of storey displacement between linear static analysis and P-Delta analysis, Variation of storey drift, Variation of axial force in column, Variation of moment in column and percentage of variation against slenderness ratio to systematically scrutinize the response characteristics of the structure due to P-Delta effects with respect to slenderness.

4.1Variation Of Horizontal Displacement In Top

All 12 models and 6 storey case are studied to describe how the structure produce difference with height which represent the slenderness and obviously to present the priority of P-Delta analysis over Linear Static analysis. To establish the object top displacement is studied and found that structure studied under P-Delta effect causes much displacement in top then the structure analyzed by Linear Static analysis. The variation is following an upward trend with increasing storey. Following Figure 2 shows that after P-Delta analysis displacement increased exponentially with increment of storey over the simple analysis, “Linear Static analysis”

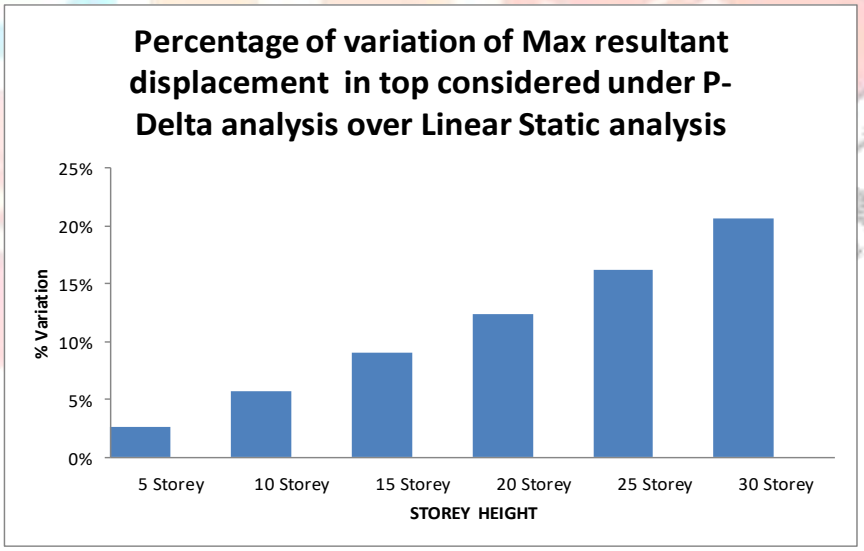

Figure 2: Percentage of variation of Max resultant displacement in top considered under P-Delta analysis over Linear Static analysis

Storey Percentage of variation must be seen keeping Linear Static analysis results as base. After P-Delta analysis storey 5, storey 10, storey 15, storey 20, storey 25 and storey 30 the top displacement increased by 3.0 %, 6.0 %, 9.0 %, 12.0 %, 16.0 % and 21.0 % respectively which represent the variations do not follow any linear trend. It seems with increasing slenderness variation between Linear Static and P-Delta will be maximized and vice-versa so proper understanding and policy should be taken when designing a high-rise.

Table 2 : Max resultant displacement

	Resultant Displacement (mm)				Difference of P-delta and Linear static displacement (mm)	% Variation of P-delta and Linear static displacement (mm)
	Linear Static Analysis		P delta Analysis			
	Case	Displacement	Case	Displacement		
5 Storey	Case 1	20.699	Case 2	21.238	0.539	3%
10 Storey	Case 3	36.517	Case 4	38.602	2.085	6%
15 Storey	Case 5	65.542	Case 6	71.468	5.926	9%
20 Storey	Case 7	92.979	Case 8	104.51	11.539	12%
25 Storey	Case 9	127.829	Case 10	148.46	20.636	16%
30 Storey	Case 11	165.445	Case 12	199.57	34.131	21%

4.2 Story Displacement Of Different Storey Cases

Storey displacements for both types of analysis: P-Delta analysis and Linear Static found maintaining the same trend of increasing with incrementing storey whereas the displacement outcomes of P-Delta analysis is found to be greater that corresponding displacement of Linear Static analysis. This characteristic is found in every storey case and represents the presence of P-Delta effects during performing P-Delta analysis Figure 3 and 4. This phenomenon represent that Linear Static consider only the 1st order loading effects which is not realistic for high-rise but P-delta analysis is suitable to get the iterative action as it consider 2nd order loading effects after analyzing the 1st order loading effects.

Maximum displacement is found in top of the storey and it could be mentioned to present the scenario. After P-Delta analysis displacement for storey 5, storey 10, storey 15, storey 20, storey 25 and storey 30 reached to 21.238 mm, 38.602 mm, 71.468 mm, 104.518 mm, 148.465 mm and 199.576 mm respectively, from 20.69 mm, 36.517 mm, 65.542 mm, 92.979mm, 127.829 mm and 165.445 mm respectively. These trends aware the caution to use Linear Static analysis for analysis phase of high-rise. With increasing trend it becomes much significant than Linear Static and the considering sway effects of P-Delta during analysis becomes basic needs. Figure 4 shows Variation of Storey Drift for six storey cases for P-Delta and Linear Static analysis. Comparing the results it is found that P- delata analysis has significant effect in storey drift on high rise buildings over linear static analysis.

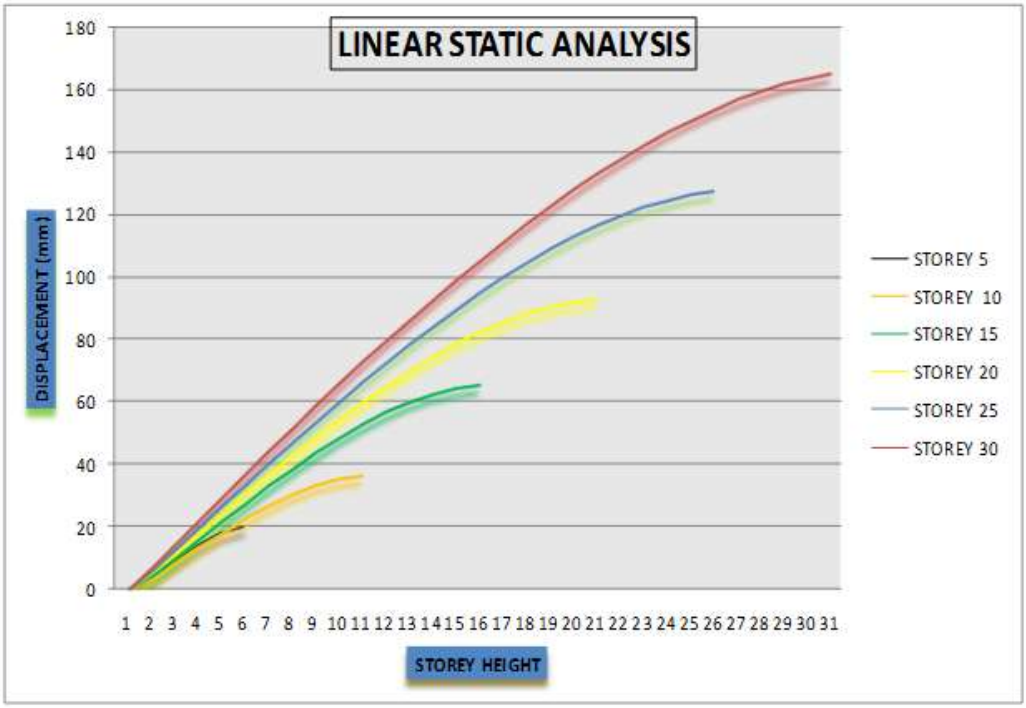

Figure 3: Storey displacement considered for six storey cases under consideration of Linear Static Analysis

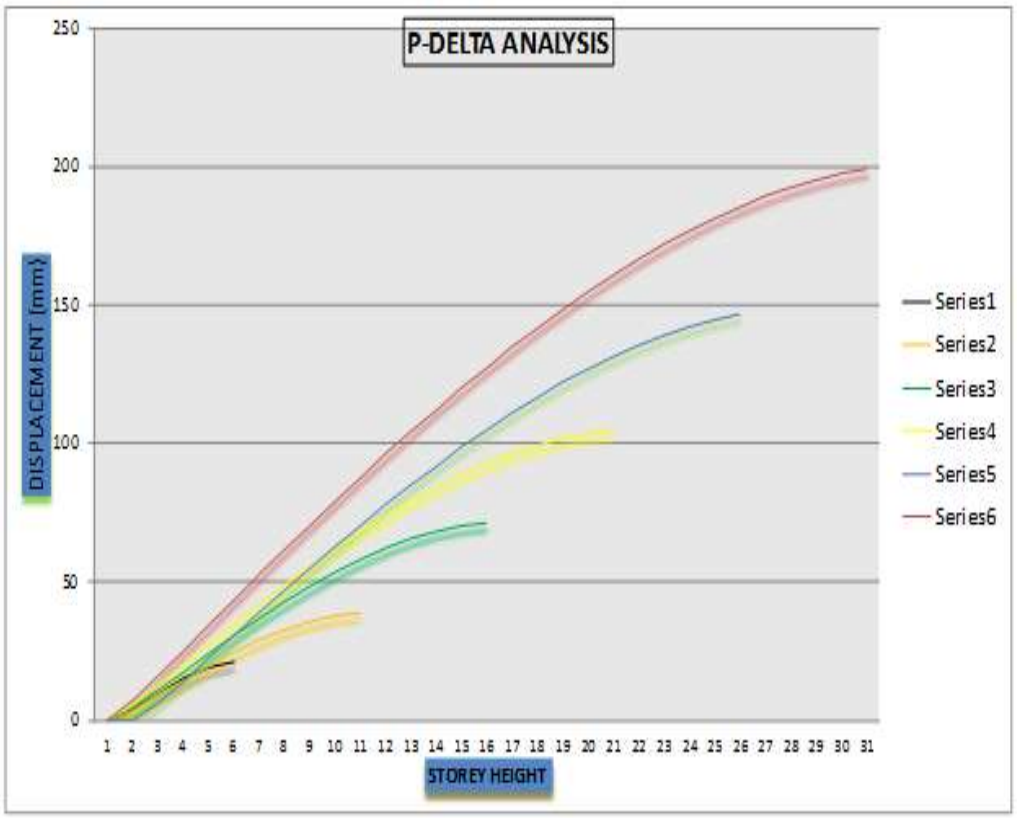

Figure 4: Storey displacement considered for six storey cases under consideration of P-Delta effects

4.3 Axial Force In Critical Zone Of Different Cases

As the storey increases so the slenderness too which push the difference to positive side and variation maintains an exponential characteristic. From the study it is found that P- delta analysis has significant effect in axial forces. This variation is the key parameter for design too. The section required under P-Delta analysis must be stronger than section designed considering Linear Static only. Axial loads are taken from storey 1 of each storey case of each analysis as a maximum axial load is found in that position. Like the displacement trend, here also the P-Delta results over flow the corresponding case of the Linear Static analysis and represent the necessity of P-delta analysis over the Linear Static for reinforced concrete high-rise structures Figure 5.

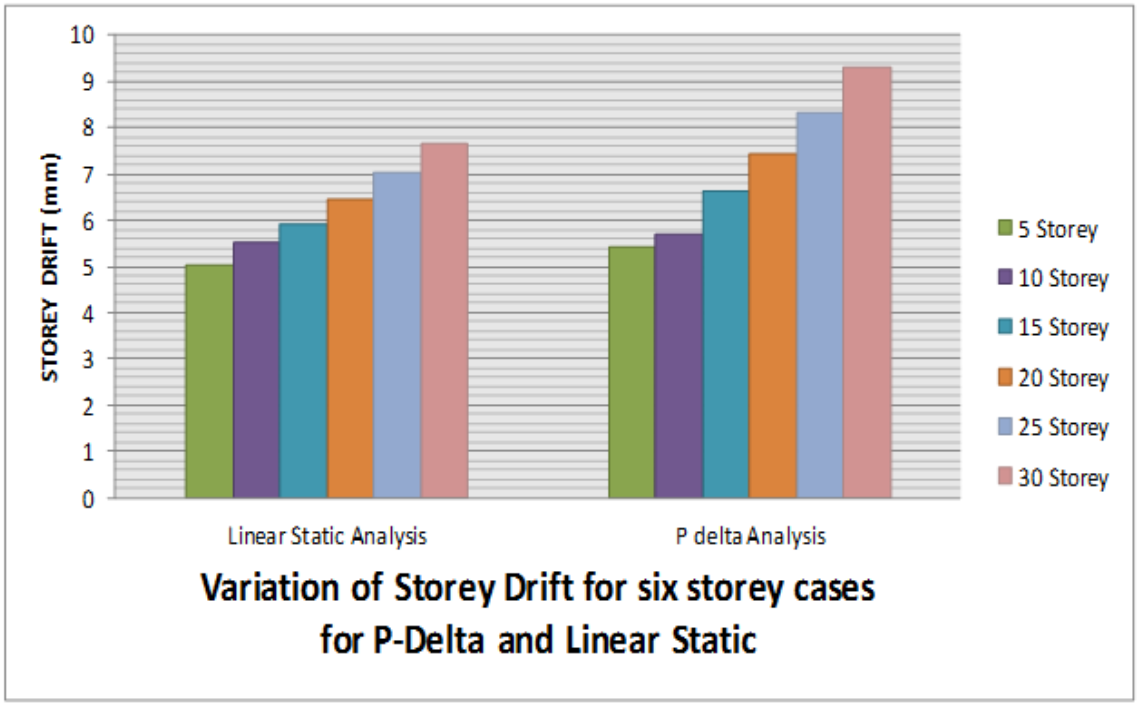

Figure 5: Variation of Storey Drift for six storey cases for P-Delta and Linear Static

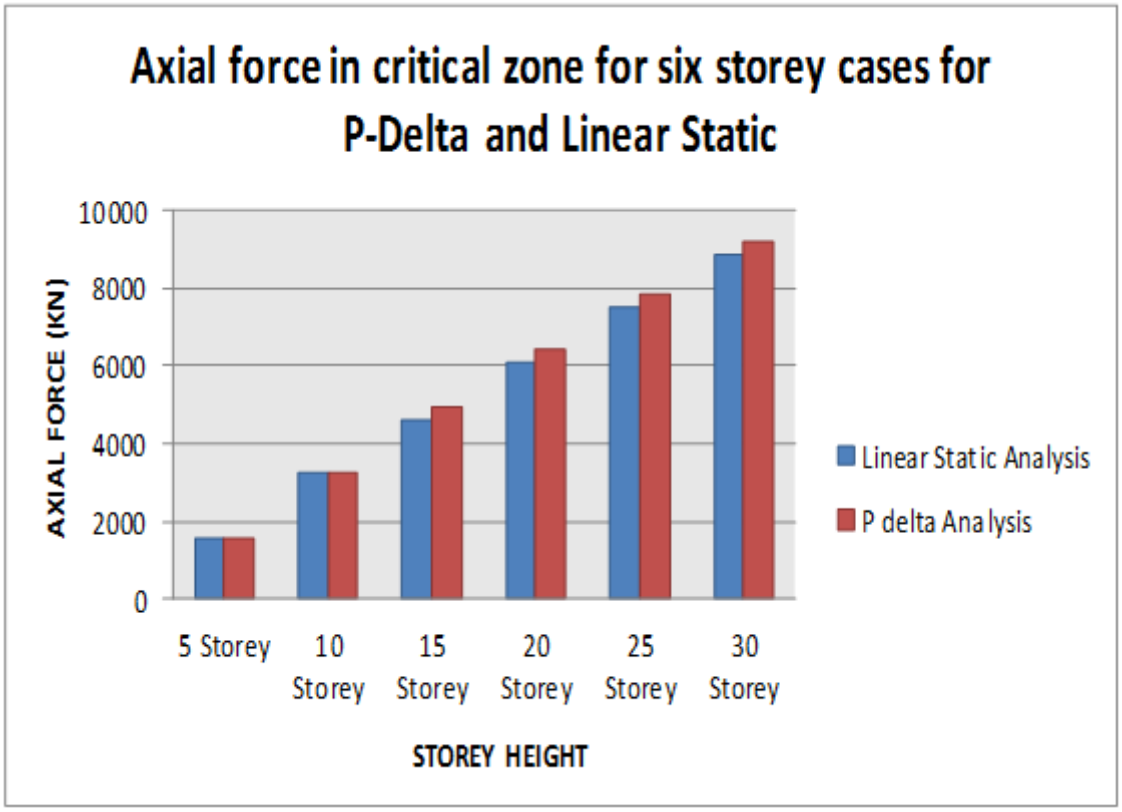

Figure 6: Axial force in critical zone for six storey cases for P-Delta and Linear Static

4.4 Storey Moment Of Different Cases

A specific column is observed for storey moment of each storey case with two different case: P-Delta analysis and Linear Static analysis. The storey moment trend is different to axial force trend seen in previous section. Moment is seem to increase in P-Delta analysis over linear static analysis. This structural behavior let designer think about the axial part properly as that governs the critical situation. However the moments are not so insignificant to not count during design. Again the moment increases with increment of storey so slenderness has effects to the moment. As our structural frame was 4X4 in plan which is 20 meter by 20 meter, May has its significant role in the moment characteristics. Further addition or substation may change the trend significantly.

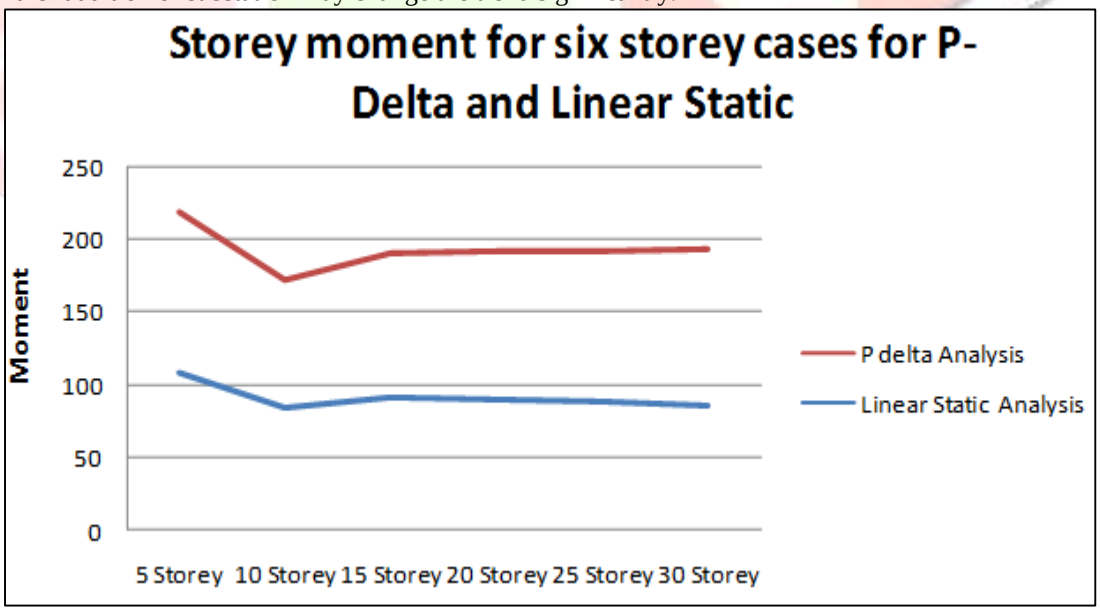

Figure 7: Storey Moment of different cases

V. CONCLUSION

Based on the second order analysis using STAAD-Pro and verification with other authors following conclusions can be drawn.

1) As number of storey increases P-delta effect becomes more significant.

2) Generally, P-delta effects are negligible up to 10 storey buildings where only gravity loads are governing load combinations. But having significant effects in high-rise structure.

3) The iterative method, in which the gravity load is transformed to an equivalent additional horizontal load, gives very accurate results for both shear and flexurally deforming structures.

4) It could be summarized that analyzing and designing RC high-rise structure needs expert observation and understanding. Analysis found was adaptable in characteristics but it could be said, displacement varies exponentially under P-Delta analysis with increasing height or increment in storey and so the axial force too.

5) Axial force changes in positive side rapidly over the Linear Static analysis, if P-Delta is performed to find it. For moments P-delta effect is only observed in some of the beams and columns (Exterior columns and their adjacent beams) in some load cases. If these load cases are governing load cases for design of member, then only we can say that it is considerable.

6) So, Linear Static and P-Delta both are necessary for RC structures and have to use after proper understanding to prevent any catastrophic. Hence we can say that, at least it is necessary to check the results of analysis with and without considering P-delta effect for the buildings.

7) Axial and displacement could be observed by P-Delta analysis while keeping the moment section to the Linear Static analysis. All these results were for reinforced concrete structure of rigid joint which is very common in society.

REFERENCES

[1] Mallikarjuna B.N, Ranjith A (Aug 2014)

[2] Yousuf Dinar, Nazim Uddin Rahi2, Pronob Das (2013) Variation of Deflection of Steel High-Rise Structure Due to P- Delta Effect considering Global Slenderness Ratio.

[3] Prashant Dhadve, Alok Rao, Atul Rupanvar, Deokate K., Dr. Nemade. P.D (May-2015) ' Assessment of P-Delta Effect on High Rise Buildings'

[4] Dr.S.K. Dubey, Prakash Sangamnerkar, Deepak Soni (2014) 'Dynamic Behavior of Reinforced Concrete Framed Buildings under Non Linear Analysis'

[5] Rafael Shehu (Feb-2014) 'The P-Δ-Ductility Effect: Overview The Effect of The Second Order in The Ductile Structures'

[6] Prof. C. G. Konapure, Mr. P. V. Dhanshetti (Jan-2015) 'Effect of P-Delta Action on Multi-Storey Buildings'

[7] A.S. Moghadam and A. Aziminejad 'Interaction Of Torsion And P-Delta Effects In Tall Buildings'.