Analysis of P-Delta Effect on High Rise Building

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Abstract- *P-delta effect is secondary effect on structure. It is also known as 'Geometric nonlinearity effect'. As number of storey's increases, P-delta effect becomes more important. If the change in bending moments and displacements is more than 10%, P-delta effect should be considered in design. In this study the P-delta effect on Tall RC building is studied. Non-Linear static analysis (with P-delta effect) on Tall RC building having different number of storey's is carried out. We are doing analysis of building G+15, G+20, G+25 & G+30. For RCC frame building. Considering the earthquake load on the structure as per IS-1893(2002) For zone III in ETABS & Load combination for analysis is set as per IS-456(2000). We are using ETABS software for analysis purpose .moment, story displacement with and without p-delta effect is calculated and compared for all the models. Then by trial and error method suitable cross-section are provided for unsafe building to bring within acceptable limit by increasing stiffness of a building. The result shows that it is essential to consider the P-delta effect for 25storey building. So buildings having height more than or equal to 75m, should be designed considering P-delta effect. Also we can say that up to 25 storey building, it is not necessary to consider P-delta effect in design and primary or first order analysis is sufficient for design.*

Keywords- P-delta effect, high-rise building, Static nonlinear analysis, ETABS16, Seconder efect.

I. INTRODUCTION

Generally Structural designers are prone to use linear static analysis, which is also known as first order analysis, to compute design forces, moments and displacements resulting from loads acting on a structure. First order analysis is performed by assuming small deflection behavior where the resulting forces, moments and displacements take no account of the additional effect due to the deformation of the structure under vertical load prior to imposing lateral loads. P-Delta is a non-linear (second order) effect that occurs in every structure where elements are subject to axial loads. It is a genuine "affect" that is associated with the magnitude of the applied axial load (P) and a displacement (delta). If a P-Delta affected member is subjected to lateral load, then it will be prone to deflect more which could be computed by P-Delta analysis not the linear static analysis.

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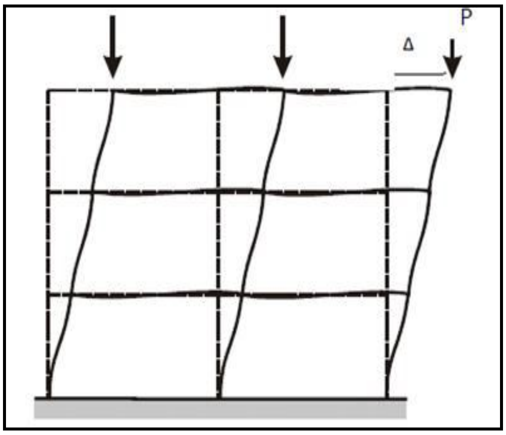
The magnitude of P-delta effect is related to the: -

- Magnitude of axial load.
- Stiffness of the structure as whole.
- Slenderness of individual elements



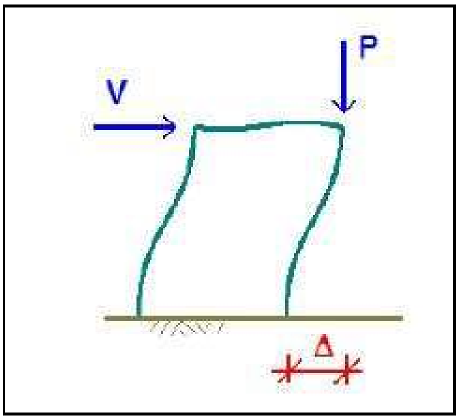


Fig1 P-Delta effect

II. IDENTIFY, RESEARCH AND COLLECT IDEA

- **Analysis methods**

Pushover analysis

Pushover analysis is a technique by which a computer model of the building is subjected to a lateral load of a certain shape (i.e., inverted triangular or uniform). The intensity of the lateral load is slowly increased and the sequence of cracks, yielding, plastic hinge formation, and failure of various structural components is recorded. Pushover analysis can provide a significant insight into the weak links in seismic performance of a structure. Pushover analysis is a simplified nonlinear analysis whose central focus is generation of the pushover curve or capacity curve. This represents the lateral displacement as a function of force applied to the structure. This capacity curve is representation of the structures ability to resist the seismic demand. To generate the capacity curve, the structure is pushed in a representative lateral load pattern which is applied monotonically while the gravity loads are in place. Any type of representative lateral load pattern can be defined but the load pattern similar to first mode shape amplitude of the structure is the most commonly used to determine the capacity. The A predefined lateral load pattern as shown in fig.1.which is distributed along the building height is then applied. The lateral forces are increased until some member's yield. The structural model is modified to account for the reduced stiffness of yielded members and lateral forces are again increased until additional member's yield. The process is continued until a control displacement at the top of building reaches a certain level of deformation or structure becomes unstable. The roof displacement is plotted with base shear to get the global capacity curve

- **AIM & objective**

Scope of this study includes analysis of 20, 25 and 30 storey R.C.C. building with and without considering P-delta effects. Analysis can be done using ETABS. Lateral load is Earthquake load for zone III. If the change in the values of deflections, forces, and bending moments considering P-delta effect is not more than 10%, they can be neglected. From this analysis we can decide whether it is necessary to include P-delta effect for the buildings up to 30 storeys'.

Analysis of Tall RC Building in ETABS.

Buildings having same plan but with different number of stories are analyzed in SAP2000 with and without considering P-delta effect and their results are compared.

Case1. 20storey
Case2. 25storey
Case3. 30storey.
Case3. 25storey.

Following loads are considered for the analysis of the buildings. The loads are taken in accordance with IS: 875 (Part 1) and (Part 2).

The plan of a model is a 8*8 bay. The size of a bay in X direction is 4m and Y direction is 5m. Properties of all materials for asymmetric building are similar to symmetric building,

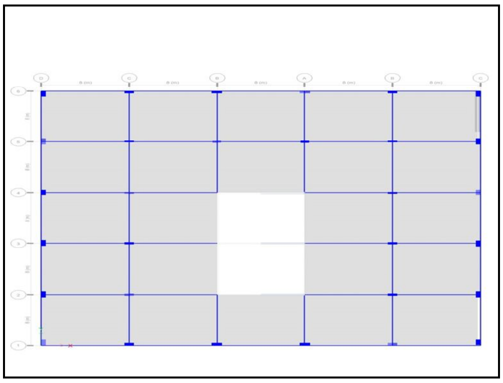


Fig.2-ETBS Model (plan view)

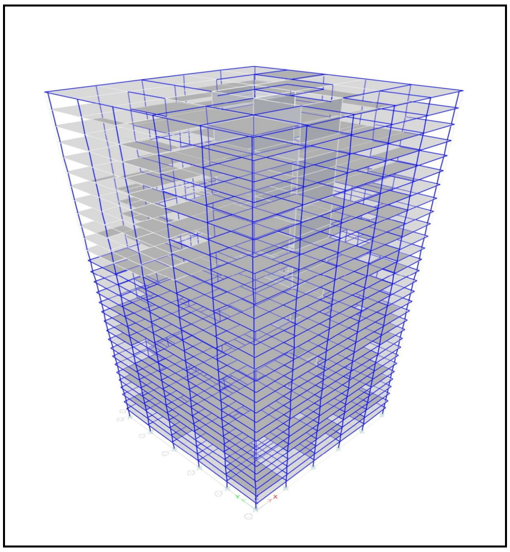
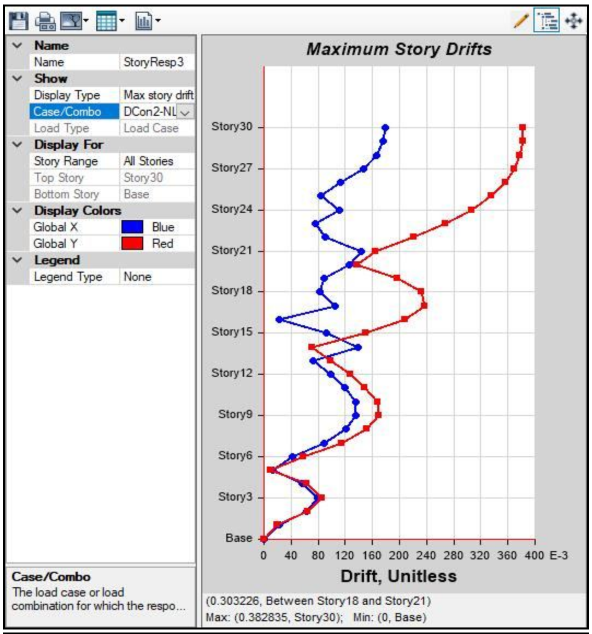


Fig.3- ETABS Model (3D view)



VI. CONCLUSION

In this study, the three building models with different number of stories are analyzed with and without considering P-delta effect for seismic loads. By studying the results of analysis, following conclusions are drawn.

- As number of storey increases P-delta effect becomes more important.
- 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. This condition is observed in 25 and 30 storey buildings and mostly in 30 storey building.
- So 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 with 25 stories (height = 75m).

VII. ACKNOWLEDGMENT

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