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P-DELTA ANALYSIS IN THE DESIGN OF TALL RC STRUCTURES

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Abstract - *As urbanization increases worldwide, the available land for buildings is becoming scarcer and scarcer, and the cost of land is becoming higher and higher. Thus the popularity of high rise structures are increasing day by day to accommodate growing population in metropolitan cities. As number of stories increases, P-delta effect becomes more important . In this study the P-delta effect on high rise building is studied. For the analysis G+10, G+20, G+30, G+40 , G+50 R.C.C. framed building are modeled. Earthquake load and Wind Loads are applied on model of structure as per IS-1893(2002) and IS -875(part-3) for zone II . Load combination for analysis is set as per IS-456(2000). The drift ratio and Overturning Moment is found out for both, earthquake and wind loading, considering with and without p-delta effect for different number of stories such as 10, 20, 30, 40, 50 stories. However, when a structure deforms, the applied loads may cause additional actions in the structure that are called second order or P-Delta effects.The analysis of multistoried RC building has been done using ETABS 2013 Structural analysis software.*

Key Words: **Geometric non-linearity, P-Delta, Drift Ratios, E-tabs.**

1. INTRODUCTION

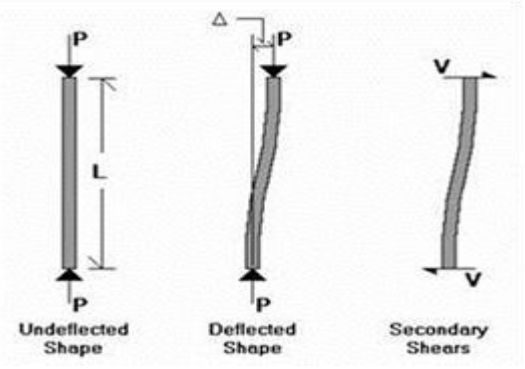
The Tall Structures are used as Residential , Commercial and more-over as a modern trend among the people which is growing towards the development of Tall Structures . The Loads on the Tall Structures are combined developed from the resulting Earthquake and Wind Loads. These Loads are generally termed as P-Delta Effect Loads. Shaking of the Earth is caused due to the sudden release of energy in the Earths Lithosphere which causes the Earthquake. Earth quake range in size from those that areas so weak that they cannot be felt to those violent enough for People around and destroy whole cities . Buildings are susceptible to Earthquake forces because of the fact that during earthquake the very ground on which a building stands start shaking . This ground motion is characterized by displacement , velocities and accelerations that are erratic in direction, magnitude, duration and sequence .Earthquake Effect occurs mainly on Tall Structures due to Lateral Loads applied on it . As according to the code India is divided into several seismic zones, i.e. Zone II, III, IV & V as proven . In particular, wind speed at any height is called the Gradient Height because here the atmospheric boundary level increases from zero to ground floor with minimum height to maximum height. The terrain conditions primarily depend on the variation with height. Here, the speed of the wind remains constant at any height and it has been found convenient to resolve its instantaneous magnitude into an average or mean value .

2. METHODOLOGY

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 performed by assuming small deflection behaviour 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 (2^{nd} order) effect that occurs in every structure where elements are subject to axial loads. It is a genuine "effect" that is associated with the magnitude of the applied axial load (P) and a displacement (Δ). 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.

3. IMPORTANCE OF STUDY

In the present days , the Tall Structures which are being built are accepted by people because due to the provision that lots of people can accommodate in it . But because of its huge height it may lead to many structural failures because of inappropriate design by many Structural parameters due to its framed system and its own weight and it may lead Structural destruction .Generally here Multistoried buildings are performed for linear static analysis but the results obtained gets a lot off difference from the practical aspects and therefore to understand clearly the concept of destruction non-linear P-Delta analysis is performed on the structure.



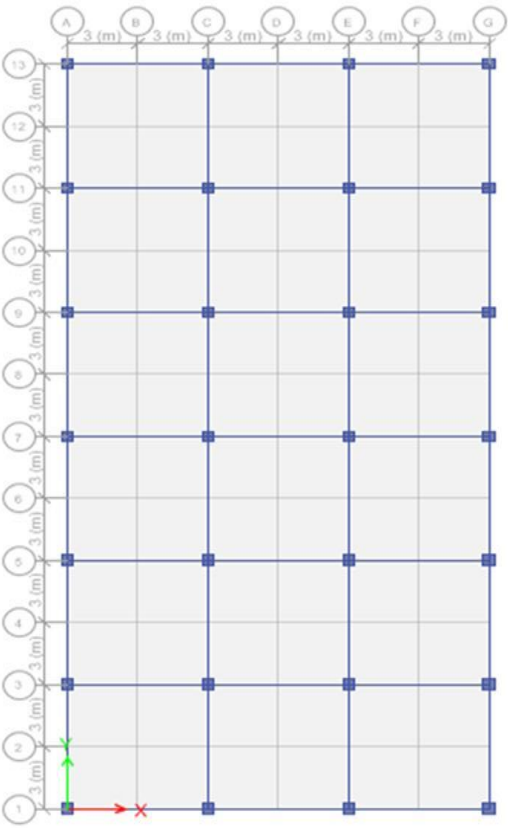
4. OBJECTIVES OF THE STUDY

The following are major objectives of present study.

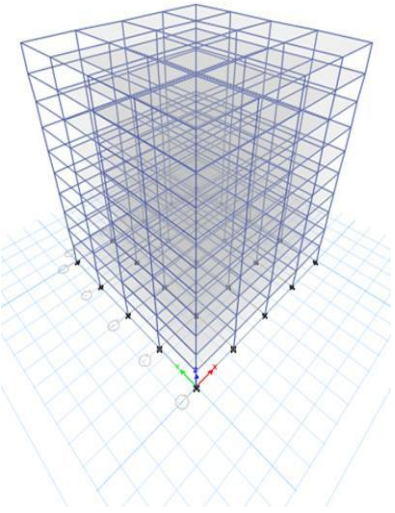
- ✓ To perform Static Linear analysis on Tall RC Structure using E-Tabs 2013.
- ✓ To perform P-Delta analysis on Tall RC Structures using E-Tabs 2013.
- ✓ To Study the effects of both Earthquake and Wind Loading on the Structure.
- ✓ To study the results of Displacements , overturning moments acting on the Structure by considering both for With P-Delta and Without P-Delta.
- ✓ To compare the results of the structure for different heights of the building.
- ✓ To study the Inter-story drift performances on various structures.
- ✓ To study the location at which deflection and various other factors are greater on the structure.
- ✓ To study the seismic performance of slenderness columns and deflections on various structures

5. MODEL GEOMETRY

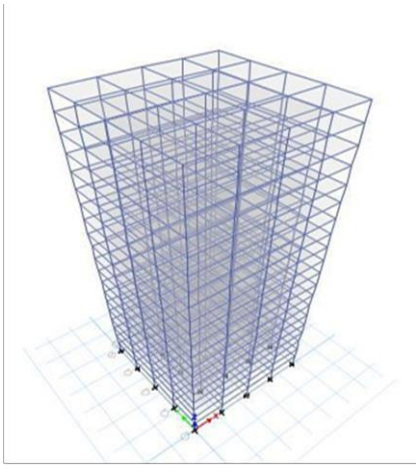
Parameters	Values
No .Of Stories	10 , 20 , 30 , 40 , 50
Number of bays along X- direction	7
Number of bays along Y- direction	13
Typical Story Height	4m
Bottom Story Height	5m
Bay width along X – direction	3m
Bay width along Y – direction	3m
Depth of the slab	150mm
Size of the beam	600mm*300mm
Size of the column	500mm*500mm for 10 Story
Size of the column	700mm*700mm for 20 Story
Size of the column	800mm*800mm for 30 Story
Size of the column	1000mm*1000mm for 40 Story
Size of the column	1100mm *1100mm for 50 Story
Zone	II
Response reduction factor	5
Importance factor	1
Soil condition	Medium



Plan Of The Building

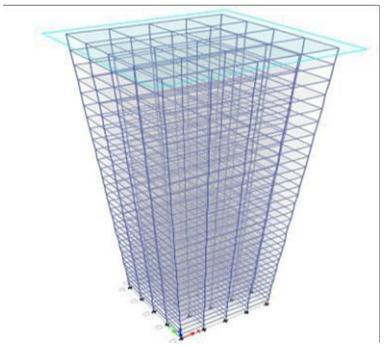


10 Story Building

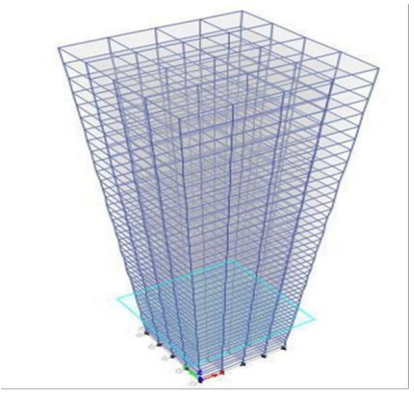


20 Story Building

30 Story Building



40 Story Building

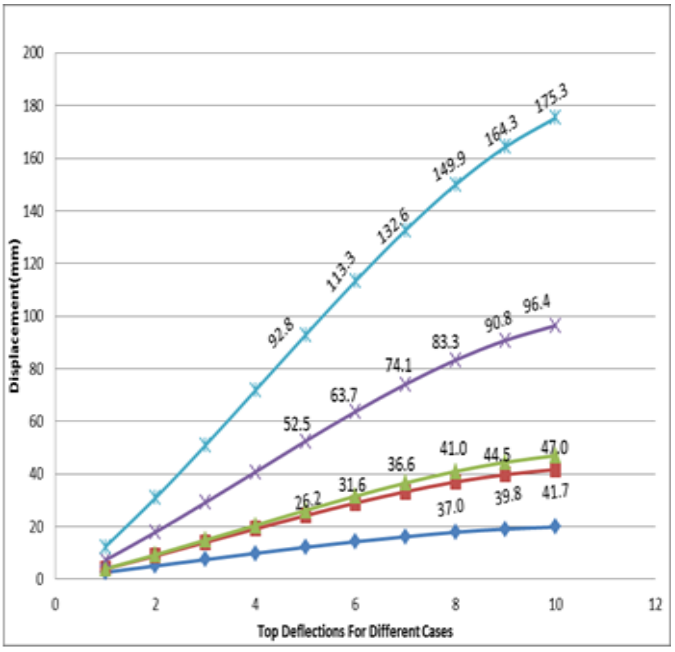


50 Story Building

6. Analysis Of Models

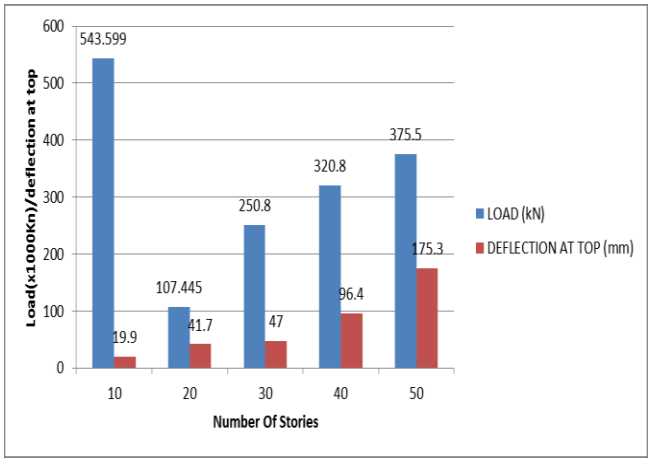
6.1 ANALYSIS FOR DIFFERENT MODELS WITHOUT P-DELTA

LATERAL DISPLACEMENT

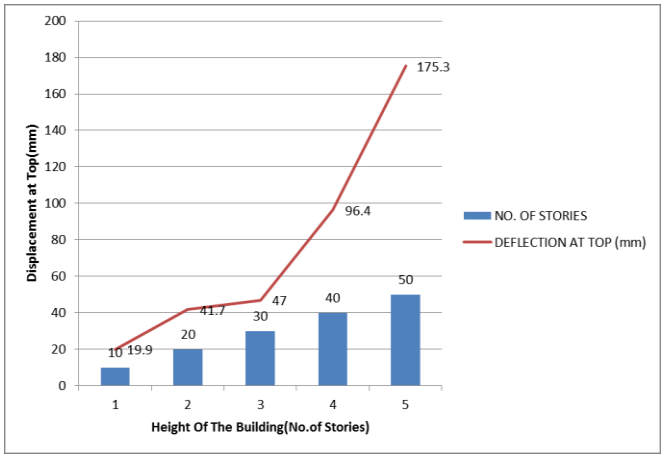


6.2 RESULTS FOR VARIOUS LOADING WITHOUT P-EFFECT

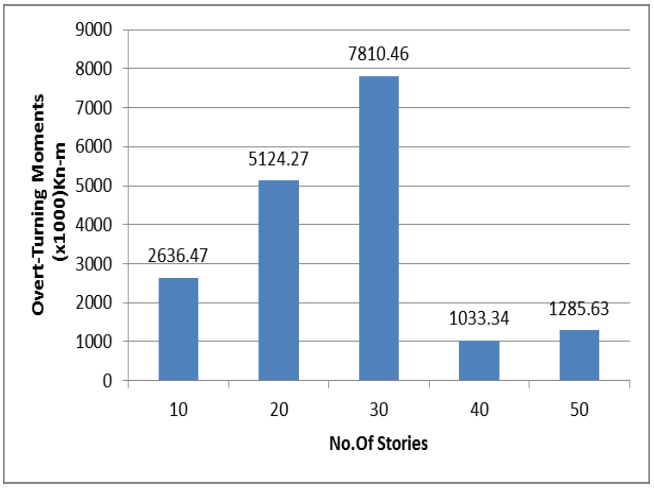
RELATIONSHIP BETWEEN LOAD, DEFLECTION AND NO. OF STORIES :-



The graph of load Vs deflection for different number of stories considering without p-delta effect under both Earthquake and wind loading is shown below :-

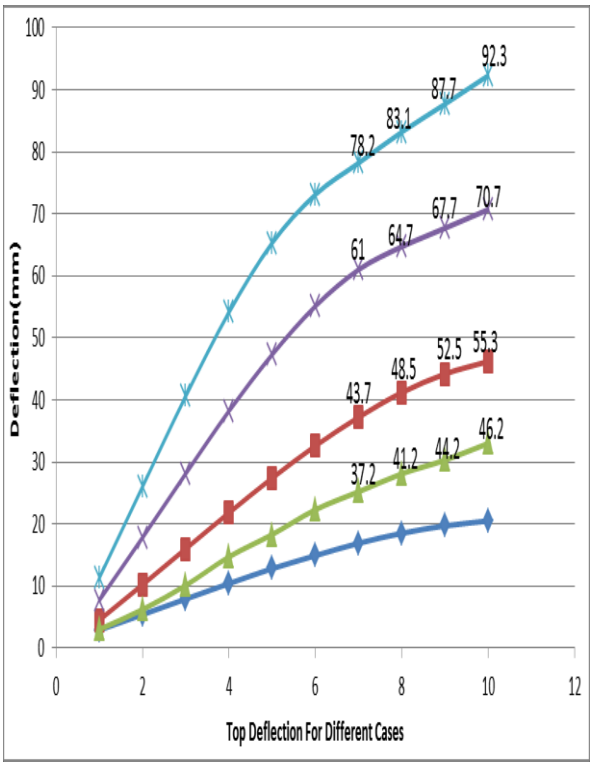


6.3 OVER-TURNING MOMENTS

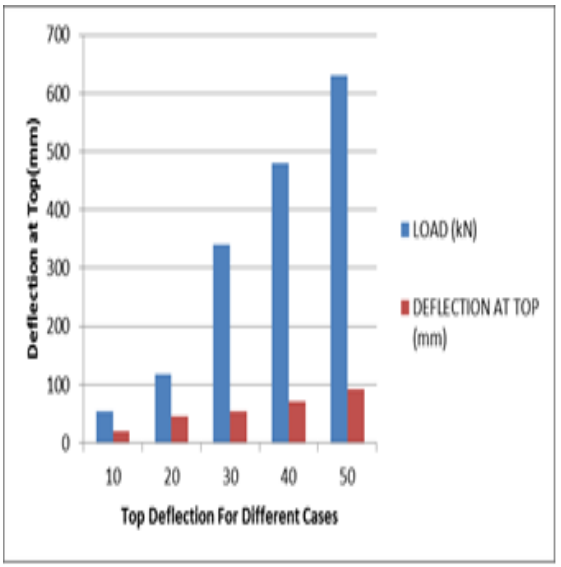


7. ANALYSIS FOR DIFFERENT MODELS WITH P-DELTA

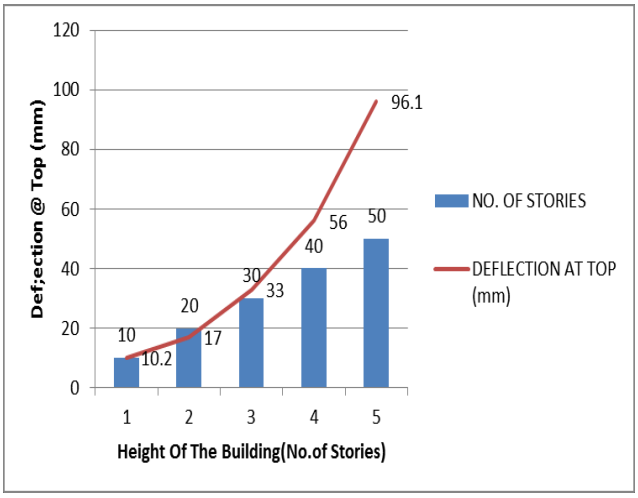
7.1 Lateral Displacement



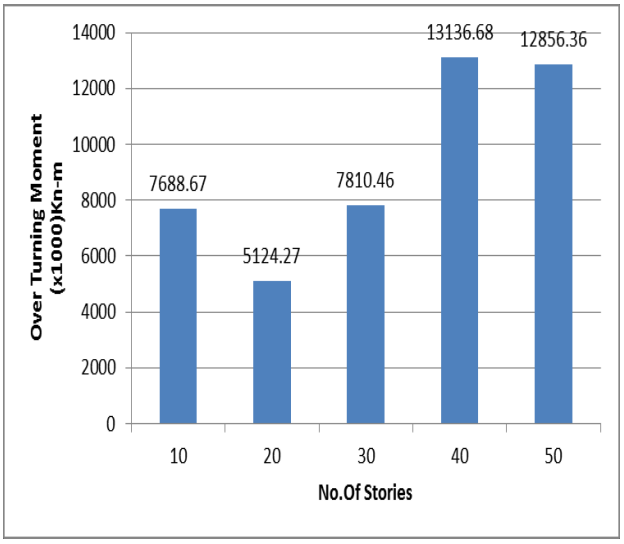
7.2 RELATIONSHIP BETWEEN LOAD, DEFLECTION AND NO. OF STORIES



The graph of load Vs deflection for different number of stories considering p-delta effect under both Earthquake and wind loading is shown below :-



7.3 OVER-TURNING MOMENTS



8. FUTURE WORK

The design optimizations based only on drift ratios may not necessarily apply to cases, where gravity loads also contribute significantly to the building response. In future investigations, design optimizations will consider the building response dominated by both gravity and lateral loads.

9. CONCLUSIONS

To investigate the non-linear behavior of the building the P-Delta effect is a very simple way to use.. The drift ratio and overturning moments is found out by considering both Earthquake and Wind Loading considering with and without p-delta effect for different number of stories such as 10, 20, 30, 40 & 50 in ETABS software.

1) Displacements obtained from the each model designed is quite large but the drift ratios nearly matches the safety limit .
2) As the height of the building decreases P-Effect decreases and earthquake loading has significant effect on the building comparable to wind loading .
3) As the height of the building increases , P-Effect increase and the wind loading has significant effect on the building comparable to earthquake loading .
4) Drift Ratio is very small in lower stories and reaches maximum at the top stories.
5) The Story Drift is more at the top when compared to With P-Delta than Without P-Delta.
6) The Overturning moments graphs obtained are also verified by providing graphs and compared using the relationship between various stories .
7) Overturning moment is greater for P-Delta than for the values without P-Delta.
8) Moments obtained here shows a very different tendency as increase in story decrease the moment value.
9) The P-Delta effect from the above results shows that it is necessary for stories greater than 20.

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