

# Analysis of Diagrid Structure by using P-delta Analysis Method

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**ABSTRACT:** Construction of multi-storey building is rapidly increasing throughout the world. Recently the diagrid structural system has been widely used for tall buildings due to the structural efficiency and aesthetic potential provided by the unique geometric configuration of the system. These days the latest trend of technology in diagrid structures is evolving. These are more efficient in achieving stiffness against lateral loads and are considered better options in designing tall buildings. P delta effects are the additional overturning moments applied to the structure resulting from lateral load. In this paper steel diagrid structure without P-delta effect and with P-delta effect is compared and changes in deflection moment and forces are found out, Design is done using STAAD Pro. software V8i (Select series 6).

**KEYWORDS:** Diagrid structure, high rise building, P-delta analysis.

## I. INTRODUCTION

The diagrid (diagonal grid) is a framework of diagonally intersecting metal, concrete or wooden beams that is used in the construction of buildings and roofs. It requires less structural steel than a conventional steel frame. Traditionally, the function of tall buildings has been as commercial office buildings. Other usages, such as residential, Mixed-use, and hotel tower developments have since rapidly increased. P-Delta effects have one more adverse effect, specifically in tall buildings. As we know, in case of earthquake a building deforms. And this deformation is huge. This means that the structure is already losing its stiffness. Now the P-Delta shear (The force that is generated at the top and bottom of the column because of P-delta moments), generates an additional demand for lateral shear resistance of the structural system. This additional demand is in addition to the earthquake shear demands. Which means that if we have not considered the P-delta demands and if we provided sufficient shear resistance, then the building might collapse.

## II. LITERATURE REVIEW

- A Simplified P-Delta Second Order Numerical Analysis of High Rise Buildings: Formulation and Validation Maaz Siddig Ibrahim and Abdel Rahman Elzubair Mohamed College of Engineering, Sudan University of Science and Technology (SUST), Khartoum, Sudan. SUST Journal of Engineering and Computer Sciences (JECS), Vol. 17, No. 3, 2016

In this paper, a simplified numerical method of global and local second order P-Delta 2D and 3D analysis of tall buildings subjected to vertical and horizontal loads is presented. The method was based on developing the moment transformation (MT) and the moment-force transformation (MFT) methods those are formulated using the moment distribution methods and have been successfully used in linear analysis of tall buildings neglecting and/or taking into account axial deformation in vertical members. The method was developed to include second order effects, by coupling the axial force and the bending moments in each of the vertical members with large lateral displacements at floor levels. Validity of the method was established by comparing the results of two 2D and 3D problems with those resulted from a reliable finite element approach. The comparisons show that, the results are in good agreement thus verifying the accuracy of the proposed method. (1)

- EFFECTS OF P-DELTA ON HIGH RISE BUILDINGS LOCATED IN SEISMIC ZONES Vijayalakshmi R., Bindu N Byadgi, Vahini M. International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 04 Issue: 08 | Aug -2017 [www.irjet.net](http://www.irjet.net) p-ISSN: 2395-0072 © 2017, IRJET | Impact Factor value: 5.181 | ISO 9001:2008 Certified Journal | Page 1371 (2) P-Delta effect becomes more significant when columns are slender. A method of designing of P-Delta effects in high rise buildings presented. In this paper the effect of lateral load on the structural system is considered for the P-Delta effect. The drift ratio is found for both, earthquake and wind loading, considering with and without P-Delta effect for different number of stories such as G+10, G+20, G+30 and G+40 stories. The load deflection curves and drift ratios have been obtained for different cases and

results so obtained have been compared to identify the drift ratios for different stories of the structure. The results of the analysis show that the P-Delta effect is more in the upper stories. In this present study, the Non-Linear static analysis has been carried out using ETABS 9.7 with identification of P-Delta effects in multi-storey buildings based on its behaviour. The load deflection curves and the results so obtained have been compared(2)

- Effectiveness of P-Delta Analysis in the Design of Tall Slender RC Structures Saranya S. Pillai1a\*, Namitha Chandran2 International Journal of Science and Research (IJSR) 2016

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. The present study focusses on the effectiveness of p-delta analysis in the design of tall slender reinforced concrete structures. A study on the stability of tall structures to lateral forces with and without considering p-delta effects is carried out in the present investigation The building models with different storey heights have been analysed to investigate the maximum response in the building in terms of displacement, moment and shear forces. The analysis of multi-storeyed RC building have been done using ETABS 2015 Structural analysis software.(3)

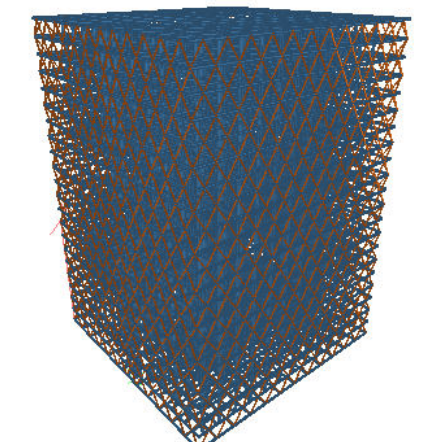
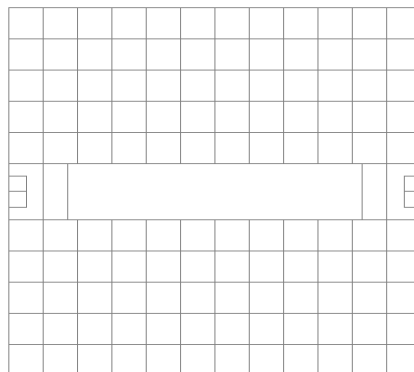
### III. OBJECTIVES OF STUDY

1. To analyse the structure by using P- delta analysis method.
2. To check the base shear.
3. To check deflection of the structure.

### IV. METHODOLOGY

1.The design methodology is applied to a structures G+20 storey tall building. Primary data required for the project is taken from “Nita Reality,Pune.

2.The diagrid structure of each storey height is 4m.The building’s plan dimensions are 60x 59 meters.





**Data-**

Soil bearing capacity-32 tonne.  
Zonal factor  $Z=0.16$   
Importance Factor=1.2  
Response Reduction Factor=5.0  
Time period both in x and y direction= $0.075 \times H^{0.75}$   
 $=0.075 \times 84^{0.75}$   
 $=2.08$   
 $Sa/g=0.68$   
For Wind Calculations  
 $Vb=47$  m/s.  
 $K1=1.0$   $K3=1.0$   $K4=1$   $K2$  (as per IS875 part 3)

**Material properties:-**

Steel: Fe500  
Density: 7850 Kg/m<sup>3</sup>  
Modulus of Elasticity:  $2.1 \times 10^5$  N/mm<sup>2</sup>  
Poisson's ratio: 0.3

**Section Properties:-**

Beam:- ISHB450  
Column-ISWB600  
Bracings-ISA120x120x12

**Load Cases:-**

As per IS-456(2000) in which both gravity and lateral loads are included.

**Load combination for serviceability**

- 1 DL + LL
- 2 DL + WL X+
- 3 DL + WL X-
- 4 DL + WL Z+
- 5 DL + WL Z-
- 6 DL + SL X+
- 7 DL + SL X-
- 8 DL + SL Z+
- 9 DL + SL Z-
- 10 DL + 0.5 LL + 0.8 WL X+
- 11 DL + 0.5 LL + 0.8 WL X-
- 12 DL + 0.5 LL + 0.8 WL Z+
- 13 DL + 0.5 LL + 0.8 WL Z-
- 14 DL + 0.5 LL + 0.8 SL X+
- 15 DL + 0.5 LL + 0.8 SL X-
- 16 DL + 0.5 LL + 0.8 SL Z+
- 17 DL + 0.5 LL + 0.8 SL Z-

**Load combination for collapse**

- 18 1.5 DL + 1.5 LL
- 19 1.5 DL + 1.5 WL X+
- 20 1.5 DL + 1.5 WL X-
- 21 1.5 DL + 1.5 WL Z+
- 22 1.5 DL + 1.5 WL Z-
- 23 1.5 DL + 1.5 SL X+
- 24 1.5 DL + 1.5 SL X-
- 25 1.5 DL + 1.5 SL Z+
- 26 1.5 DL + 1.5 SL Z-
- 27 0.9 DL + 1.5 WL X+
- 28 0.9 DL + 1.5 WL X-
- 29 0.9 DL + 1.5 WL Z+
- 30 0.9 DL + 1.5 WL Z-
- 31 0.9 DL + 1.5 SL X+



- 32 0.9 DL + 1.5 SL X-
- 33 0.9 DL + 1.5 SL Z+
- 34 0.9 DL + 1.5 SL Z-
- 35 1.2 DL + 0.6 LL + 1.2 WL X+
- 36 1.2 DL + 0.6 LL + 1.2 WL X-
- 37 LOAD COMB 47 1.2 DL + 0.6 LL + 1.2 WL Z+
- 38 1.2 DL + 0.6 LL + 1.2 WL Z-
- 39 1.2 DL + 0.6 LL + 1.2 SL X+
- 40 1.2 DL + 0.6 LL + 1.2 SL X-
- 41 1.2 DL + 0.6 LL + 1.2 SL Z+
- 42 LOAD COMB 52 1.2 DL + 0.6 LL + 1.2 SL Z-

V. ANALYSIS RESULTS

% Variation in Deflection

SR NO	NODE NO.	LOAD CASES	DEFLECTION		% DIFFERENCE
			WITHOUT P-DELTA	P DELTA	
Max X	930	1.5 DL + 1.5 SL X+	621.69	633.58	1.91
Max Y	540	0.9 DL + 1.5 SL X+	9.99	10.011	0.2
Max Z	4081	1.5 DL + 1.5 WL Z+	232.02	243.69	5.03
Max X	930	DL + SL X+	414.46	422.39	1.91
Max Y	540	DL + SL X+	6.033	6.058	0.41
Max Z	4081	DL + WL Z+	154.86	162.46	4.91

% Variation in Bending moments

SR NO	NODE NO.	LOAD CASES	BENDING MOMENTS		% DIFFERENCE
			WITHOUT P-DELTA	WITH P DELTA	

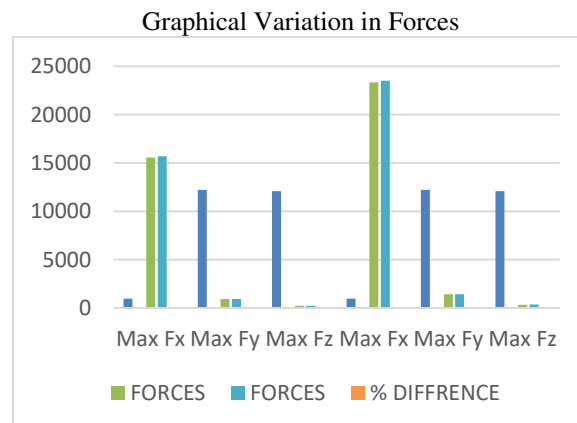
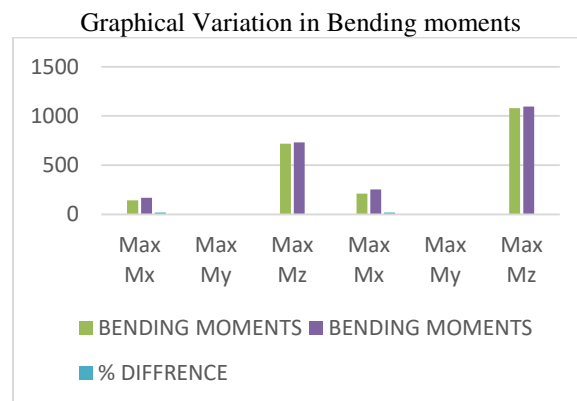
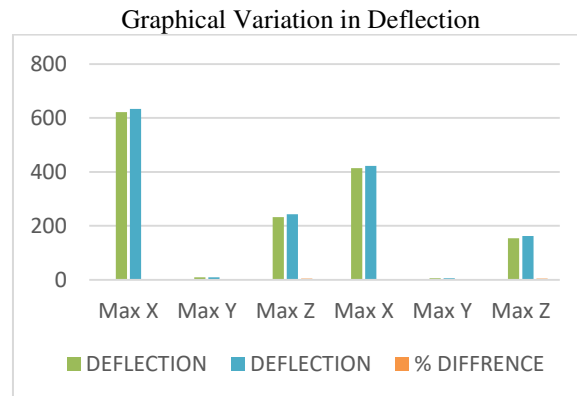


|| Volume 9, Issue 7, July 2020 ||

Ma x Mx	340	DL + WL Z-	140.6	168.1	19.54
Ma x My	356	DL + WL Z+	0.826	0.842	1.937
Ma x Mz	339	DL + SL X+	718.6	731.2	1.757
Ma x Mx	339	1.5 DL + 1.5 WL Z-	211	252.2	19.54
Ma x My	356	0.9 DL + 1.5 WL Z+	1.26	1.269	0.714
Ma x Mz	340	1.5 DL + 1.5 SL X+	1078	1097	1.757

% Variation in Forces

S R N O	NODE NO.	LOA D CAS ES	FORCES		% DIFF REN CE
			WITH OUT P- DELT A	WITH P DELTA	
M ax Fx	974	DL + SL X+	15557	15676	0.765
M ax Fy	12216	DL + SL X+	947.09	950.88	0.399
M ax Fz	12086	DL + SL X+	237.22	255.69	7.785
M ax Fx	974	1.5 DL + 1.5 SL X+	23336	23514	0.765
M ax Fy	12216	1.5 DL + 1.5 SL X+	1420.6	1426.3	0.399
M ax Fz	12086	1.5 DL + 1.5 SL X+	355.83	383.53	7.785



## VI. RESULTS

1. Maximum % variation found in deflection at z i.e 5.03 %.
2. Maximum % variation found in moment at x i.e 19.5%
3. Maximum % variation found in forces at z i.e 7.785 %.

## VII. CONCLUSION

As number of storey increases P-delta effect becomes more important. This conclusion is valid for Steel Building and may not be applicable for other buildings. The analysis is performed by considering the seismic loading in zones in India.

### VIII. FUTURE WORK

Composite material can be used for p delta analysis.

Can be studied for higher structures.

Structure without application of bracings can also be analysed using the same method.

RCC structure with shear wall can also be studied for P-delta effects.

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