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"Comparative Analysis of RC Multi-Storey Building Framed Structure With and Without Considering P-Delta Effect"

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Abstract - *In this exploration work correspond of four structure models with G 13 storey height and analysis is done with and without considering the P- Delta effect with Staad Pro Software. In this work the following parameters are used like Size of Column = 500 mm X 650 mm Beam = 500 X 600 mm, Height of each bottom = 3.5 m, Consistence of Arbor = 180 mm, Support- Fixed Support, arbor dead cargo4.5 KN/ mm2, masonry cargo13.34 KN/ m, for alcazar4.60 KN/ m, bottom finish1.0 KN/ m2, Live cargo on typical bottoms = 3.0 kN/ m2, Live cargo seismic computation = 0.75 kN/ m2 and other parameter similar as Seismic Zone- III and V, Type of soil- Medium Soil, Analysis Done With and Without Consideration of P- Delta Effect for Each Models, Damping = 5(as per table- 3 clause6.4.2), Zone factor for zone III, and V, Z = 0.16 and0.36, significance Factor I = 1.5(Important structure as per Table- 6), Response Reduction Factor R = 5 for Special RC Moment defying Frame(Table- 7), Sa/ g = Average acceleration measure(depend on Natural abecedarian period). In this exploration work the 4 model of different fabled with consider two seismic zone, medium soil condition with and without considering P- Delta effect that's total 16 models are anatomized by the software and relative analysis is done in the term of Maximum storey relegation, maximum bending moments, maximum shear force and maximum axial force.*

Key Words: P-Delta effect, second order effect, building models, storey drift, storey displacement, seismic zones.

1. INTRODUCTION

In conventional first order structural analysis, the equilibrium is expressed in terms of the figure of the disfigured structure. In case of linearly elastic structure, relation between relegation and external force is commensurable. In addition, stress- strain relationship of material is direct. therefore, by description, this system excludes nonlinearity, but it generally represents conditions at service loads veritably well. The first order elastic analysis is grounded on following hypotheticals(1) Material behaves linearly and hence all yielding effect can be ignored.(2) The member behaves linearly, and the member insecurity effect similar as those caused by axial contraction(these are called P- δ goods), which reduces the member's flexural stiffness, can be ignored.(3) The frame also behaves linearly, and the frame insecurity goods, similar as those caused by the moments due to vertical frame deviation and graveness loads acting on the displaced structure(these are called P- Δ goods), can be ignored. Though the first – order elastic analysis provides an ' exact result ' that satisfies the conditions of comity and equilibrium of the disfigured structure, it doesn't give any information about the influence of malleability and stability on the behaviours of the structure. Hence, these influences are typically handed laterally in member capacity checks. A first- order elastic analysis is sufficient for normal framed structures, which are braced against sway, still, first- order elastic analysis won't yield sufficiently accurate results for some suspense systems, bends, altitudinous structures, and structure subordinated to early localized yielding or cracking. Modeling of Building Frames A RCC Structure is for the utmost part a gathering of shafts, Columns, Crossbeams and establishment connected to one another as a solitary unit. By and large the exchange of burden in these structures is from section to bar, from bar to member incipiently member to establishment which therefore moves the whole burden to the dirt. In this examination, we've embraced colorful cases by awaiting colorful shapes for the structure displayed exercising STAAD- Pro. We've embraced three cases by awaiting distinctive arrangement of L- Shape.

1.1 Building Plan Configurations

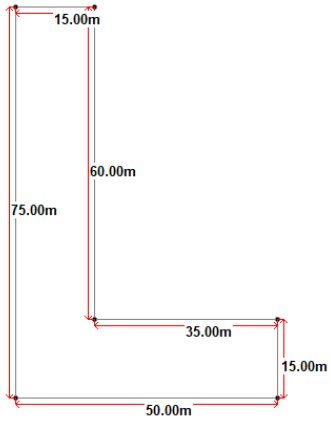

Fig.1.2a Common Plan of building

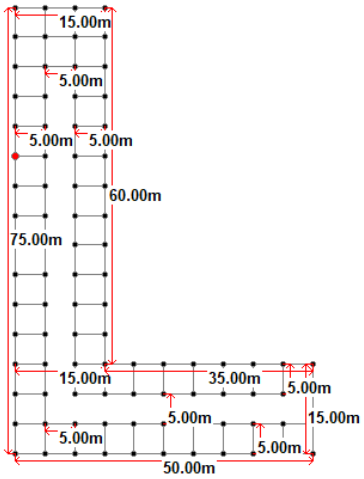

Fig. 1.2b Common Plan of building

In this research work, the Building Plan configuration as L-shape with G+13 each floor height 3.5m. Building is locate in seismic zone III & V with Medium.

1.6 OBJECTIVE OF WORK

The objective of the study comprises of the following:

1. To study the different RC Building of L-shape Models of P Delta analysis

2. To Perform the Delta effects influence the variation of responses of structure

3. To compare the different model of RC structures in zone III and V.

2. LITRERATURE REVIEW

Payal N. Shah, V.G jadhav:- They studied that Non-linear dynamic analysis of stepped building structure with considered P-Delta effect. They are taken G+14 RCC building with irregularities of the structures with different parameter are used like seismic zone V, zone factor 0.36, importance factor one with damping ratio five, IL for residential and commercial as 2.0 and 3.5 KN/m2, with every floor height is taken three meter and bricks infill walls of 230mm, property of the 300X600mm and 230X600mm as columns and beams respectively. They analysed and designed the RCC G+14 model with irregularities building by using Time History Method in SAP200V16 considering P-Delta effect. They performed the structure in the term of base shear story drift, overturning moments and found that the effect of P-Delta effect in the building needs to be considered and controlled. **Swathi Hasabi, M.B. Mogali (2019):-** They studied that G+10 storey RCC building of plan configuration 22.5m by 22.5m with 30.6m height of building with and without P-Delta effect. They analysed the building structure in seismic zone II & III with different load combination applied as per IS:456:2000 with the help of ETAB 2016 structural software and considering Linear Static Analysis and Non-Linear Static Analysis (P-Delta effect). They also used different parameters like section of columns 0.5mX0.5m, beams as 0.3mX0.6m, thickness of slab 0.100m, storey height 3.0m, M25 & M30 grade of concrete, tow earthquake regions as II & III with medium soil condition. They observed that second order analysis increase the moments, deflection and force beyond by the results of first order analysis and also increase the slenderness ratio. **Sivalekshmi S Pillai, Chaithra (2019):-** They analyzed Ten Storey building of polypropylene fiber reinforced concrete structure, due to secondary moment consideration- analysed the second order effect including in every structure where axial load is subjected. The analysed the structure of G+19 of building plan configuration 28m x 15m with base height of 4m and typical floors height of 3.5m in moderate earthquake region III, medium soil condition, consider general structure as importance factor taken as 1, damping factor 1 for the damping ratio five percent and all the model was completed by Etab Software. They observed that the maximum displacement and storey drift is found in 10th storey of the structure when considering the delta effect on the structure. **Bhavani Shankar, Dheekshith K, Naveen Kumar (2017) :-** They are worked on the different six models of 5, 10,15, 20, 25 and 30 storey of the 28m by 15 in plan of building structure with and without P-delta effect in three region of the III, IV & V and other parameters are used as per Indian Standard Code by using ETAB Software and complied the models. They found that in conventional building have less displacement as compared to delta Effect on the building and also found that the storey drift in model is more when considering the effect of the delta on the building. **Rupali Bondre, Sandeep Gaiwade (2016)** :- They are performed the six different storey 5 to 30 with interval of 5 storey as 15m to 90 m of 15m interval with the help of Linear Static Analysis and P-Delta effect with different parameters are used like storey height of three metres of building plan configuration 25m by 20m with 5m of bay length in both direction and this structure is located in IIIrd zone of India as per Indian Code. They observed that the displacement changes exponentially under the effect of P-Delta with height increasing and also the axial forces change rapidly over the Linear static methods if Delta is performed.

3. MATHEDOLOGY

In This research work deals with relative study of different earthquake behaviour of with and without P-Delta Effect on multistorey building structures G+13 of same plan configuration. These building frame structure of L-shape Medium soil condition and two seismic zone under the Earthquake effect as per IS 1893(part I) -2002 static analysis and also analysed nonlinear static analysis by using STAAD PRO Software. Comparative Analysis is done in the term of study of analysis in terms of Max. Bending moment, Max. Storey Displacement, Max shear force and axial forces has been carried out.

3.1 Flow Chart

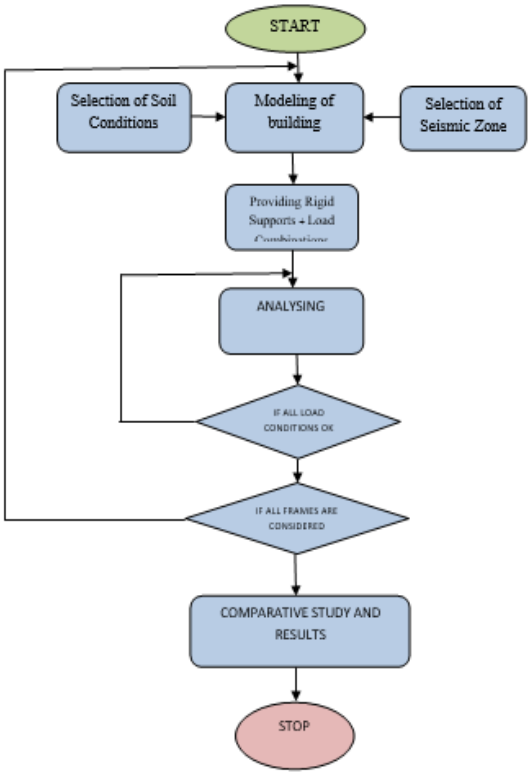

Fig -3.1: Flow Chart

4. MODELLING AND PROBLEM FORMULATION

4.1 MODELLING OF BUILDING FRAMES

STAAD.Pro is a general purpose program for doing the analysis the structure with different types Models and two seismic zone III & V. The following three activities must be performed to achieve that goal-

a. Model generation using STAAD.Pro

b. The calculations to determine the analytical results

c. Result check is all encouraged by apparatuses contained in the system's graphical surroundings.

4.2 STRUCTURAL PARAMTERS

Type of Building: Reinforced Concrete Framed Structure, Name of Models- Model-I (G+13), Size of Column = 500mm X 650mm, Beam = 500 X 600mm, Height of each floor = 3.5m, Thickness of Slab= 180mm, Support- Fixed Support

4.3 SEISMIC PARAMTERS

As per IS 1893-2002, Seismic Zone- III and V, Type of soil- Medium Soil, Analysis Done- With and Without Consideration of P-Delta Effect for Each Models, damping = 5% (as per table-3 clause 6.4.2), Zone factor for zone III, and V, Z=0.16 and 0.36, Importance Factor I=1.5 (Important structure as per Table-6), Response Reduction Factor R=5 for Special RC Moment Resisting Frame (Table-7), Sa/g= Average acceleration coefficient (depend on Natural fundamental period).

4.4 LOADING CONDITIONS

(a) Dead Load

Masonry-load					Remark
For floor height 3.5 m	=	0.23 m x (3.5 -0 .60) m x 20kN/m^3	13.34	kN/m	
Parapet wall	=	0.23 m x (1) m x 20kN/m^3	4.60	kN/m	
Floor Load					
Slab Load	=	0.180 m x 25kN/m^3	4.50	kN/m^2	Slab thick. 180 mm assumed
Floor Finish	=		1.0	kN/m^2	
Total Load	=		5.50	kN/m^2	

(b) Live Loads

as per IS: 875 (part-2) 1987, Live Load on typical floors = 3.0kN/m2, Live Load seismic calculation = 0.75kN/m2

(c) Earth Quake Loads

All frames are analyzed for two earthquake zones

The seismic load calculation are as per IS: 1893 (2002).

4.5 LOAD COMBINATION

LOAD CASE NO.	LOAD CASE
1	DL
2	LL
3	E.Q.X
4	E.Q.Z
5	1.5(DL+LL)
6	1.5(DL+E.Q.X)
7	1.5(DL-E.Q.X)
8	1.5(DL+E.Q.Z)
9	1.5 (DL-E.Q.Z)
10	1.2(DL+LL+E.Q.,X)
11	1.2 (D.L+L.L-E.Q.,X)
12	1.2 (DL+LL+E.Q.Z)
13	1.2 (DL+LL-E.Q.Z)

5. RESULT ANALYSIS

5.1. MAXIMUM DISPLACEMENTS

Table-5.1.1. Maximum Displacement (mm) in X direction

Model-I (G+13), Maximum Displacement in X-Direction (mm)				
ZONE	Zone-III		Zone-V	
STOREY	Without P-Delta	With P-Delta	Without P-Delta	With P-Delta
0	0	0	0	0
1	6.162	13.852	20.853	21.542
2	15.73	35.365	42.367	55
3	26.037	58.541	65.544	91.045
4	36.669	82.45	89.454	128.231
5	47.468	106.735	113.741	166.002
6	58.293	131.078	138.084	203.863
7	68.988	155.132	162.139	241.276
8	79.386	178.514	185.522	277.642
9	89.3	200.811	207.82	312.322
10	98.531	221.575	228.585	344.619
11	106.867	240.329	247.339	373.791
12	114.081	256.564	263.575	399.047
13	119.943	269.747	276.758	419.551
14	124.335	279.587	286.599	434.839

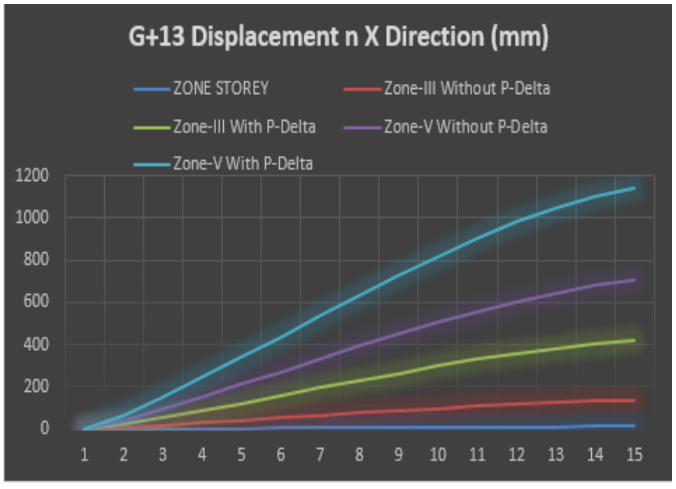

Fig.-5.1.1. Maximum Displacement (mm) in X direction.

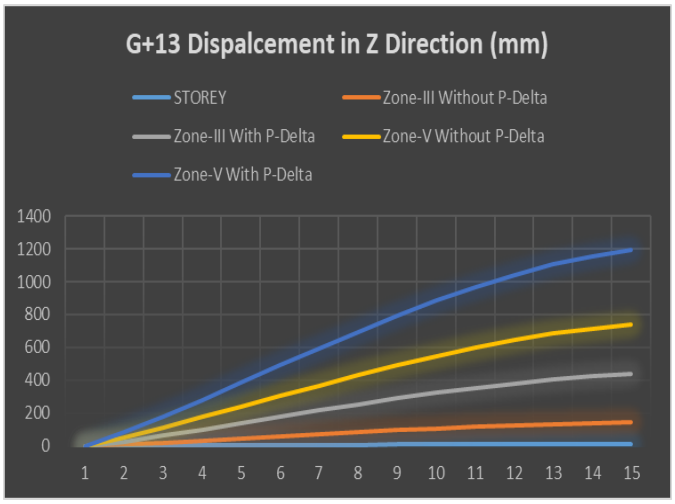

Fig.- 5.1.2. Maximum Displacement (mm) in Z direction

Table- 5.1.2. Maximum Displacement (mm) in Z direction

Model-I (G+13), Maximum Displacement in Z-Direction (mm)				
STOREY	Zone-III		Zone-V	
	Without P-Delta	With P-Delta	Without P-Delta	With P-Delta
0	0	0	0	0
1	8.18	18.383	25.384	28.586
2	18.984	42.692	49.692	66.4
3	30.159	67.716	74.715	105.273
4	41.73	93.694	100.691	145.658
5	53.312	119.687	126.682	186.062
6	64.767	145.389	152.381	226.011
7	75.943	170.455	177.445	264.967
8	86.67	194.502	201.49	302.334
9	96.759	217.113	224.099	337.467
10	106.009	237.835	244.819	369.661
11	114.205	256.194	263.176	398.183
12	121.129	271.703	278.685	422.277
13	126.572	283.905	290.885	441.238
14	130.463	292.611	299.591	454.759

5.2. MAXIMUM BENDING MOMENTS

Table- 5.2.1. Maximum Bending Moments in KN-m of Model-I (G+13)

Model-I (G+13), Maximum Bending Moments in KN-m				
STOREY	Zone-III		Zone-V	
	Without P-Delta	With P-Delta	Without P-Delta	With P-Delta
1	450.502	640.439	744.118	878.79
2	496.771	686.708	790.387	925.059
3	513.435	703.372	807.051	941.723
4	521.438	711.375	815.054	949.726
5	524.042	713.979	817.658	952.33
6	520.977	710.914	814.593	949.265
7	511.547	701.484	805.163	939.835
8	494.982	684.919	788.598	923.27
9	470.49	660.427	764.106	898.778
10	438.268	628.205	731.884	866.556
11	398.733	588.67	692.349	827.021
12	348.772	538.709	642.388	777.06
13	319.755	509.692	613.371	748.043
14	206.026	395.963	499.642	634.314

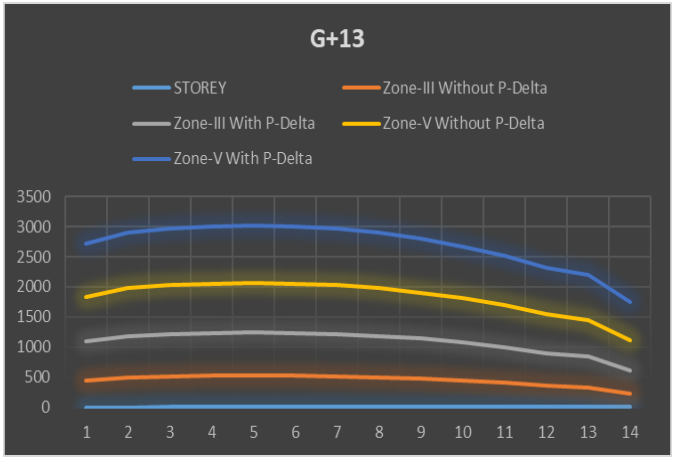

Fig.- 5.2.1. Maximum Bending Moments in KN-m of Model-I (G+13)

5.3. MAXIMUM SHEAR FORCE

Table- 5.3.1. Maximum Shear Force in KN of Model-I (G+13)

Model-I (G+13), Maximum Shear Force in KN				
STOREY	Zone-III		Zone-V	
	Without P-Delta	With P-Delta	Without P-Delta	With P-Delta
1	221.544	265.6024	397.714	441.7724
2	242.922	286.9804	433.782	477.8404
3	249.35	293.4084	439.971	484.0294
4	252.501	296.5594	439.779	483.8374
5	253.6	297.6584	435.929	479.9874
6	252.549	296.6074	428.113	472.1714
7	249.08	293.1384	422.003	466.0614
8	243.314	287.3724	410.308	454.3664
9	236.293	280.3514	392.347	436.4054
10	226.055	270.1134	367.618	411.6764
11	212.395	256.4534	335.629	379.6874
12	196.775	240.8334	295.593	339.6514
13	199.925	243.9834	251.442	295.5004
14	122.891	166.9494	149.128	193.1864

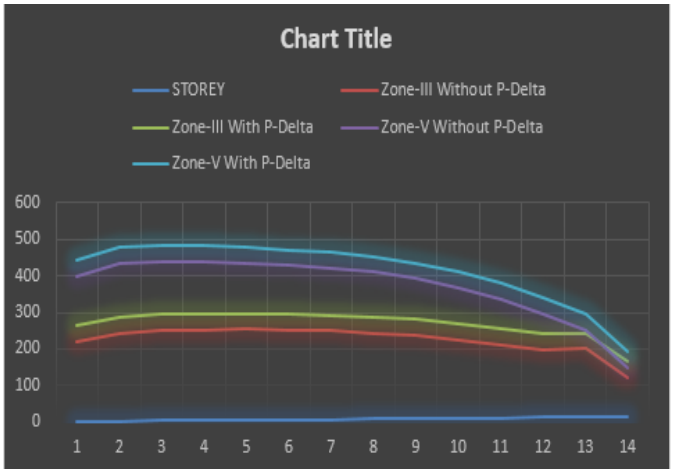

Fig. - 5.3.1. Maximum Shear Force in KN of Model-I (G+13)

5.4. MAXIMUM AXIAL FORCE

Table- 5.4.1. Maximum Axial Force in KN of Model-I (G+13)

Model-I (G+13), Maximum Axial Force in KN				
STOREY	Zone-III		Zone-V	
	Without P-Delta	With P-Delta	Without P-Delta	With P-Delta
1	11174.409	11357.664	11358.477	11357.664
2	10329.318	10490.91	10491.671	10490.91
3	9489.38	9571.21	9571.773	9571.21
4	8655.999	8656.526	8655.999	8656.526
5	7829.11	7829.559	7829.11	7829.559
6	7008.635	7009	7008.635	7009
7	6194.265	6194.55	6194.265	6194.55
8	5385.565	5385.773	5385.565	5385.773
9	4581.99	4582.13	4581.99	4582.13
10	3782.924	3783.008	3782.924	3783.008
11	2987.702	2987.743	2987.702	2987.743
12	2195.616	2195.633	2195.616	2195.633
13	1405.833	1405.842	1405.833	1405.842
14	620.109	620.146	620.109	620.146

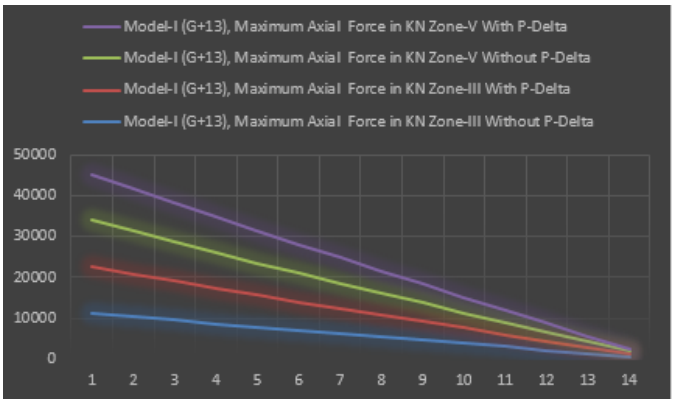

Fig. - 5.4.1. Maximum Axial Force in KN of Model-IV (G+13)

6. CONCLUSITION

It is seen that that the maximum storey displacement at 14th storey of the building in each cases such as with and without p-delta effect in both the seismic region and minimum displacement at first storey while in each cases zero displacement at the base of the structure in X direction of the structures.

It is found that the storey displacement is increased with the number of storey increased it means that if the storey height is increased displacement is also increased.

It is observed that the maximum displacement in seismic zone V with and without effect of the P-delta when comparing to seismic zone III with same effect of Delta.

It is seen that the in minimum bending moment 206.024 KN-m at 14th storey and 395.963 KN-m at 14th storey and maximum bending moment 524.042 KN-m at 5th storey and 713.979 KN-m at 5th storey in without and with P-delta effect respectively in earthquake region III.

It is seen that the in minimum bending moment 499.642 KN-m 14th sotrey and 634.314 KN-m 14th storey and maximum bending moment 817.658 KN-m 5th storey and 949.726 KN-m at 4th storey in without and with P-delta effect respectively in earthquake region V.

As comparing the maximum bending moment 817.658 KN-m at 4th floor in zone V minimum bending moments 206.024 KN-m at 14th floor in Zone-III in without considering the P-delta effect.

As comparing the maximum bending moment 949.726 KN-m at 4rd floor in zone V minimum bending moments 395.963 KN-m at 14th floor in Zone-III in with considering the P-delta effect.

It is seen that the minimum shear force 122.1891 KN and 166.9494 KN at 14th floor and maximum shear force 253.600 KN at 5th floor and 279.5684 KN at 5th floor in the cases of without and with considering P-Delta Effect in earthquake zone III.

It is seen that the minimum shear force 149.128 KN and 193.1864 KN at 14th floor and maximum shear force 493.971 KN and 484.0294 KN at 3rd floor in the cases of without and with considering P-Delta Effect in earthquake zone V.

As comparing the maximum shear force 439.971 KN at 3rd floor in zone V and minimum shear force 122.891 KN at 14th floor in Zone-III in without considering the P-delta effect.

As comparing the maximum shear force 484.0294 KN at 3rd floor in zone V and minimum shear force 166.9494 KN at 14th floor in Zone-III in with considering the P-delta effect.

It is found that minimum axial force 620.109 KN and 620.146 KN at 14th storey and maximum axial force 11174.409 KN and 11357.664 KN at 1st storey in the both cases without and with P-Delta Effect in seismic zone III.

It is found that minimum axial force 620.109 KN and 620.146 KN at 14th storey and maximum axial force 11358.477 KN and 11357.664 KN at 1st storey in the both cases without and with P-Delta Effect in seismic zone V.

As comparing the zone wise, the minimum axial force 620.109 KN at 14th storey in both zone and maximum axial

force 11358.477 KN at 1st storey level in zone V in without considering the P-Delta Effect.

As also comparing the zone wise, the minimum axial force 620.146 KN at 14th storey in both zone and maximum axial force 11357.664 KN at 1st storey level in zone V in with considering the P-Delta Effect.

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