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Research Article

Analysis of Building with Tower on Sloping Ground

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Abstract

The structures are fundamentally manufactured on a typical plain ground. These days due to lack of land area, construction has been done on a sloping ground. The mountainous areas are the majority exaggerated due to earthquake activity. High damage experienced by the high rise structure in the mountainous region, as outcome causes harm and breaking up; hence reason of designing towards protection in opposition to natural disasters. The key point is to analyze the seismic task applied by Multi-Storied RC structure on a sloping ground with specific angle 29^o. The Multi-Storied building is taken at different position of tower of slope angle. The outcomes have been evaluated with the structure taken without slope and with sloping ground 29^o angle having on plane ground. Thus the seismic analysis is the part of Dynamic analysis. There are two types of arrangements taken for the study along sloping ground .i.e. set back and step backset back. Hence G+10 RCC building is considered with different location of building with sloping ground with set back and step back condition for analyzing. The analysis was carried by the Seismic Analysis Method. The whole process and the methods are carried out by IS-1893-2016. STAAD pro software is used to explore the Response Spectrum Method. All the operations performed are the part of procedure which gives the result that the step back set back building is more suitable than other methods.

Keywords: *Seismic activities, inclined ground, High-rise, Slope angles, Seismic analysis method, Step back-Setback, Response Spectrum Method*

1. Introduction

The multistory RCC buildings are constructed on plane level or ground level. In the mountainous areas having sloping ground it is hard to build the multistory RCC structures. It is very complex circumstances to dig in such regions. The constructions of inclined region are in progress now days due to the lack of plane level. These mountainous areas are the most hazardous sometimes due to some natural calamities like land sides and seismic activity. The earthquake is the one of the major factor on the sloppy and mountainous areas. Thus, due to growing level of population the biggest reason of construction on mountainous areas. Earthquake causes due to the shaking of ground plates and causes the damage all over the ground level as well as sloping ground. This may cause damage as well as on ground and structure. To avoid such damages and such type of problem, it is necessary to observe the seismic behavior and the stability of structure and ground. Different type of method is used to for analyzing the situation. The one of the method using for analysis the structure is Response spectrum Method. Thus to analyze the seismic analysis dynamic analysis is carried out. Thus, such data and information in response spectrum method is using by I.S.-1893 2016.

Types of Building on sloping Ground

i) Step back- A step back requires that any area of a building above a certain height is further pushed-in towards the center of the property.

ii) Step back set back - A setback, it is also known as step back. The reason behind is it has steps on vertical members. At the starting ages it is used for the structural purpose but now it uses also for non-structural purpose.

2. Objectives

In mountainous area, there are probabilities of indecision spoliation to building structure. To avoid the seismic activities the multi-storied structure on different location like set back and step back set back, there are six cases setback condition with different location of tower and six cases for step back set back location with different location. Result analyze for stresses displacements base shear etc. in longitudinal and transverse direction. After this, the most efficient

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case will be optimizing after all location cases in both condition.

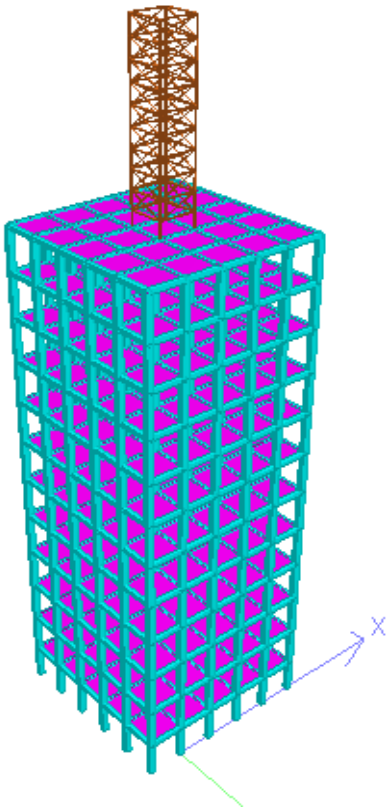

Fig. 1: Structure on Plain Ground

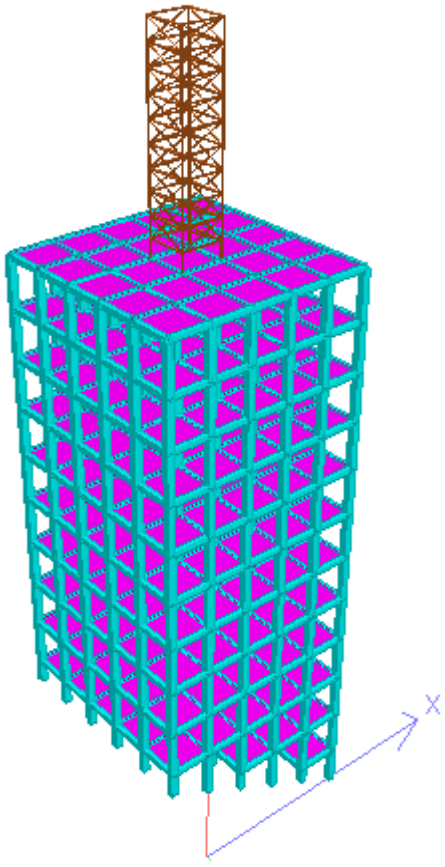

Fig. 2: Structure on Set Back

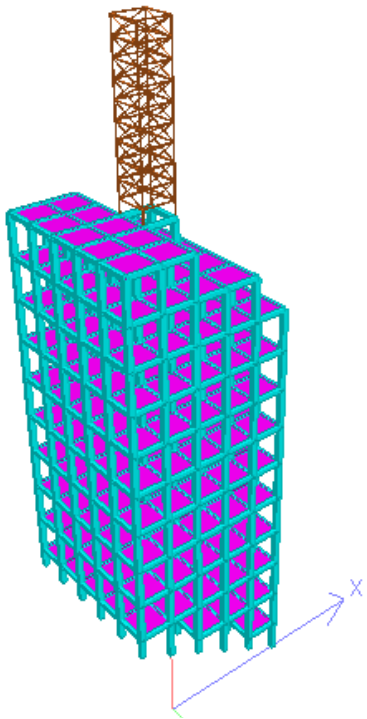

Fig. 3: Structure on Step Back Set Back

Table 1: Details of building

Building configuration	G+10
No. of bays in X direction	5
No. of bays in Z direction	5
Height of building	43.26 m
Dimensions of building	15M X 15m
Size of beam	0.45 X 0.45
Size of column	0.40 X 0.30
Concrete and Steel Grade	M 30 & Fe 415

Table 2: Details of loading

Earthquake parameters	Zone III with RF 4 & 5% damping ratio
Period in X & Z direction	1.00527 sec & 1.00527 sec in both direction
Dead load for floor with Water proofing	2 KN/m^2
Live load for floor and roof	2.9 KN/m^2 & 1 KN/m^2

3. Results and Discussion

For Step back condition for all locations

Table 3: Maximum Displacement in X and Z direction for all locations in Zone III

Location	Maximum Displacement (mm)	
	For X Direction	For Z Direction
PG	67.489	62.288
A	58.476	49.106
B	58.412	48.981
C	58.319	48.935
D	58.383	48.913
E	58.302	48.872
F	58.204	48.842

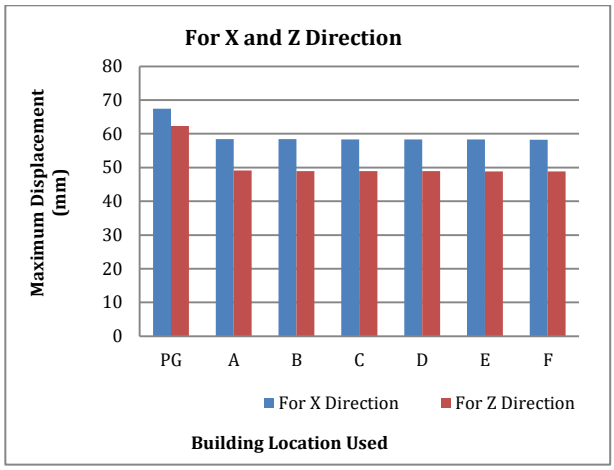

Fig. 4: Maximum Displacement in X and Z direction for all locations in Zone III

Table 4: Base Shear in X and Z direction for all Building locations

Location	Base Shear (KN)	
	X direction	Z direction
PG	1326.53	1797.45
A	1314.00	1431.03
B	1315.31	1433.00
C	1316.71	1433.17
D	1316.14	1434.48
E	1317.54	1434.57
F	1319.41	1434.79

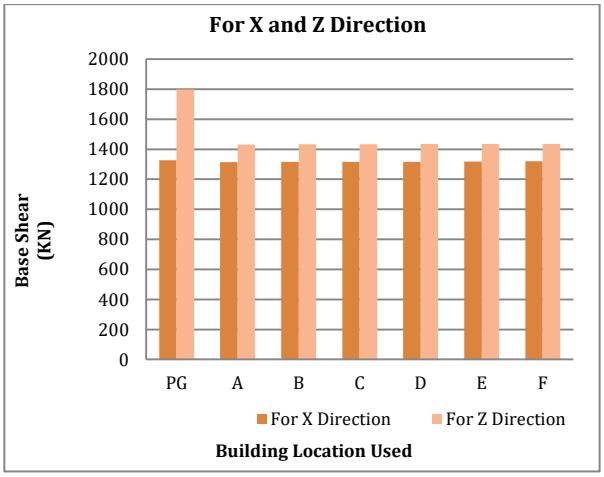

Fig. 5: Base Shear in X and Z direction for all Building locations

Table 5: Maximum Axial Forces in Column for all Building locations

Location	Column Axial Force (KN)
PG	2650.439
A	6347.310
B	6344.104
C	6342.596
D	6339.522
E	6339.969
F	6339.804

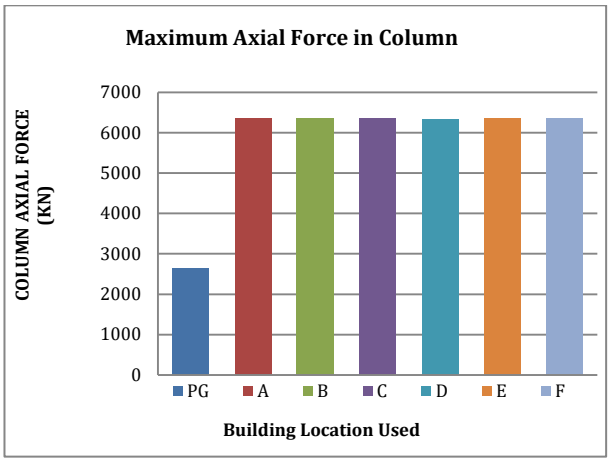

Fig. 6: Maximum Axial Forces in Column for all Building locations

Table 6: Maximum Shear Force in Columns for all Building locations

Location	Column Shear Force (KN)	
	Shear along Y	Shear along Z
PG	64.511	67.191
A	245.027	278.423
B	244.945	278.265
C	244.827	278.255
D	244.883	278.074
E	244.761	278.061
F	244.638	278.020

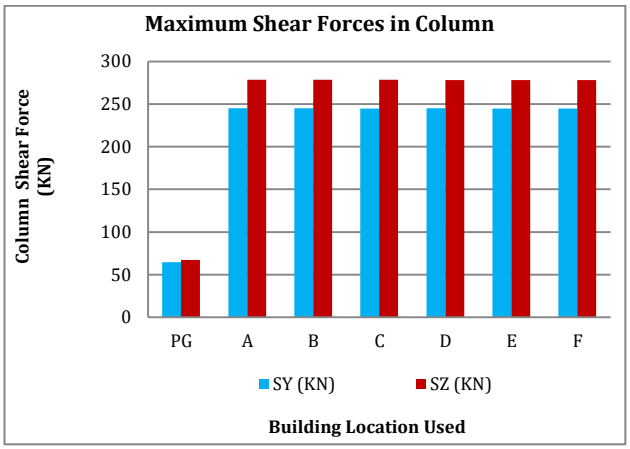

Fig. 7: Maximum Shear Forces in Columns for all Building locations

Table 7: Maximum Bending Moment in Columns for all Building locations

Location	Column Bending Moment (KNm)	
	Bending Moment Y	Bending Moment Z
PG	123.257	118.499
A	226.336	290.894
B	226.210	290.798
C	266.208	290.651
D	226.052	290.573
E	266.048	290.573
F	266.013	290.423

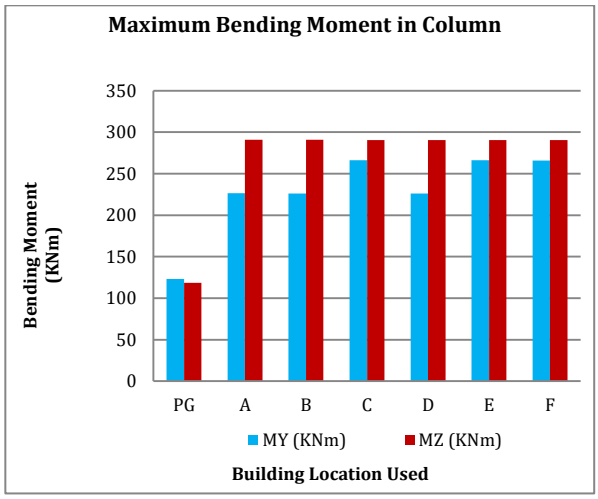

Fig. 8: Maximum Bending Moment in Columns for all Building locations

Table 8: Maximum Shear Forces in Beam for all Building locations

Location	Beam Shear Force (KN)	
	Shear along Y	Shear along Z
PG	64.550	0.705
A	69.172	1.840
B	69.562	1.839
C	69.136	1.839
D	69.152	1.838
E	69.126	1.838
F	69.100	1.838

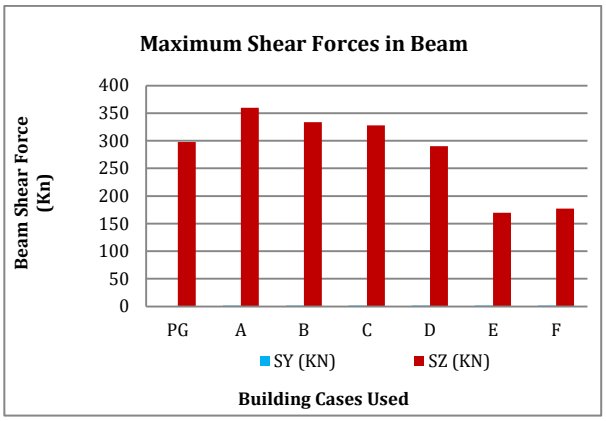

Fig. 9: Maximum Shear Forces in Beam for all Building locations

Table 9: Maximum Bending Moment in Beam for all Building location

Location	Beam Bending Moment (KNm)	
	Bending Moment Y	Bending Moment Z
PG	1.144	69.570
A	3.420	57.538
B	3.418	57.533
C	3.418	57.483
D	3.416	57.526
E	3.416	57.478
F	3.416	57.430

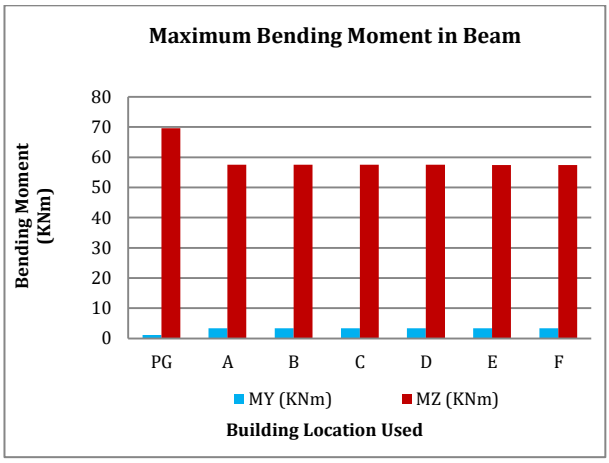

Fig. 10: Maximum Bending Moment in Beam for all Building location

Table 10: Maximum Torsional Moment in Beam for all Building location

Location	Torsional Moment (KNm)	
	TorsionalMoment X	Torsional Moment Z
PG	3.720	3.668
A	3.898	5.785
B	3.895	5.779
C	3.896	5.779
D	3.892	5.774
E	3.893	5.774
F	3.842	5.775

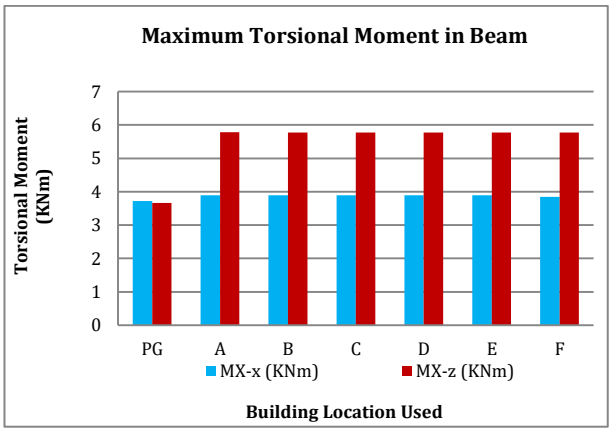

Fig. 11: Maximum Torsional Moment in Beam for all Building location

For Step Back Set Back condition for all location

Table 11: Maximum Displacement in X and Z direction all locations in Zone III

Location	Maximum Displacement (mm)	
	For X Direction	For Z Direction
PG	67.489	62.288
A	50.519	45.317
B	50.132	45.318
C	50.024	45.348
D	50.143	45.398
E	50.045	45.377
F	49.927	45.331

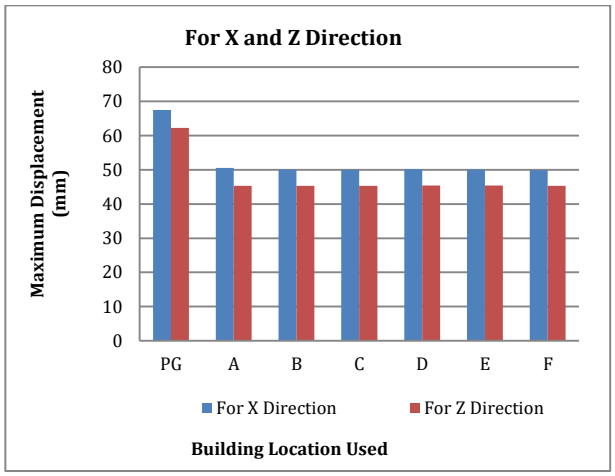

Fig. 12: Maximum Displacement in X and Z direction for all locations in Zone III

Table 12: Base Shear in X and Z direction for all Building locations

Location	Base Shear (KN)	
	X direction	Z direction
PG	1326.53	1397.45
A	1323.541	1501.37
B	1326.95	1502.77
C	1328.14	1502.81
D	1327.12	1502.53
E	1328.43	1502.52
F	1330.19	1502.40

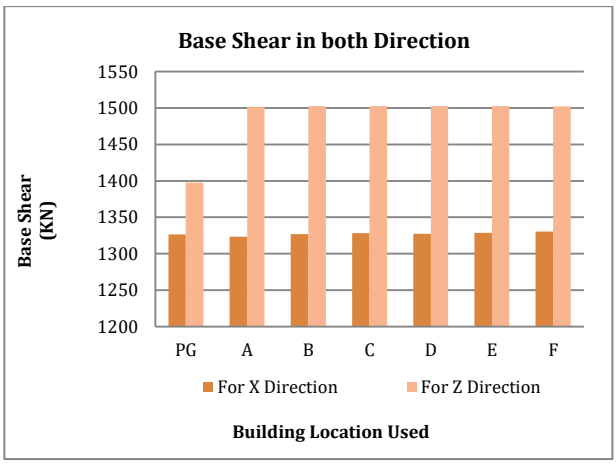

Fig. 13: Base Shear in X and Z direction for all Building locations

Table 13: Maximum Axial Forces in Column for all Building locations

Location	Column Axial Force (KN)
PG	2650.439
A	5983.005
B	5983.947
C	5947.363
D	5944.019
E	5943.791
F	5943.393

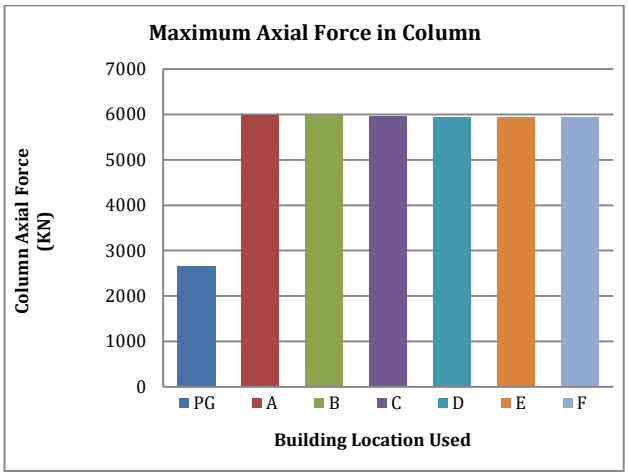

Fig. 14: Maximum Axial Forces in Column for all Building location

Table 14: Maximum Shear Forces in Columns for all Building location

Location	Column Shear Force (KN)	
	Shear along Y	Shear along Z
PG	64.511	67.191
A	225.650	257.790
B	225.631	256.631
C	224.880	256.621
D	224.947	256.427
E	224.813	256.413
F	224.680	256.372

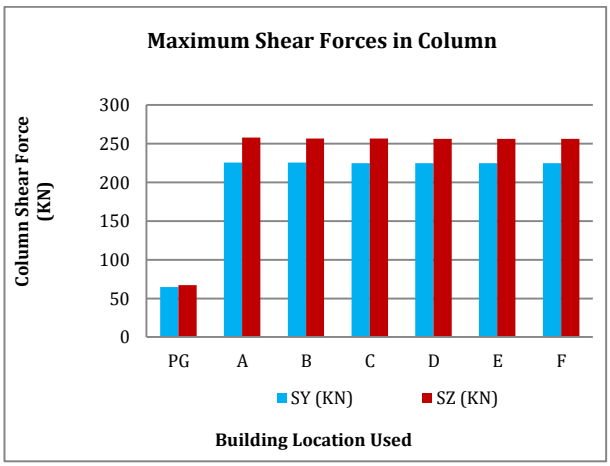

Fig. 15: Maximum Shear Forces in Columns for all Building location

Table 15: Maximum Bending Moment in Columns for all Building location

Location	Column Bending Moment (KNm)	
	Bending Moment Y	Bending Moment Z
PG	123.257	118.499
A	210.901	267.976
B	209.892	267.223
C	209.890	267.064
D	209.723	267.153
E	209.718	266.986
F	209.684	266.822

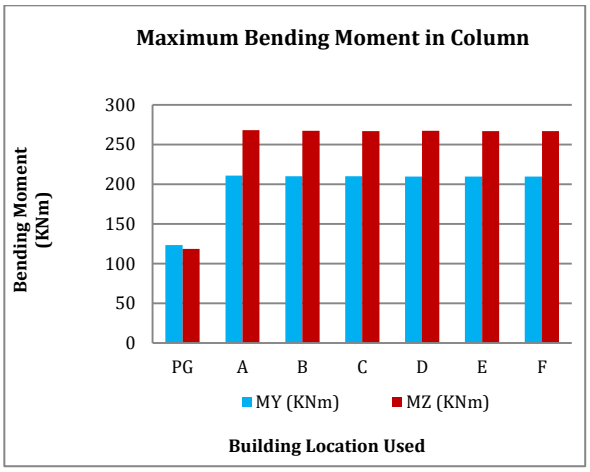

Fig. 16: Maximum Bending Moment in Columns for all Building locations

Table 16: Maximum Shear Forces in Beam for all Building locations

Location	Beam Shear Force (KN)	
	Shear along Y	Shear along Z
PG	64.550	0.705
A	66.809	1.707
B	66.740	1.696
C	66.713	1.696
D	66.731	1.695
E	66.703	1.695
F	66.675	1.695

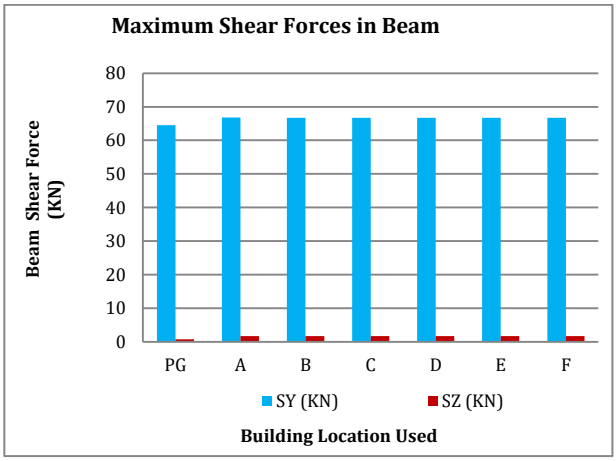

Fig. 17: Maximum Shear Forces in Beam for all Building locations

Table 17: Maximum Bending Moment in Beam for all Building locations

Location	Beam Bending Moment (KNm)	
	Bending Moment Y	Bending Moment Z
PG	1.144	69.570
A	3.188	55.323
B	3.166	55.271
C	3.166	55.218
D	3.164	55.263
E	3.164	55.211
F	3.164	55.159

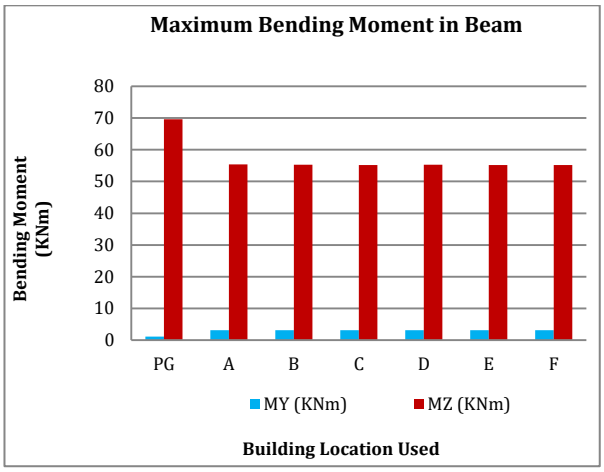

Fig. 18: Maximum Bending Moment in Beam for all Building locations

Table 18: Maximum Torsional Moment in Beam for all Building locations

Location	Torsional Moment (KN)	
	Torsional Moment X	Torsional Moment Z
PG	3.720	3.668
A	3.787	5.119
B	3.784	5.367
C	3.782	5.085
D	3.789	5.079
E	3.788	5.079
F	3.786	5.079

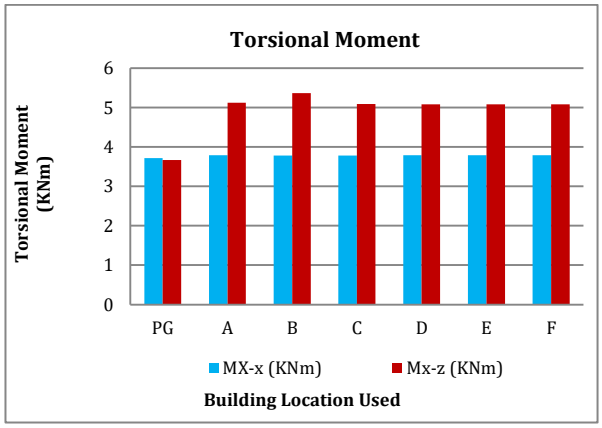

Fig. 19: Torsional Moment in Beam for all Building locations

Conclusion

On comparing with setback six building with tower ,different location condition with plain ground has been concluded that the maximum displacement in X direction obtained for location F, maximum displacement in Z direction obtained for location F, Base Shear value is not depend on tower location since 29 degree cut out on bottom side for all buildings, location in X and Z direction, location A is observed as most efficient, Axial Force for all location ,location F is observed as most efficient, it is concluded that the

location F for column shear forces in X direction values are efficient among all location, it is concluded that the location F for column shear forces in Z direction values are efficient among all location, location F is efficient in direction X for column bending moment, location F is efficient in direction Z for column bending moment ,location F for Beam shear forces in X direction values are efficient among all location, location F for Beam shear forces in Z direction values are efficient among all location, location F is efficient in direction X for beam bending moment, location F is efficient in direction Z for beam bending moment. On analyzing the setback six building with tower, different location condition with plain ground has been concluded that the Torsional Moment in beams along X direction location F is very efficient and direction for Z direction in Torsional Moment in beams location F is very efficient.

On comparing with Step Back Setback six building with tower, different location condition with plain ground has been concluded that the maximum displacement in X direction obtained for location F. The maximum displacement in Z direction obtained for location F. Base Shear value is not depend on tower location since 29 degree cut out on bottom side for all buildings, location B is observed as most efficient. Axial Force for all location, location F is observed as most efficient. Locations F for column shear forces in X direction values are efficient among all location. Locations F for column shear forces in Z direction values are efficient among all location. The location F is efficient in direction X for column bending moment. The location F is efficient in direction for column bending moment. Location F for Beam shear forces in X direction values are efficient among all location the location F is efficient in direction X for beam bending moment. The location F is efficient in direction Z beam bending moment. The Torsional Moment in beams along X direction location F is very efficient and direction for Z direction in Torsional Moment in beams location F is very efficient.

Overall analysis said that the most efficient case for Set Back as well as Step Back set back building with tower, different location for the above study is location F. It is consider as the location F best location of among all of these.

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