COMPARATIVE STUDY OF SEISMIC BEHAVIOUR OF RECTANGULAR COLUMNS WITH CIRCULAR COLUMNS

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Abstract

The earthquake resistant design of structures requires that structures should sustain, safely, any ground motions of an intensity that might occur during their construction or in their normal use. However ground motions are unique in the effects they have on structural responses. In this study the seismic behaviour of a frame building has been analysed by using software called as Staad. Pro. The seismic performance evaluation of the building has been carried out by changing the sizes of the columns and also by replacing the rectangular columns with the circular columns. The buildings are designed for the gravity and seismic loadings as per IS 456: 2000 and IS 1893: 2002.

Keywords: rectangular columns , circular columns, Base Shear, Displacment, Story Drift, Area of Steel, Shear Force, Axial Force, BendingMoment,Etc.

1. INTRODUCTION

RC axially loaded members like columns or piles may have circular cross sectional shape due to architectural desire and/or structural requirements. Indeed, axially loaded members do not carry gravitational loads alone. But due to the seismic actions, lateral load components originate causing the generation of shear and flexural forces. In order to make structures safe against earthquakes these must be made ductile enough to withstand the lateral forces while some damage may be allowed. As the flexural design of RC circular members is following the same procedure as of the rectangular members, the detailed calculations for the circular cross section are a little bit of complexity. In this case we are going to study the behaviour of circular and rectangular column having same area under the effect of earthquake.

METHODOLOGY AND MODELING

2.1 GENERAL

The following basis has been considered for modelling of buildings

1. The building will be used for residential purpose, as an apartment. So that there are walls inside the building. External walls 230 mm thick.
2. The main beams rest centrally on columns to avoid local eccentricity.
3. For all structural elements, M25 grade concrete will be used.
4. Sizes of all columns in all floors are kept the same.
5. The floor diaphragms are assumed to be semi rigid to have actual effect of floors slab.
6. Centre-line dimensions are followed for analysis and design.
7. Preliminary sizes of structural components are fixed by experience.
8. For analysis purpose, the beams are assumed to be rectangular so as to distribute slightly larger moment in columns.
9. Seismic loads will be considered acting in the horizontal direction (along either of the two principal directions) and not along the vertical direction, since it is not considered to be significant.
10. All dimensions are in mm, unless specified otherwise.

2.2 CASE CONSIDERATION

Problem for analysis of Rectangular and Square column on following data:

2.2.1 Modelling and analysis

The design parameters are as follows:

Live load: 25% of 3.0 KN/m^2 at typical floor &
: 0.0 KN/m^2 on terrace

Floor finish: 1.0 KN/m^2

Earthquake load: As per IS-1893 (Part-I) - 2002

Type of soil: Type II, Medium as per IS: 1893

Story height: Typical floor 3.2 m.

Floors : G.F. + 09 upper floors.
Wall thickness: 230 mm thick brick masonry wall
Column size: 200 mm Diameter for Circular Column
Column size: 160X200 mm Diameter for Rectangular Column
Main Beam size: 160X200mm

2.2.2 Material Properties

i) Concrete

All components are modelled with concrete grade M25 unless specified in analysis.
For Grade of concrete M 25

$Ec = 5\ 000\ \sqrt{fck}$ N/mm^2
$= 5\ 000\ \sqrt{fck}$ MN/m^2
$= 25000$ N/mm^2 $= 25000$ MN/m^2.

ii) Steel

HYSD bar of Fe 415 confirming to IS: 1786 is used throughout.

3. OBSERVATION AND REMARK:

Following are the observations obtained from analysis of Circular Column and Rectangular Column buildings

Base Shear comparison of various Shaped Building along X- Direction and Z- Direction.

Table: - 3.1 shows Base Shear comparison of various Shaped Building along X- Direction

Various cases	Circular column	Rectangular column
Value of Base Shear along X- Direction	3025	3024

Table: - 3.2 shows Base Shear comparison of various Shaped Building along Z- Direction

Various cases	Circular column	Rectangular column
Value of Base Shear along Z- Direction	2584	2583

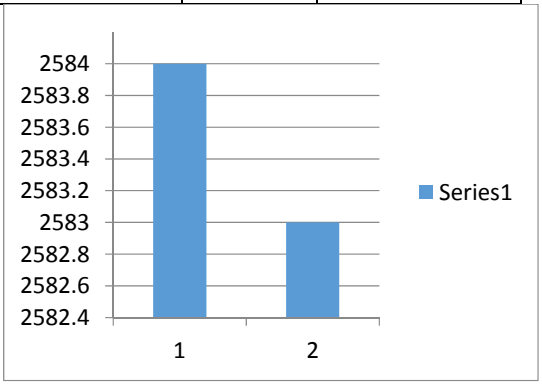

Fig: 3.1 show Base Shear comparison of various Shaped Building along X- Direction.

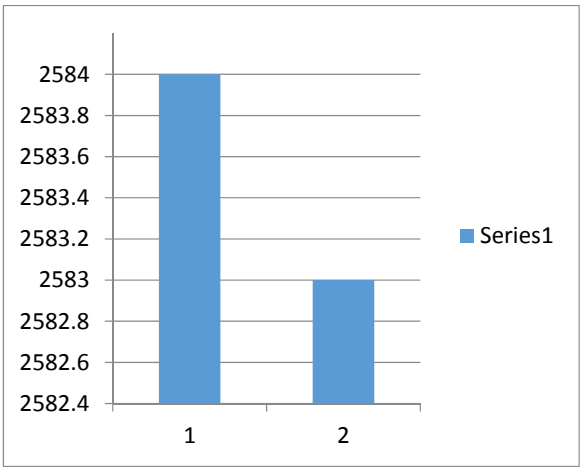

Fig: 3.2 show Base Shear comparison of various Shaped Building along Z- Direction.

Table: - 3.3 Story Shear summery for all the types of building along X direction.

Floor N0.	Circular column	Rectangular column
10	326.348	326.195
9	654.917	654.928
8	517.465	517.474
7	396.184	396.191
6	291.074	291.079
5	202.135	202.138
4	129.366	129.368
3	72.769	72.770
2	32.342	32.342
1	8.085	8.086

Table: - 3.4 Story Shear summery for all the types of building along Z direction

Floor N0.	Circular column	Rectangular column
10	278.771	278.624
9	655.170	654.927
8	517.665	517.473
7	396.338	396.190
6	291.187	291.078
5	202.213	202.138
4	129.416	129.368
3	72.797	72.769
2	32.354	32.342
1	8.089	8.085

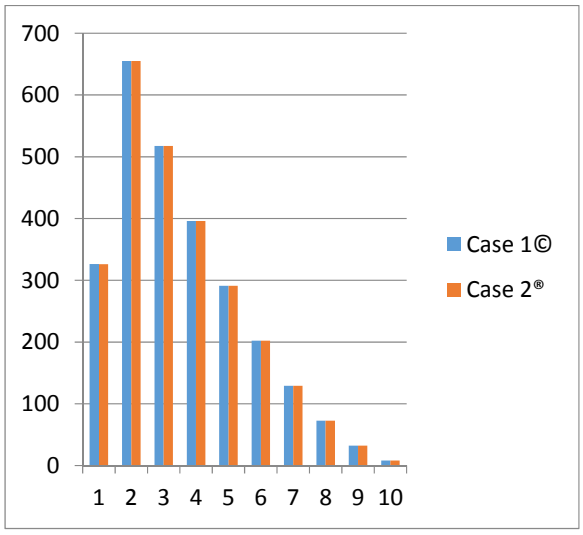

Fig.3.3: - Story shear along X direction

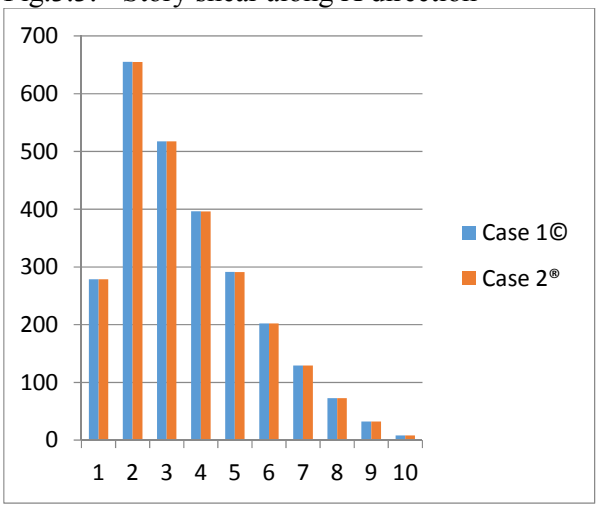

Fig.3.4: - Story shear along X direction

Table 3.5: - Corner Edge Displacement Value along X Direction considering all the cases for load combination 1.5(DL+ (X)).

Floor No.	Circular column	Rectangular column
10	2331.467	4945.642
9	2268.408	4774.94
8	2139.779	4470.929
7	1951.086	4054.948
6	1715.119	3552.531
5	1444.087	2986.408
4	1148.581	2375.985
3	837.438	1737.309
2	518.789	1084.71
1	207.924	444.192

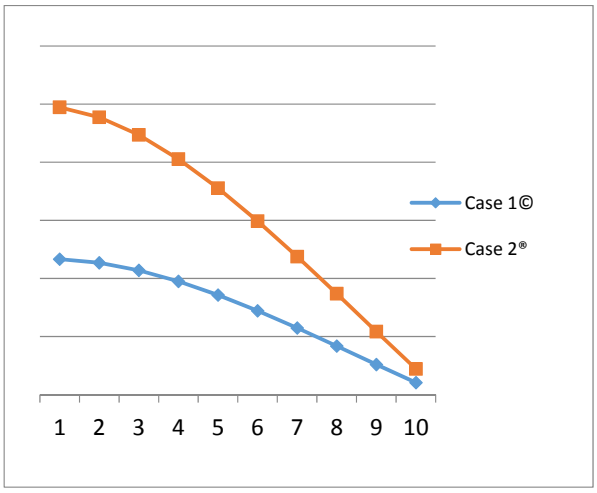

Fig:3.5: - Shows Corner Edge Displacement Value along X Direction for load combination 1.5(DL+(X)).

Table 3.6: - Corner Edge Displacement Value along X Direction considering all the cases for load combination 1.2(DL+LL+ (+X)).

Floor No.	Circular column	Rectangular column
10	1865.196	3956.52
9	1814.731	3819.956
8	1711.823	3576.743
7	1560.869	3243.958
6	1372.095	2842.025
5	1155.27	2389.126
4	918.864	1900.787
3	669.95	1389.847
2	415.039	867.768
1	166.335	355.35

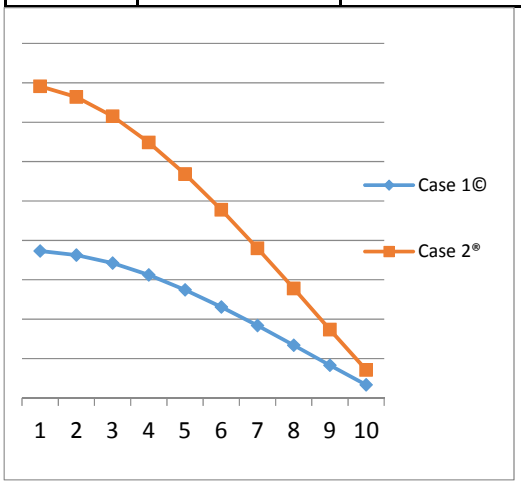

Fig:3.6: - Shows Corner Edge Displacement Value along X Direction for load combination 1.2(DL+LL+ (+X)).

Table 3.7: - Corner Edge Displacement Value along X Direction is considering all the cases for load combination 0.9DL+1.5(+X).

Floor No.	Circular column	Rectangular column
10	2331.403	4945.562
9	2268.41	4774.94
8	2139.78	4470.93
7	1951.087	4054.949
6	1715.121	3552.532
5	1444.089	2986.41
4	1148.582	2375.987
3	837.441	1737.313
2	518.797	1084.708
1	207.957	444.224

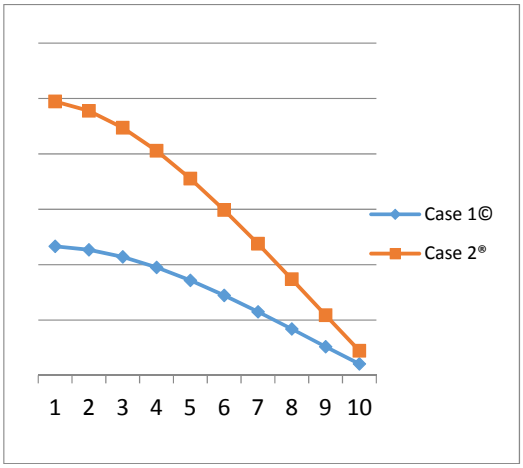

Fig:3.7: - Shows Corner Edge Displacement Value along X Direction for load combination 0.9DL+1.5(+X).

Table 3.8: - Shows Corner Edge Displacement Value along Z Direction for load combination 1.5(DL+ (Z)).

Floor No.	Circular column	Rectangular column
10	2205.086	3848.858
9	2144.459	3710.261
8	2022.323	3470.674
7	1844.063	3143.816
6	1621.544	2749.026
5	1366.115	2304.012
4	1087.689	1824.086
3	794.569	1322.202
2	494.269	811.133
1	200.255	318.166

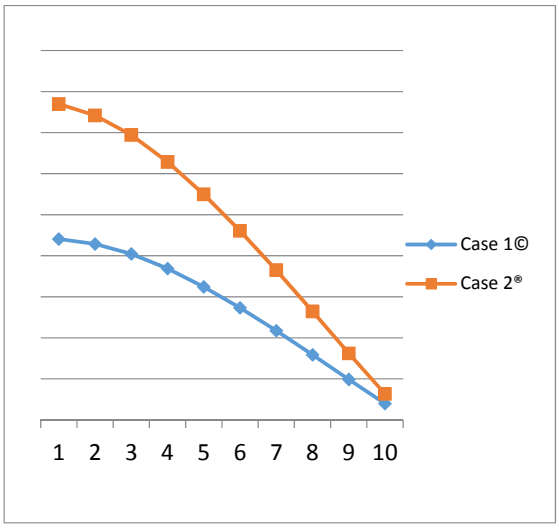

Fig:3.8: - Shows Corner Edge Displacement Value along Z Direction for load combination 1.5(DL+ (Z)).

Table 3.9: - Shows Corner Edge Displacement Value along Z Direction for load combination 1.2(DL+LL+ (+Z))

Floor No.	Circular column	Rectangular column
10	1764.073	3079.092
9	1715.569	2968.21
8	1617.858	2776.539
7	1475.25	2515.053
6	1297.235	2199.221
5	1092.892	1843.209
4	870.151	1459.268
3	635.655	1057.761
2	395.415	648.907
1	160.202	254.53

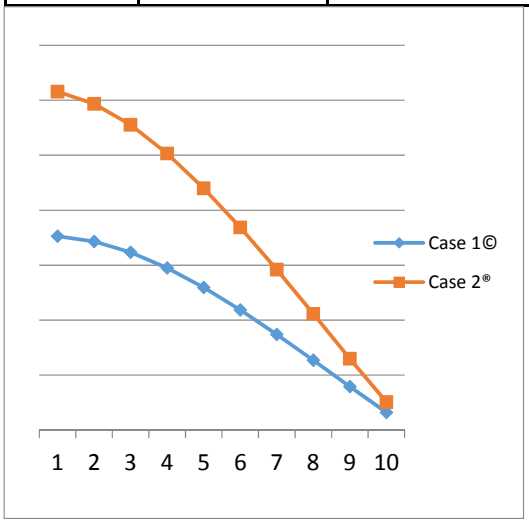

Fig:3.9: - Shows Corner Edge Displacement Value along Z Direction for load combination 1.2(DL+LL+ (+Z))

Table 3.10: - Shows Corner Edge Displacement Value along Z Direction for load combination 0.9DL+1.5(+X).

Floor No.	Circular column	Rectangular column
10	2205.036	3848.804
9	2144.461	3710.264
8	2022.323	3470.674
7	1844.064	3143.817
6	1621.545	2749.027
5	1366.117	2304.013
4	1087.691	1824.087
3	794.572	1322.205
2	494.269	811.133
1	200.274	318.185

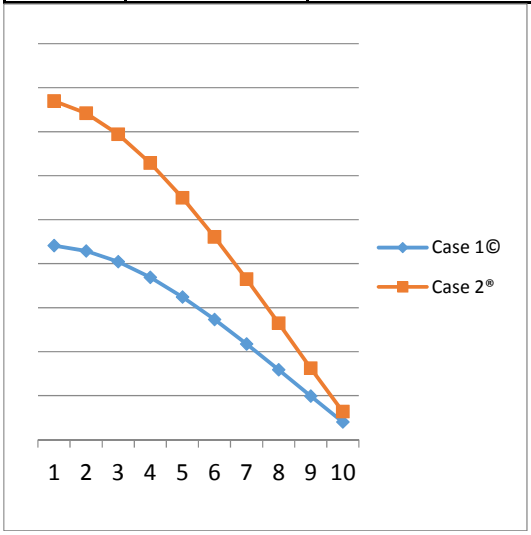

Fig:3.10: - Shows Corner Edge Displacement Value along Z Direction for load combination 0.9DL+1.5(+X).

Table 3.11: - Story Drift Value along X Direction considering all the cases for load combination 1.5(DL+ (X)).

Floor No.	Circular column	Rectangular column
10		
9	63.059	170.702
8	128.629	304.011
7	188.693	415.981
6	235.967	502.417
5	271.032	566.123
4	295.506	610.423
3	311.143	638.676
2	318.649	652.599
1	310.865	640.518

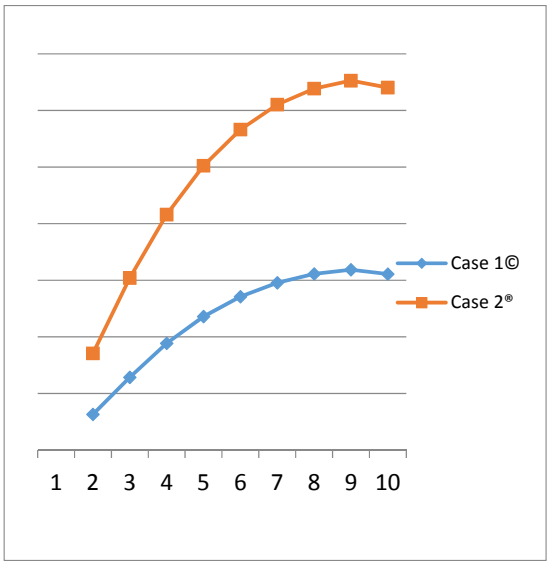

Fig:3.11:- Shows Drift Value along X Direction for load combination 1.5(DL+(X)).

Table 3.12: - Story Drift Value along X Direction considering all the cases for load combination 1.2(DL+LL+(+X)).

Floor No.	Circular column	Rectangular column
10		
9	50.465	136.564
8	102.908	243.213
7	150.954	332.785
6	188.774	401.933
5	216.825	452.899
4	236.406	488.339
3	248.914	510.94
2	254.911	522.079
1	248.704	512.418

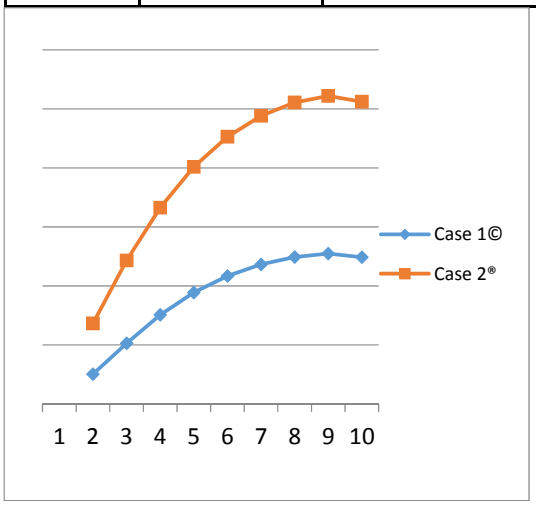

Fig:3.12:- Shows Drift Value along X Direction for load combination 1.2(DL+LL+ (+X)).

Table 3.13: - Story Drift Value along X Direction considering all the cases for load combination 0.9DL+1.5(+X).

Floor No.	Circular column	Rectangular column
10		
9	62.993	170.622
8	128.630	304.01
7	188.693	415.981
6	235.966	502.417
5	271.032	566.122
4	295.507	610.423
3	311.141	638.674
2	318.644	652.605
1	310.840	640.484

Table 3.14: - Story Drift Value along Z Direction considering all the cases for load combination 1.5(DL+ (Z)).

Floor No.	Circular column	Rectangular column
10		
9	60.627	138.597
8	122.136	239.587
7	178.260	326.858
6	222.519	394.79
5	255.429	445.014
4	278.426	479.926
3	293.120	501.884
2	300.300	511.069
1	294.014	492.967

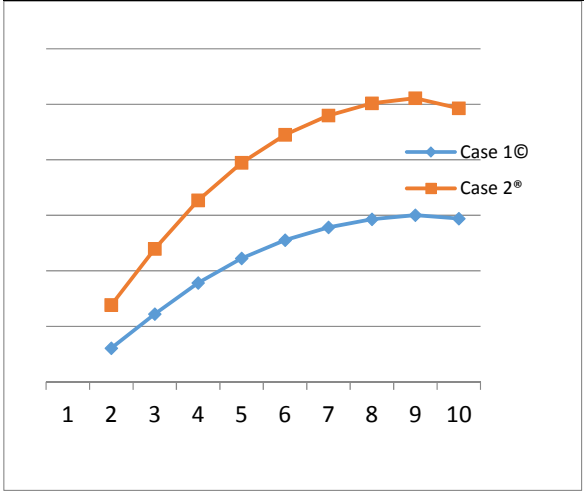

Fig:3.14:- Shows Drift Value along Z Direction for load combination 1.5(DL+ (Z)).

Table 3.15: - Story Drift Value along Z Direction considering all the cases for load combination 1.2(DL+LL+ (+Z)).

Floor No.	Circular column	Rectangular column
10		
9	48.504	110.882
8	97.711	191.671
7	142.608	261.486
6	178.015	315.832
5	204.343	356.012
4	222.741	383.941
3	234.496	401.507
2	240.240	408.854
1	235.213	394.377

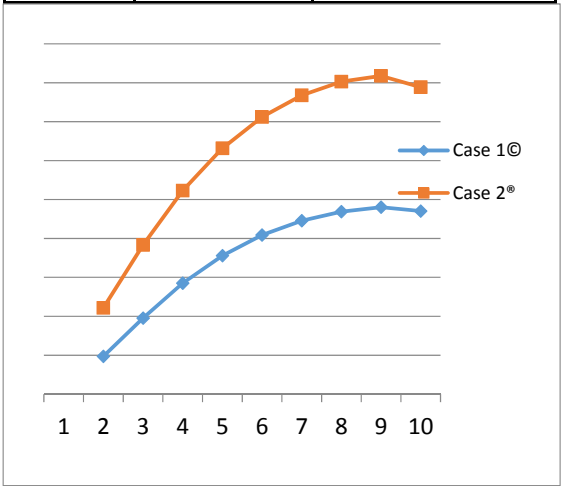

Fig:3.15:- Shows Drift Value along Z Direction for load combination 1.2(DL+LL+ (+Z)).

Table 3.16: - Story Drift Value along Z Direction considering all the cases for load combination 0.9DL+1.5(+Z).

Floor No.	Circular column	Rectangular column
10		
9	60.575	138.54
8	122.138	239.59
7	178.259	326.857
6	222.519	394.79
5	255.428	445.014
4	278.426	479.926
3	293.119	501.882
2	300.303	511.072
1	293.995	492.948

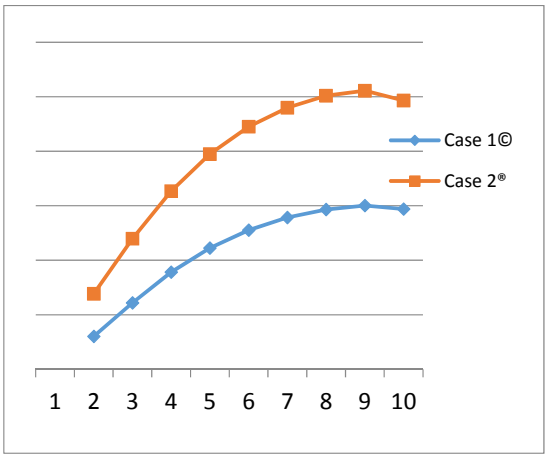

Fig:3.16:- Shows Drift Value along Z Direction for load combination 0.9DL+1.5(+Z).

4. CONCLUSION:

1.The analysis of the multi-storeyed building reflected that there is not much variation of base shear between the rectangular and circular building. Almost both the buildings have same base shear. This is due to the assumption of same dimensions for both buildings.

2. Corner Edge Displacement is found to be more in the rectangular columns than the frames having circular columns. Thus, the rectangular column building will perform better with less roof displacement as compared to circular column building with same amount of loading.

3. Story drift is found to be more in the rectangular columns than the frames having circular columns. Thus, the behaviour of rectangular column building is good as compared to circular column building.

4. From the above points discussed we can conclude that rectangular shaped columns give good performance against earthquake as compared to circular column, hence rectangular shaped columns should be preferred as compared to circular shaped columns in areas porn to high risk of earthquake.

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