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COMPARISON BETWEEN SPECIALLY SHAPED COLUMNS AND RECTANGULAR COLUMNS IN R.C. STRUCTURE

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Abstract — *The objective of this study is to assess the comparative seismic performance of buildings with Rectangular columns and buildings with Specially shaped columns. Four different buildings (i.e. 6 story, 9 story, 12 story and 15 story) are analyzed using Equivalent static analysis for zone III in Amravati. The maximum story drift and lateral displacement are calculated. The cost comparison is done between building with rectangular columns and the building with specially shaped columns in this study. ETABS v9.7.4 software is used for the analysis and design. It is observed that the seismic performance of the building with specially shaped columns is better as compared to the building with rectangular columns and also the cost required is less.*

Keywords- *Earthquake, Rectangular columns, Specially shaped columns, Displacements, Drifts*

I. INTRODUCTION

Building is constructed by joining various main components like slab, beam, columns and footing. Self weight of components, dead load, live load, floor load is acting on the building. Load is transferred from slab to beam and beam to column and column to footing. Columns play very important role in buildings because total load is transferred through columns. Various shapes of columns are used in the construction such as rectangular columns, Square columns, circular columns, T-shaped columns, L-shaped columns, Cross (+) shape columns. So, Rectangular, Square and Circular columns are called as Regular columns and T-shape columns, L-shape columns, Cross (+) shape columns are called as Specially shaped columns. Columns are structural elements which are predominantly subjected to axial compressive forces and moments. The IS code 456:2000 defines the column as Compression Member, the effective length of which exceeds three times the least lateral dimension and unsupported length l shall not exceed sixty times of b (least lateral dimension), if restrained at the two ends. Further, if one end of a column is unrestrained, its unsupported length shall not exceed $100b^2/D$, where D is the larger lateral dimension which is also restricted up to four times of b. It is called compression member because compression forces and stresses dominate their behavior. Concentrically loaded columns are subjected to pure axial load. However, such columns rarely occur in practice.

II. GEOMETRY AND DESCRIPTION

For this study, a G+5, G+8, G+11 and G+14 buildings with 3.8 meters height for each story, regular plan is modeled. This building consists of four spans of 5 meter, 4 meter, 4 meter and 5 meter in X-direction and 3 spans of 4 meter, 5 meter and 4 meter in Y-direction. The plan of all buildings measures 18m x 13m. These buildings were designed in compliance to the Indian Standard 1893 (Part 1); 2002 (Indian Code of Criteria for Earthquake Resistant Design of Structures). Story heights are assumed to be same for all buildings including the ground story. The buildings are assumed to be fixed at the base. The floors of all buildings act as rigid diaphragms. Shopping Complex is analyzed and designed by using ETABS v9.7.4 software.

In this paper, two buildings are considered to analyze and design in which, Rectangular columns are used in one and Specially shaped columns are used in another building and compared them by varying there heights. Comparison is done between different storied buildings in the Amravati (i.e. Zone III). For this purpose, plan is selected as a commercial building. The dimensions of building are decided on the basis of use of commercial building. Two buildings are modeled with Rectangular columns in one and Specially shaped columns in another. Sizes of members and loads are assigned and then analyze and design are done further. After designing, percentage of bar of columns are taken from ETABS v9.7.4 results to calculate the cost and also calculated cost save in brickwork and carpet area in Specially shaped columns structure. Analysis and design for 6 story and 9 story are done by using ETABS v9.7.4 software.

The plan of the building models are given below:

Model 1 – Floor plan of the R.C. framed structures with Rectangular columns.

Model 2 – Floor plan of the R.C. framed structures with Specially shaped columns.

2.1 Preliminary Data:

Table 1. Preliminary Data

Table 2. Loading Data

Sr. No .	PARAMETERS	VALUES	UNITS
1	Grade of concrete	25	N/mm^2
	Grade of steel	415	N/mm^2
2	Density of concrete	25	kN/m^3
3	Density of brick wall	20	kN/m^3
4	Floor to floor height	3.8	m
5	Bottom story height	2	m
6	Parapet height	1	m
7	Beam sizes		
	B1	230 x 530	mm^2
	B2	230 x 750	mm^2
	B3	230 x 600	mm^2
8	Thickness of slab	150	mm
9	Wall thickness		
	External wall	230	mm
	Internal wall	115	mm

Sr. No.	PARAMETERS	VALUES	UNITS
1	Live Load	4	kN/m2
2	Roof Live Load	1.5	kN/m2
3	Floor Finish Load	1.87	kN/m2
4	Wall load		
	a) External wall		
	For 530 mm beam depth	15.04	kN/m
	b) Internal wall		
	i) For 530 mm beam depth	7.521	kN/m
	ii) For 600 mm beam depth	7.36	kN/m
	iii) For 750 mm beam depth	7.02	kN/m
5	Parapet load	4.6	kN/m

Table 3. Sizes of Columns

Sr. No.	STORY	COLUMN	SIZES	
			RECTANGULAR COLUMNS	SPECIALLY SHAPED COLUMNS
1	G+5 (6 story)	C1	300x550	L- 450
		C2	300x530	T- SHAPE(730x480)
		C3	300x550	T- SHAPE(770x530)
		C4	380x850	+ -SHAPE-810
		C5	300x580	T- SHAPE(730x480)
2	G+8 (9 story)	C1	300x680	L- 610
		C2	300x680	T- SHAPE(690X610)
		C3	300x750	T- SHAPE(870X680)
		C4	380x980	+ -SHAPE-990
		C5	300x750	T- SHAPE(690X680)

2.2 Plan Details:

Columns, beams and walls are shown in plan below. The plans of the buildings are developed with the help of AutoCAD software.

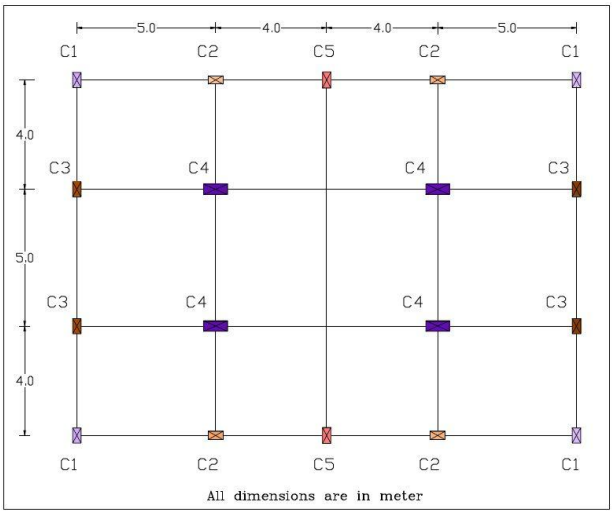

Figure1. Detail of Rectangular Columns in Plan

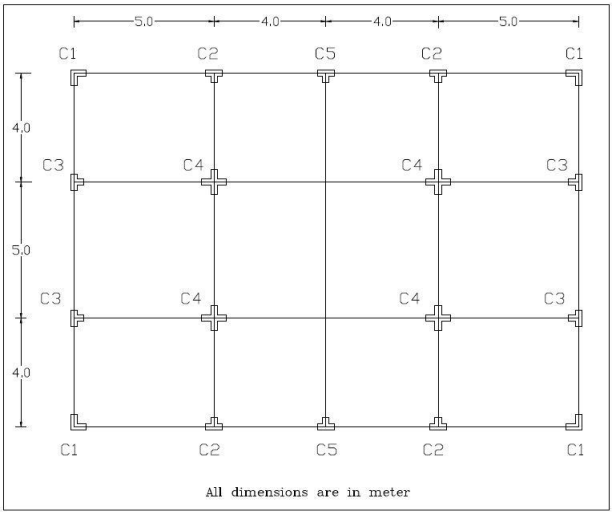

Figure2. Detail of Specially Shaped Columns in Plan

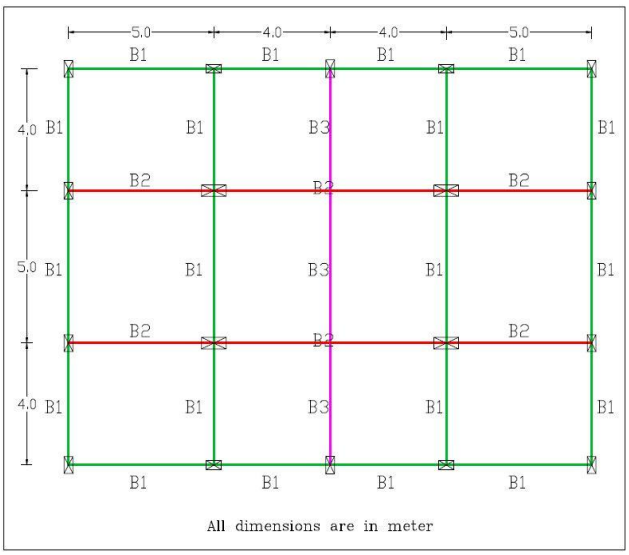

Figure3. Detail of Beams in Plan

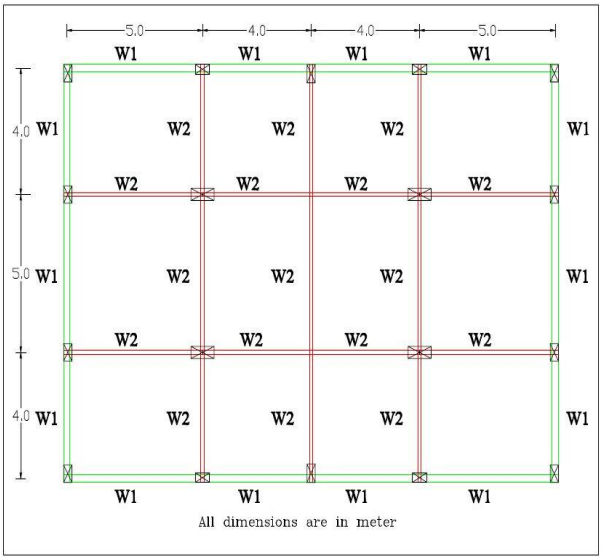

Figure4. Detail of Walls in Plan

III. RESULTS AND DISCUSSIONS

In this paper, two buildings i.e. G+5 and G+8 for zone III have been analyzed by Seismic Coefficient Method by using ETABS v9.7.4 software. The results regarding the lateral displacements and storey drifts for G+5 and G+8 for zone III has presented below.

3.1 Lateral Displacements:

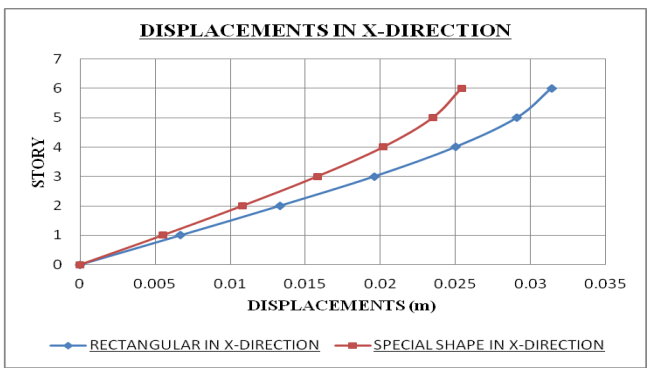

Figure 5. Displacement Curve for G+5 in X-Direction

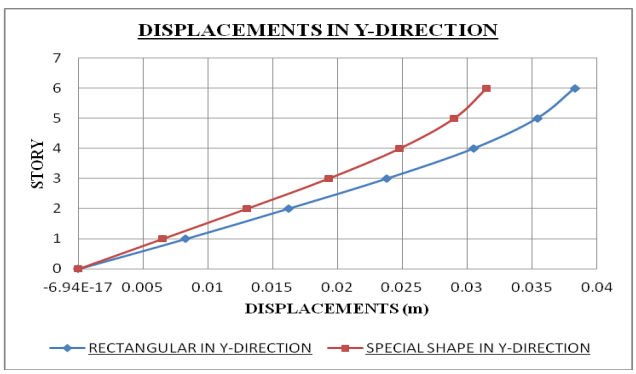

Figure 6. Displacement Curve for G+5 in Y-Direction

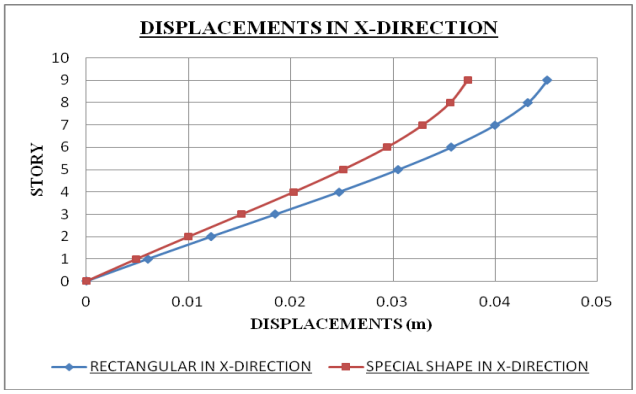

Figure 7. Displacement Curve for G+8 in X-Direction

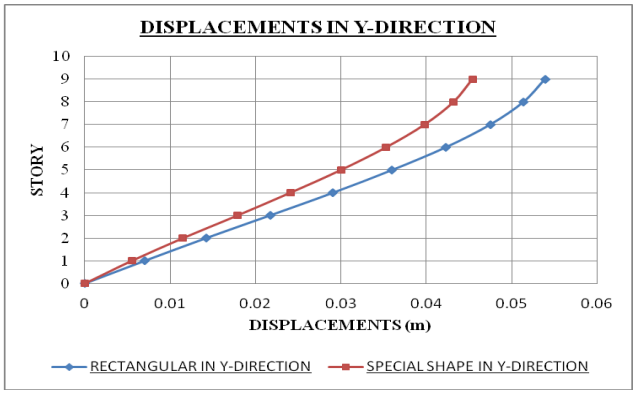

Figure 8. Displacement Curve for G+8 in Y-Direction

From above Fig. 5, 6, 7 and 8, it is observed that displacements in R.C. frame with Specially Shaped Columns are minimum than R.C. frame with Rectangular Columns

3.2 Story Drifts:

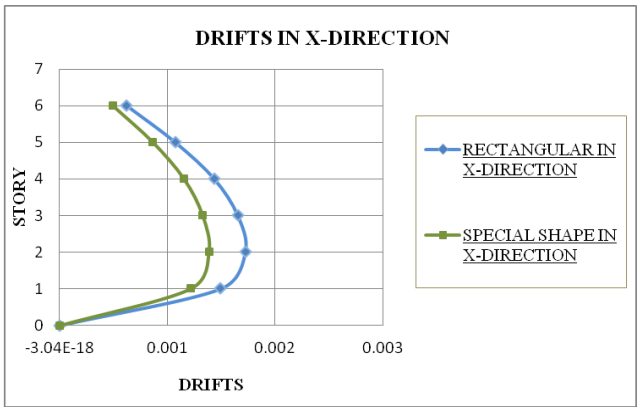

Figure9. Drift Curve for G+5 in X-Direction

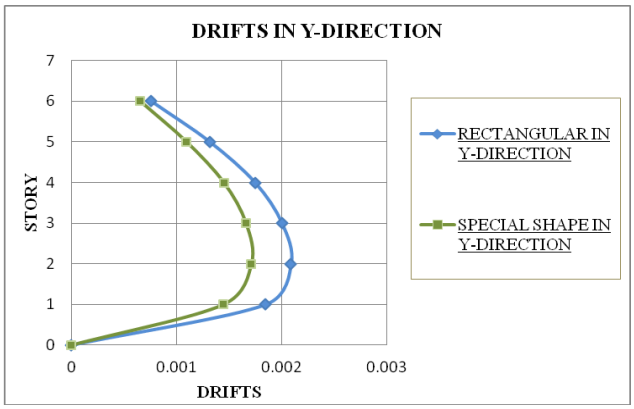

Figure10. Drift Curve for G+5 in Y-Direction

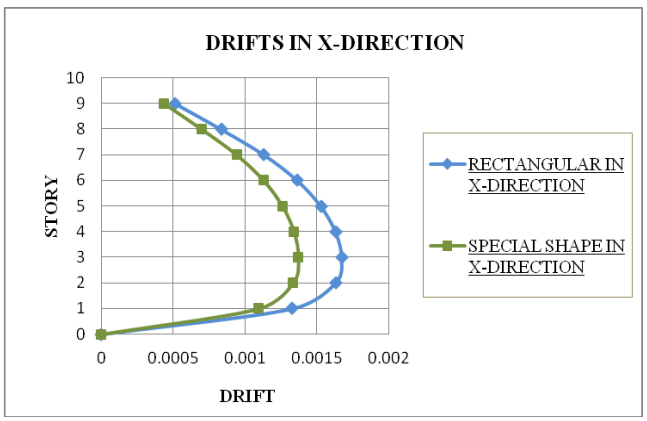

Figure11. Drift Curve for G+8 in X-Direction

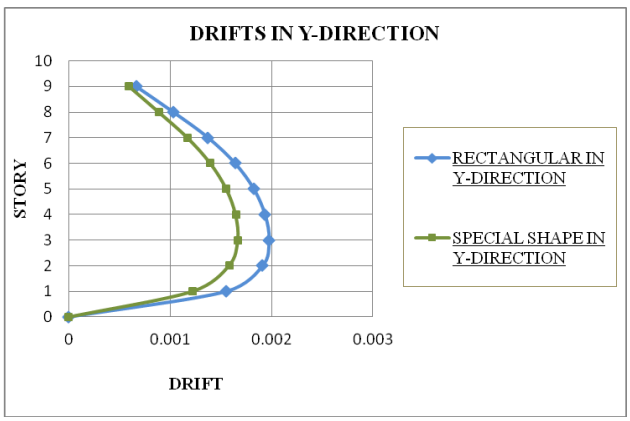

Figure12. Drift Curve for G+8 in Y-Direction

From above Fig. 9, 10, 11, 12, it is observed that maximum drifts in R.C. frame with Specially Shaped Columns are minimum than R.C. frame with Rectangular Columns.

3.3 Cost Comparison:

Cost of steel and concrete in columns of rectangular shapes and specially shaped is calculated and comparison is done. Cost saved in steel and concrete in specially shaped columns than rectangular columns and can be easily seen in the chart below.

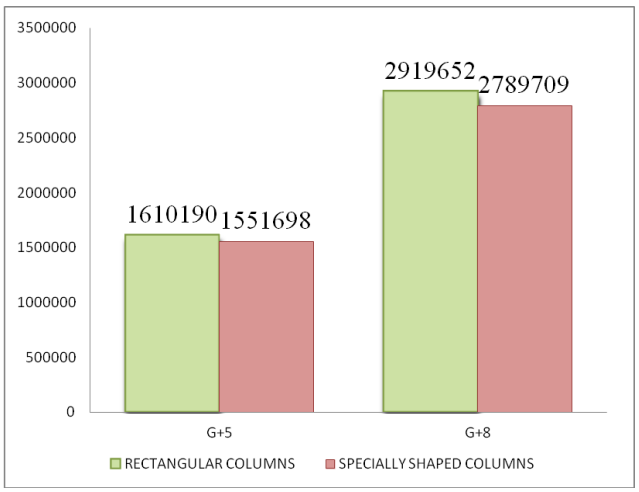

Figure13. Cost Saved in Steel and Concrete in Columns

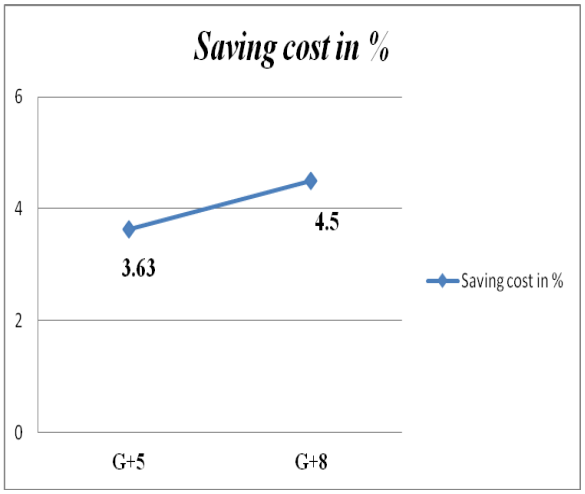

Figure14. Cost Saved in Steel and Concrete in %

In the figure 13., it is observed that cost of steel and concrete in R.C. frame with Rectangular columns showing in green color is more than R.C. frame with Specially shaped columns showing in red color.

- In G+5 building, the cost saved in steel and concrete for R.C. frame with Specially shaped columns is 3.63% less than R.C. frame with Rectangular columns.
- In G+8 building, the cost saved in steel and concrete for R.C. frame with Specially shaped columns is 4.5% less than R.C. frame with Rectangular columns.

Table 4. Cost Saved in Steel and Concrete in Column, Brick Work and Carpet Area

Sr. No.	Story	Parameters	Cost (Rs.)	Total Cost (Rs.)
1)	**G+5**	Column(Steel+ Concrete)	58492	**240905**
		Carpet area	88344	
		Brick work	94069	
2)	**G+8**	Column(Steel+ Concrete)	129943	**474781**
		Carpet area	174778	
		Brick work	170060	

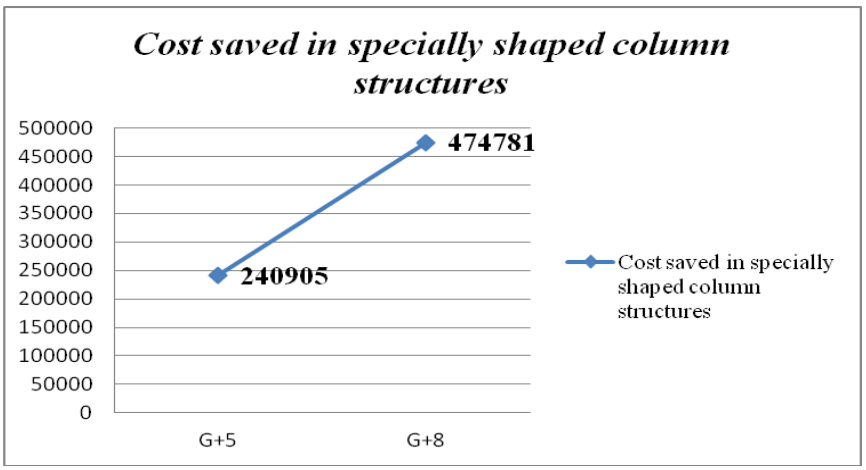

Figure15. Cost Saved in specially shaped column structures.

In this Fig.15, it is observed that cost saved in steel and concrete in columns, brick work and carpet area for R.C. frame with Specially shaped column is increased according to building's height.

IV. CONCLUSION

- From above analysis, it is observed that in G+5 and G+8 buildings, Specially shaped columns in R.C. structure give minimum displacement and minimum drift than Rectangular columns in R.C. structure.
- As per analysis, it is concluded that displacement at every story in Special shaped column structures is less than Rectangular column structures.
- As per analysis, it is concluded that drift at every story in Special shaped column structures is less than Rectangular column structures.
- More carpet area will be available to use in Specially shaped columns in R.C. structure than Rectangular columns in R.C. structure.
- Specially shaped columns give more usable floor area at the corners in rooms as compared to rectangular columns in R.C. structure.
- No obstruction will be created by the offset of columns in case of Specially shaped column structures.
- It is concluded that building with Specially shaped columns is constructed in lower cost as compare to building with Rectangular columns.
  - In G+5 building, the cost saved in steel and concrete for R.C. frame with Specially shaped columns is 3.63% less than R.C. frame with Rectangular columns.
  - In G+8 building, the cost saved in steel and concrete for R.C. frame with Specially shaped columns is 4.5% less than R.C. frame with Rectangular columns.

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