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Comparative Analysis of Rectangular and Square Column for Axial loading, Uniaxial & Biaxial Bending

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Abstract – *This study tells the type of column (Rectangular, Square) which is best suited & most economical, for a column is subjected to axial loading or uniaxial or biaxial bending. In RCC frame building loads from the slabs and beams are transferred to the columns and columns further transfers these loads to the foundation. These columns may be subjected to axial loading or uniaxial or biaxial bending. So there is a need of study which shape of column is best suitable and economical.*

In all general buildings construction mostly rectangular and square shape columns are used because they are easy to construct. In this study I have compared both of the shapes of column and study shows which shape of column is best suited and most economical and also try provide a general idea for placing the column in a RCC building.

For this study I have used STAAD Pro. Software for the analysis and design of columns as per IS 456 – 2000.

Key Words: **Rectangular and square column, STADD Pro., Analysis, Design, Axial loading, uniaxial bending, biaxial bending.**

1. INTRODUCTION

In all general buildings mainly two shapes of column rectangular and square are used, but there is a large conflict among the shape of column be preferred to fulfill the structural requirements of building.

In the construction process, shape of column is so chosen to meet the aesthetic requirements, this may lead to uneconomical column design. This study gives the general idea in decision making on shape of column to be used in a building for an economical design and also fulfill the structural requirement of building for axially loading or uniaxial and biaxial bending.

In this study I have taken a G+2 storey residential house of 12*12 m^2 plan area. The analysis and design of building is done with three models of identical dimensions and same loading with different shapes of columns. After the analysis and design the identification of columns which are subjected to axial loading, uniaxial and biaxial bending, and comparison of their deflection, bending moments, design details and geometric properties is done and the best economical and structurally strong arrangement of column is provided.

1.1 Specifications of building:-

Plan area	12*12 m^2
No. of storey	G + 2
Storey height	15m (5m each)
Loading	2 KN/m
Load combination	1.5(D.L + L.L)
Column size 1. Rectangular	0.4m* 0.3m
2. Square	0.3m*0.3m
Beam size	0.3m*0.3m

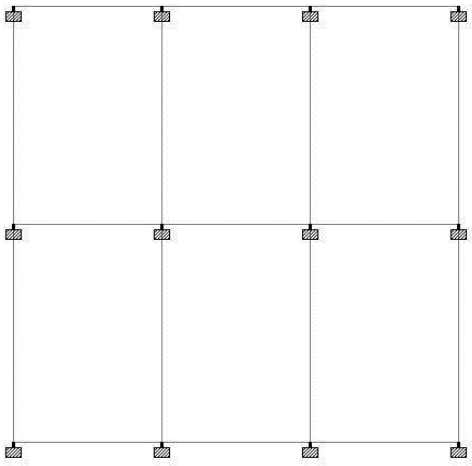

Fig 1. (Plan)

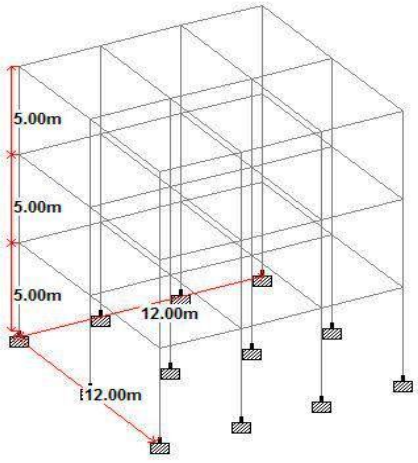

Fig 2. (3D view)

Fig 3. (3D rendered view)

1.2 Axial Loading in columns:-

Axial loading in columns occur when the loads act normal to the cross-section of the column without any eccentricity.

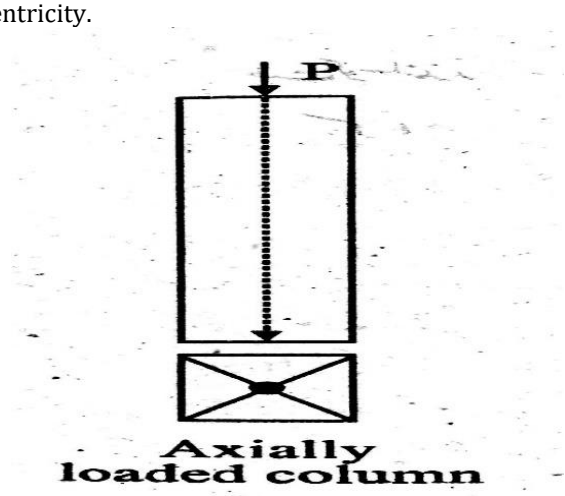

Fig. 4

1.3 Uniaxial and Biaxial Bending –

Uniaxial bending in column occur when the load act in the column with an eccentricity about one axis of cross-section of column or axial load act with a moment about one axis of column. Left hand side of fig. 5 shows the uniaxial bending.

Biaxial bending in columns occur when the load act in the column with an eccentricity about two axes of cross-section of column or axial load act with two moments about both axis of cross-section of column. Right hand side of fig. 5 shows the biaxial bending.

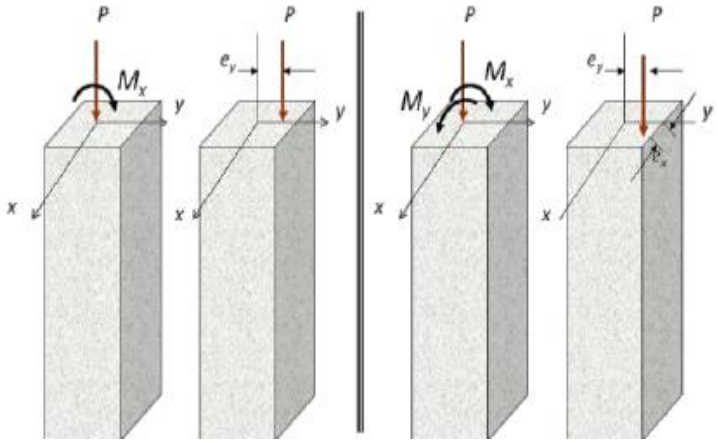

Fig. 5

2. Analysis:-

The analysis of this G+2 storey house (fig.1&2) shows the column of a single storey which are subjected to axial loading and uniaxial and biaxial bending. The Result is shown below.

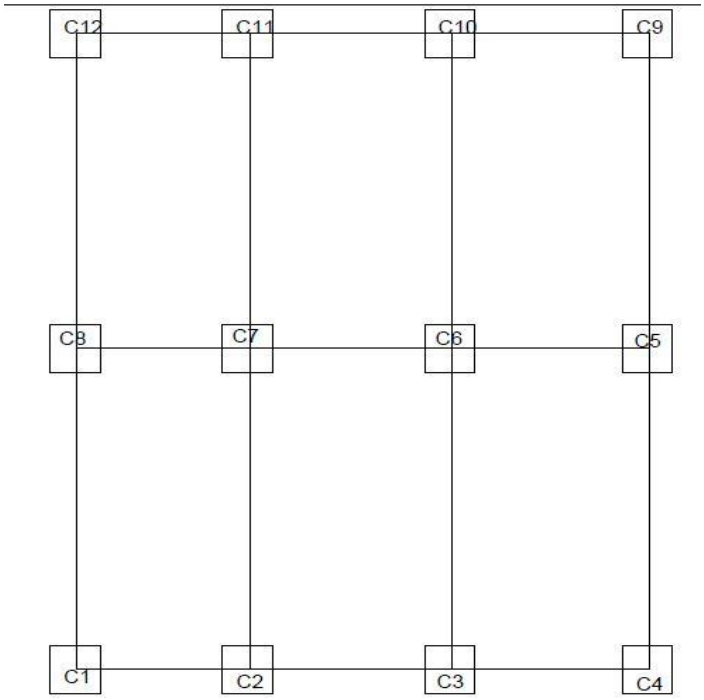

Fig. 6

Axial Loading:- C6, C7.
Uniaxial Bending:- C2, C3, C5, C8, C10, C11
Biaxial Bending:- C1, C4, C9, C12

The same pattern of loading in column is same for all the three floor columns.

The column will be studied under three conditions-

1. All column are Square.
2. All columns are Rectangular.
3. Mix of both Rectangular and Square.

2.1 All Columns are Square:- In this arrangement all columns of size 0.3m*0.3m are chosen.
Result of this arrangement are-

NOTE- All these arrangements are for the Load combination of 1.5DL + 1.5 LL.

2.1.1 MAXIMUM DEFLECTION:-

Type Of Column	Max. Deflection (mm)		
	x	y	z
Axial	0.024	-1.084	0
Uniaxial	-0.15	-0.913	0
Biaxial	-0.15	-0.639	-0.382

Table. 1

2.1.2 DESIGN DETAILS:-

The design of column is done by IS 456-2000 & design details are same for all the three types of columns.

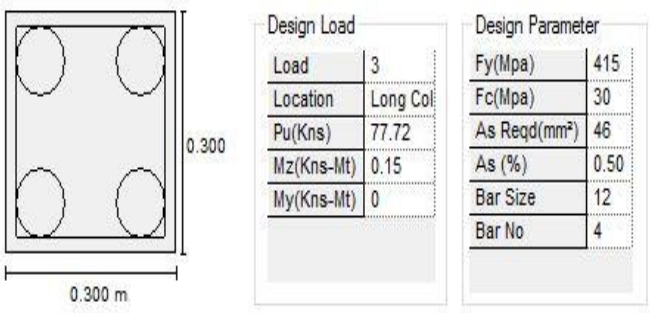

Fig. 7

2.2 All columns are Rectangular:-

In this all the columns of size 0.3m* 0.4m are chosen, the orientation of the rectangular column is longer side of the column is face towards the C1 to C8. For the same amount of loading and load combinations the results are:-

2.2.1 MAXIMUM DEFLECTION:-

Type Of Column	Max. Deflection (mm)		
	x	y	Z
Axial	0.021	-0.719	0
Uniaxial	-0.131	-0.592	0
Biaxial	-0.131	-0.426	0

Table. 2

2.2.2 DESIGN DETAILS:-

The design of column is done by IS 456-2000 & design details are same for all the three types of columns.

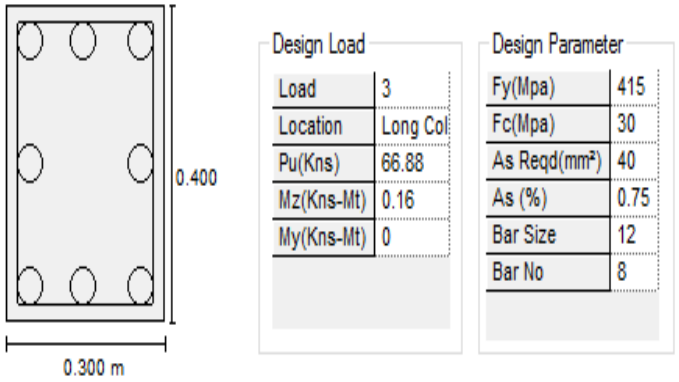

Fig. 8

The above results shows that rectangular columns are good at resisting the uniaxial and biaxial moment about 'x' and 'z' axis and square column in resisting the axial load; however, the deflection of column in 'y' direction is more as compared to other direction but the columns are long columns so there is no danger of deflection of column in vertical or 'y' direction because long column mainly fail in buckling and this vertical deflection is small as compared to its height so there will be no danger.

By showing these result I have taken next model with mix of rectangular and square column.

2.3 Mix of both Rectangular and Square:-

In this mix of both rectangular and square column is chosen. Rectangular column is chosen for uniaxial and biaxial loading because the rectangular shape reduces the moments in lateral directions and long column mainly fail by buckling so there is need to reduce the deflection in lateral direction i.e x&z direction. Square column is chosen for axial loading because the deflection in vertical direction is small as compared to its vertical height.

Rectangular column of 0.3m*0.4m is chosen and orientation is same as is previous case, square column of 0.3m*0.3m is chosen. For the same amount of loading and load combination the results are-

2.3.1 MAXIMUM DEFLECTION:-

Type Of Column	Max. Deflection (mm)		
	x	y	z
Axial	0.015	-0.902	0
Uniaxial	-0.145	-0.595	0
Biaxial	-0.132	-0.426	0

Table. 3

2.3.2 DESIGN DETAILS:-

The design details of rectangular columns for uniaxial and biaxial loading is same as the above for the rectangular case and the design details of columns of square shape column is same as previous case of square columns.

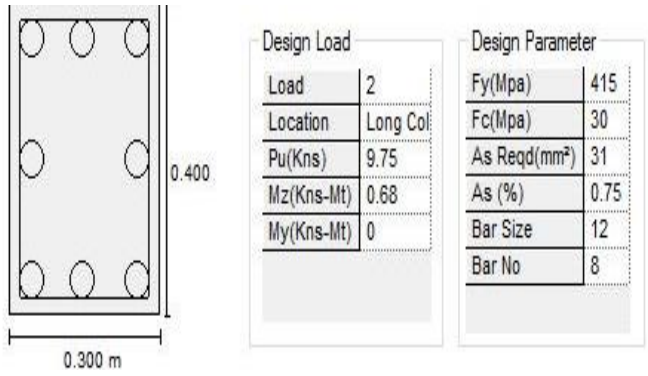

Fig. 9 (design details for uniaxially and biaxially loaded column)

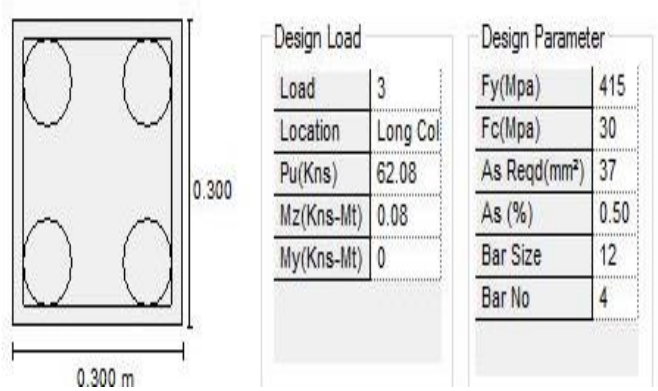

Fig. 10(design details for axially loaded column)

3. CONCLUSION:-

After comparing the data from all the three cases the arrangement of column using rectangular column for uniaxial and biaxial bending and square column for axial loading show best results, in general case, in a building the axial load rarely act on the column small eccentricity always occur which can be neglected and considered as axially loaded column, the minimum eccentricity can be found from IS 456 - 2000 (Cl. 25.4).

In general, thumb rule tells that; column in which four beams meet, these are mostly subjected to axial loading and square column can be used in that condition and in outer face of building where 3 beams meet, these are mostly subjected to uniaxial bending and in outer four corners of the building where two beams meet these columns are mostly subjected to biaxial bending and rectangular column can be used there. The orientation of rectangular column should be such that the longer axis of column should be provided in the shorter direction of the building to provide maximum structural stability in lateral short direction at the time when earthquake or lateral force acts on the building and try to sway the building frame.

This arrangement of choosing rectangular column for uniaxial and biaxial bending and square column for axial loading also provide an economical design of column in building which reduce the total area of concrete and total area of reinforcement for column as compared to the case when all column are rectangular.

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5. BIOGRAPHY:-

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