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Seismic response of Column with different shapes

Gourav Sachdeva[1], Ankit Sachdeva[2], Prof. P. Hiwase[3]
[1,3]*(Assistant Professor, Dept. of Civil Engineering, RCOEM, Nagpur, India)*
[2]*(M. Tech. Scholar, Dept. of Applied Mechanics, VNIT, Nagpur, India)*

Abstract :- A comparative analytical work is carried out to understand the behavior of column shapes. In this work two shapes are considered i.e., circular & rectangular. Height & Cross sectional areas of both shapes of columns are kept constant and OMRF is used. Seismic forces are considered to figure out the realistic behavior of structures. The analytical approach is based over two models. The dimensions of columns & beams are taken as per the requirements of construction practice. The conclusion of this work is presented which is based on the variation of floor wise shear forces and the equations for the same are developed.

Keywords: - Seismic forces, Column shapes, OMRF, Circular, Rectangular, Shear forces (Y).

I. INTRODUCTION

A column is a vertical compression member, which transfers load finally to the ground level. Circular columns are symmetric about any centroidal axis but Square columns have only four axes of symmetry. Minimum number of bars required in a square column is 4 while for circular columns, it is 6. Form work for square columns is simpler (due to the straight sides) compared to circular columns. As per the role of pleasant look, column with circular cross section is preferred. Now there are many pros and cons of shapes of columns. To understand the structural behavior of column, both shapes are considered and analysis has done. Columns with circular cross section and square cross section with constant cross sectional area are considered in the work. Equivalent static method is used for seismic analysis of structure.

Fig.1. Circular Column

Fig.2. Rectangular Column

II. LOADING CONSIDERATION

LOADS:

Table1: Loading and description

LOADING	DESCRIPTION
Dead Load (DL) and Live load (LL)	As per IS 875 (Part 1) (1987) and IS 875 (Part 2) (1987), respectively.
DL	Self weight : Floor load-3.5 kN/m^2, Typical storey wall load - 4.9 kN/m^2 & Terrace wall load- 13.23 KN/m^2
LL	Floor Load- 4 KN/m^2(other floors) and Floor Load- 1.5 KN/m^2 for (terrace)

SESIMIC PARAMETERS :

Table 2: Seismic parameter and description

SEISMIC PARAMETER	DESCRIPTION
Code	IS 1893-2002 (Part1)
Zone	IV (0.24)
Response reduction factor	3
Importance factor	1
Rock and soil site factor	1
Damping Ratio	0.05
Depth of foundation	2.5m

III. LITERATURE REVIEW

There are many researches are available over seismic forces. The effect of earthquake has been considered in many works. Some of them are taken under consideration for this research.

Riad Benzaid and Habib - Abdelhak Mesbah worked on "Circular and Square Concrete Columns Externally Confined by CFRP Composite: Experimental Investigation and Effective Strength Model". He proposed a equation based on effective lateral confining pressure and the effective circumferential FRP failure strain to predict the strength of concrete and corresponding strain for each of the cross section geometry used, circular and square.

Explanatory examples for ductile detailing of RC building, see for instance [9], discussed on Ductile Detailing of RC Building. The ductile detailing of structural members are considered. There are some topics covered in the study such as Beam Design, column design & design of interior and exterior beam-column joint for different seismic zones. They actually focused all the points regarding shear force & moment in beam and axial force and moment in columns. It is totally consist of a framed structure in 8 examples which were in good agreement with the explanatory notes. All required checks were also made for validation.

The design example of a six storey building, see [2], explained a problem regarding a six storey building with G.F. storey height as 3.4m & typical floor storey height as 5m for a commercial complex has plan of size 22.5 x 22.5 with 7.5 x 7.5 of each grid. The building is located in seismic zone III on a site with medium soil. They considered 230 mm thick brick masonry walls. Some parameters such as end shear and end moment of beam have been considered by them to explain the problem efficiently. They also investigated the behavior of storey drift and found maximum at 4^{th} storey i.e., 17.58mm which is less than permitted value i.e., 20mm (as per the taken example). The self weight of beam & column were directly calculated by using analysis software. Seismic forces are considered and for ductile detailing required IS codes were also used.

IV. PROBLEM STATEMENT

- This work consists of two models (Model-I: Building frame with circular columns & Model-II: building frame with rectangular columns).
- The height of each storey is taken as 3m.

- Model- I: Size of circular column is 0.339m (Diameter)
- Model- II: Size of square column is 0.3m x 0.3m

- **PRELIMINARY DATA:**

Table3: Specification and description

SPECIFICATION	DESCRIPTION
Wall thickness (including Plaster)	(0.23m brick wall + 0.012m x 2 plaster) = 0.254m
Number of floors	G+4
Plan size	9m x 9m (Each grid size 3m x 3m)
Size of beams	0.3m x 0.23m
Depth of slab	0.1m
Floor to floor height	3.0m
Support condition	Fixed

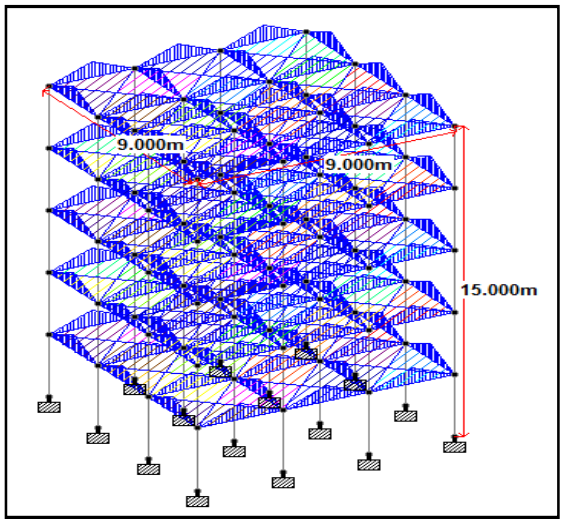

Fig.3. Dead loading: Floor load

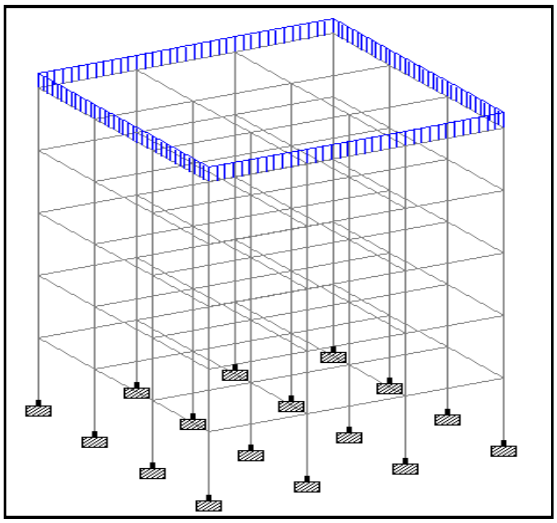
Fig.4. Dead loading: Terrace wall load

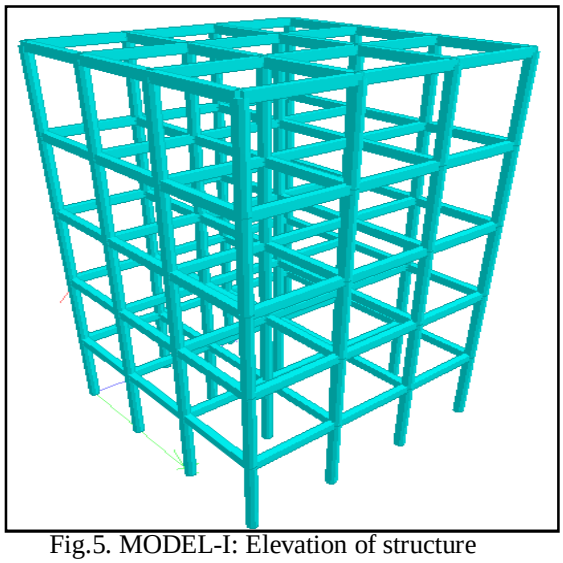
Fig.5. MODEL-I: Elevation of structure

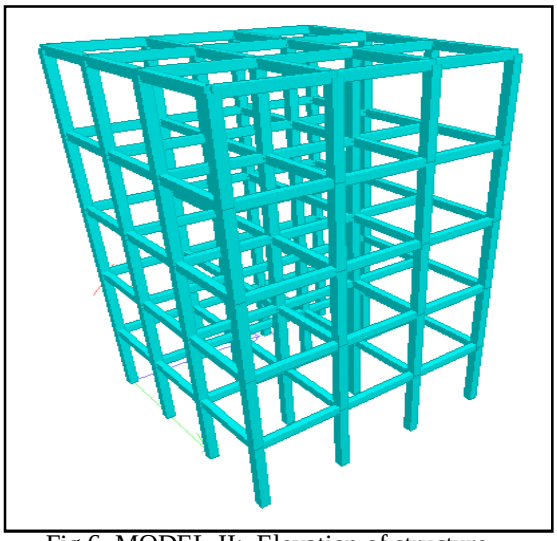
Fig.6. MODEL-II: Elevation of structure

V. RESULT AND GRAPHS

Model- I: Building frame with circular column

1. Floor wise Beam-Shear force variation in Y direction:

Table.3.: Shear Force-Y

Floor number	Shear force -Y (kN)
5	24.038
4	60.196
3	59.825
2	58.944
1	60.504

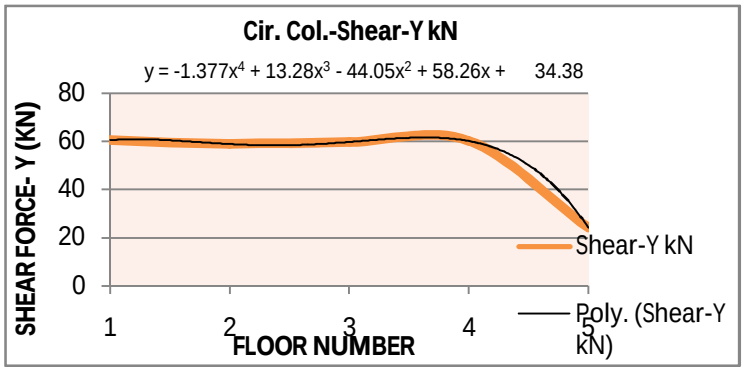

Fig.7 Graph of Shear force vs. floor number.

$$y = -1.389x^4 + 13.44x^3 - 44.78x^2 + 59.78x + 33.34 \quad \text{..... (1)}$$

The equation for variation of shear force-Y in a building frame with circular columns is given below,

Model- II: Building frame with rectangular column

1. Floor wise Beam-Shear force variation in Y direction:

Table.4. Shear Force-Y

Floor number	Shear force-Y kN)
5	24.113
4	60.326
3	59.946
2	59.057
1	60.394

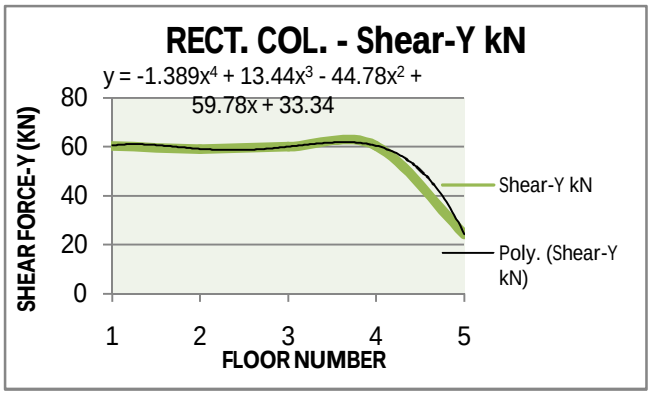

Fig.8. Graph of Shear force vs. floor number.

The equation for variation of shear force-Y in a building frame with rectangular columns is given below,

$$y = -1.377x^4 + 13.28x^3 - 44.05x^2 + 58.26x + 34.38 \quad \text{..... (2)}$$

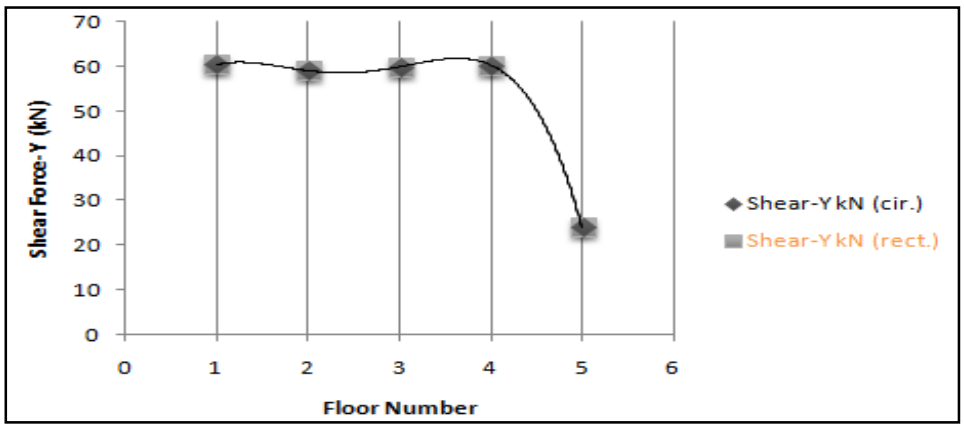

Fig.9. Variation of shear force of all floor numbers in a building frame with circular column and rectangular column.

In this work, the focus is to determine the variation of circular and rectangular columns when provided in a building frame. Values of shear forces are varying for both columns. Equations obtained for the variation of shear forces are presented. The variation of Shear forces are not so much varying. Graphs for both Models are presented and the comparisons between both Models are shown in fig. 7 by using a polynomial curve of order 4.

VI. CONCLUSION

The equation obtained shows the variation of shear force along Y direction of all maximum floor wise beam shear forces. The variation of shear force is also analyzed. Some important key points are figured out after analysis of the structure given as,

- The values for shear forces are greater for Model-II: Building frame with rectangular columns rather than Model-I except 1st floor but variation is small.
- For 1st floor, Model-I has greater values than Model-II.
- Comparison is done by using Shear force parameter.
- Equations for the variation are obtained as equation (1) & (2).

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