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Dynamic Analysis of RC Building with Different Cross-Section of the Column: A Review

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Abstract - *In this review paper, we studied different cross-section of the column that is rectangular, column, square, circular column, etc in the high rise building at the different angle of rotation. We will see that which cross-section of the column is more stable in the multi-storey building. Cross-section of the column plays a very important role in the multi-storey building because it can resist the maximum lateral load (wind or seismic load). When the mass of the column in the X- and Y- direction is the same then the effect of the natural period will be same in the both direction.*

Key Words: RC Column, RC structure, Column Orientation, Dynamic Analysis, different shape of Column.

1. INTRODUCTION

Getting up the cost of land, development of urban areas, availability of quality construction materials, and development of modern structural systems are the governing factors of tall structures development. By increasing the height of the building it becomes susceptible to lateral loads such as earthquakes and wind. The stiffness playing governing role in the analysis and design of the structure in tall buildings when subjected to lateral loads. To carry the lateral loads and control the excessive lateral deflection of buildings, the provision of an efficient structural system with a reasonable height limit is a good solution for such an issue. Moment resisting frame is a structural system that is capable of carrying the lateral loads in low to mid-rise buildings. SMRF carries the lateral loads by combined axial-shear-bending action of beams and columns. Based on the strong column- weak beam design concept, columns should be stiff compared to beams to prevent shear mode of deformation of the structure. Selection of appropriate shape, size, and orientation for columns in the building (especially rectangular plan building) are the main factors that control the overall stiffness of the building structure. In addition to providing lateral stiffness, columns are responsible for the deflection shape of the building structure. The main aim of the current paper is to find out the effect of the seismic force in the different cross-sections of the columns on the seismic response of building structures.

1.1 Column Orientation

The orientation of columns is kept symmetrical as far as possible, on both sides of the layout. If you have a rectangular column Orientation will be a mix of the architectural demands(which usually involves fewer protruding faces from the wall face) and the structural demand which keeps the lateral and axial forces in mind. The orientation may not affect the vertical axial forces sustained by the structure, but the lateral forces have to be counteracted and a greater section modulus of a column is expected in the direction of the lateral Bending moment. So, yes larger face for larger moments.

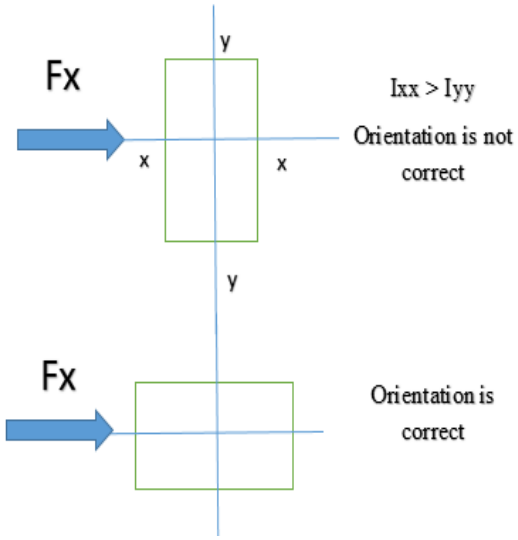

Fig -1: Column Orientation

1.2 Type of Column Cross-section

It is classified into the six types, which is given below:

1) Circular Shape Column
2) Square Shape Column
3) Rectangular Shape Column
4) Hexagonal Shape Column
5) Spherical Shape Column
6) T- Shape Column.

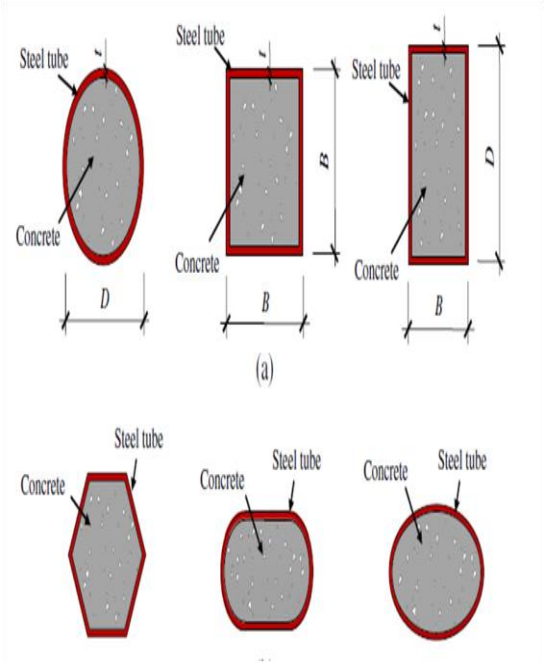

Fig -2: Type of Column Cross-section

2. LITERATURE REVIEW

In this literature survey chapter, we have studied some research papers related to the different cross-sections of the column in the RC building. The following conclusion is given below of the paper:

[1] Wen Hu Tsao(1992): This research carried out not only experimental tests but also theoretical studies as well for complete load-deformation of biaxially loaded slender reinforced concrete columns with square and L-shaped cross-sections. The finite difference method proposed herein for both standards and L- shaped columns is a very simple model to study the effect of plastic hinge and ductility behavior in columns. Six square slender columns and eight L-shaped slender columns were tested to compare their experimental load-deformation results with the analytical results derived from the theoretical studies.

[2]Shah & P. Patel(2005): A ground + 6 Storey RC space frame model with two 3m x 3m panels in each plan direction and two 3m x 4.5m panels in each principal plan direction are selected. A comparison is made between the model having the rectangular cross-section of columns and the equivalent square cross-section. The same models were also analyzed considering brick wall elements in the periphery of the frame. It can be concluded that the square shape of the column performs better under seismic forces than rectangular-shaped columns for RC framed structures without brick infill walls. This improvement in seismic response is less pronounced in symmetric plan buildings like those having square-shaped grids in the plan. The presence of brick infill walls alters the seismic response of RC space frames considerably.

[3]Ami A. Shah, B. A. Shah (2014): This research is carried out to compare the seismic performance of RC frame structures of G+15 storey which consisting of the rectangular-shaped column as against equivalent square-shaped column. The building is having 4.5m x 4.5m panels in both directions forming an overall plan dimension of 31.5m x 13.5m. All the beams are considered as 300 mm x 600 mm in size and columns of 3 m height on each floor. In the above model, all the rectangular-shaped columns are oriented with a longer side in the global Y direction and a shorter side parallel to the global X direction. The M25 grade of concrete and Fe 415 grade of steel is considered for design. Pushover analysis is carried out; using commercially available software ETABS and the behavior of RC frames is studied. Also, the comparison of normal RC frame and immediate occupancy level RC frame for both shaped columns is carried out. The numbers of plastic hinges developed in rectangular column RC frame are more as compared to square column RC frame as in rectangular column one direction is weaker direction There is a little difference in structural cost of rectangular column RC frame and Square column RC frame at immediate occupancy level. The behavior of a square column is better than a rectangular column when the comparison is in terms of storey drift, base shear, and roof displacement.

[4]Sumayya M Kareem, Linda Ann Mathew(2015): In this paper, the results of seismic analysis of reinforced concrete frames designed according to the IS 1893:2002 has been presented. The behavior of G+8 storied R.C. frame buildings (H shape in plan, with and square-shaped columns) subjected to an earthquake is also discussed using staad- pro software. And the conclusions are the lateral displacement storey drift for the model with square-shaped columns is higher than those developed in the model with T-shaped columns. It is found that a model with T-shaped columns can resist more base shear than a model with a square-shaped column. After analyzing the model's various results are obtained. And these results are evaluated by preparing various graphs the results of the analysis for model T shaped column and the model with square-shaped column are represented in the form of lateral displacement and storey drift

[5] SHRUTI. AGRAWAL (2016): The research paper "Response of Different Shapes of Columns on RC Buildings with and without Shearwalls As per analysis" it is concluded that displacement in R.C. frame building with Specially shaped columns and the shear wall is less than the R.C. frame building with Specially shaped columns only.

- As per analysis, it is concluded that drift in R.C. frame building with Specially shaped columns and the shear wall is less than the R.C. frame building with Specially shaped columns only.
- R.C. frame building with Specially shaped columns and the shear wall is economical than the R.C. frame building with Specially shaped columns only.

[6] Shruti S. Ladvikar(2016): The research paper is written by this author "Effect of Different Column Shapes on Seismic Performance of Buildings" and the conclusion is given below:

- It is concluded that the seismic performance of building with specially shaped columns is better as compared to the building with rectangular columns.
- It is concluded that displacement in R.C. frame building with specially shaped columns is less than the R.C. frame building with rectangular columns.
- It is concluded that drift in R.C. frame building with specially shaped columns is less than the R.C. frame building with rectangular columns.
- R.C. frame building with specially shaped columns is economical than the R.C. frame building with rectangular columns.

[7] Arturo E Schultz (2017): In this study, results from recent tests conducted at the MAST lab on full-scale RC columns were combined with available datasets of RC columns to assess the effect of cross-sectional size of columns on their seismic performance. A study on the parameters representing the seismic performance of RC columns confirms that effective stiffness, drift ratio capacity, displacement ductility, and bar buckling of RC columns can be significantly affected by axial load and aspect ratios. In the case of drift ratio capacity, the effect of axial load for stocky columns with an aspect ratio smaller than 2 is minor.

[8] Dhrupal S. Patel (2020) In the present study analysis of G+9, 3m & 4m height Different framed structure is carried out with the various shape of the column with equivalent cross-section area. Based on analysis and results for all models considered, the following conclusion is drawn.

- Base Shear overall less in 4m Height of each story building compares to 3m each story height of building for all type of different shaped column for both X-Direction & Z-Direction.
- 4m Heighted column Base Shear Remain Same exclude "I-Shape" column, there is a huge difference in base shear compare to another column. A & C type of "I-Shape" Column has minimum base shear but B type of "I-Shape" has maximum base shear for both X-Direction & Z-Direction.
- 3m height different shaped column nearly same base shear compare to 4m height column.
- 3m height column Story Drift is more-Compare to 4m height column Story Drift overall except "I-Shape" Column.
- "I-Shape" B type Column only, 4m Height column story drift is more than 3m height column story drift. In both X-Direction & Z-Direction.
- Circular & Square Column Shape column contains same drift and Base Shear in both Direction X-Direction & Z-Direction.
- Obstruction will be created by the offset of columns in the case of specially shaped column structures.

3. CONCLUSIONS

After studied the above research paper, we found some conclusion is given below:

1. The value of the fundamental period due to the earthquake effect is dependent upon the cross-section and mass of the column. If the dimension of the column along the X-direction and Y-direction will be the same then the value of the fundamental period will be the same in along direction.
2. When the mass of the column is heavy along any direction then the effect of the fundamental period will be less along that direction.
3. The orientation of the column plays a very important role to keep the safety of the structure from collapse due to earthquakes.
4. From the above research we found conclusion between the rectangular and square shape RC column that square RC column is more stable as compared to the RC rectangular column because the mass of the column along X- and Y –direction is same so seismic effect will be equal in the X and Y-direction.

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