

An Equivalent Static Analysis Of Space Frame Structure With Different Cross Section Of Column

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Abstract - In this thesis study, the behavior of G+9, G+14 storied R.C frame buildings subjected to earthquake, located in seismic zone III with a different cross section of column of equivalent square, equivalent circular, and specially shaped column (L, +, Z) is discussed briefly using ETAB software. Five different buildings for commercial purpose, regular in plan and irregular in plan (C shape, + shape, rectangular core shape and square core shape) is analyzed using equivalent static analysis. The maximum displacement, storey drift and stiffness are analysed in regular and irregular building with square columns, circular column and with specially shaped columns. The maximum displacement is decreased for G+9 stories ranges is from 20% to 30%. The storey drift is decreased by 20% - 40% in Z shaped column while comparing with the equivalent square, circle column in G+9 stories. The stiffness is increased by 60% in Z shaped column while comparing with the equivalent square, circle column in G+9 stories. The specially shaped Z column achieves these categories.

Key Words: seismic resistance, column, specially shaped column, equivalent static analysis, RC multistory building.

1. INTRODUCTION

Columns are the structural components which transmit all vertical loads from the floors to the foundations. The means of transmission of vertical load is related to the particular structural system used for the framework. In an RC building columns are structural elements which are predominantly subjected to axial compressive forces, moments, and transfers total load from the super structure to substructure. Various shapes of the columns are used. Some common shapes are square, rectangular, circular columns and some special shapes of column are L-shaped, T-shaped and cross (+) shaped columns as shown in Figure 1.1 which are not commonly used but gives more indoor space than commonly used shapes of column. Specially shaped columns avoid prominent corners in a room which increases usable floor area. In this report, the results of seismic analysis of reinforced concrete frames designed according to the IS1893:2002 has been presented. The behavior G+5, G+10, G+15 storied R.C frame buildings subjected to earthquake with different cross section of column in regular and irregular plan is discussed using ETAB 2015 software.

1.1 Objective

- To compare the seismic performance of the regular and irregular space frame with Equivalent Square, circular, L, + and Z shaped column.
- To find out storey drift, max displacement, stiffness.
- To conduct seismic analysis of the regular and irregular RC structure located in seismic zone III, which is modeling in ETAB 2015.

1.2 Need For Study

As we know the column is a very important factor in building. Hence the main aim of this study is,

- To resist the lateral load by the specially shaped column.
- To decrease displacement by the specially shaped column.
- To decrease story drift by the specially shaped column
- To increase stiffness by specially shaped column.

2. METHODOLOGY

2.1 Building Plan And Dimension Details

Space frame used in this study are 5, 10, 15 storied with square, circular, L, + and Z shaped column are provided in building. Table 4.1 shows the specification of G+4 storied RCC space frame located in seismic zone III. The irregular structure of plan C, plus (+), Square with Core, Rectangle with Core shape are considered.

Table 2.1 Geometry and Material Details of the Building Models

Type of structure	Multi story RC structure
Grade of concrete Column	M30
Grade of concrete Beam	M20
Grade of reinforcement	Fe415
Floor height	3 m
Slab thickness	125 mm
Beam size	230 mm x 600 mm
Density of concrete	25 kN/m ³
Slab load	3 kN/m ²
Plan	Regular and irregular

Table 2.2 Adopted column size provided for regular and irregular structure (C shape)

Columns	Dimensions
Square	375mm x 375mm
circular	418 mm
L shape	230mm x 451mm
+ shape	230 mm x 354 mm
Z shape	560 mm x 281mm x 200mm

2.2 Load Formulation

Dead loads are considered as per IS 875 (Part I) – 1987 & Live load IS 875 (Part II) -1987. In addition to the above mentioned loads, seismic loads are also be assigned.

- i. Live Load Intensity specified (Public building) = 3kN/m²

2.3 Models

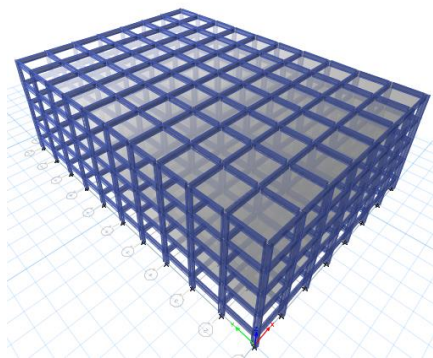


Fig 2.1 Isometric view of regular structure

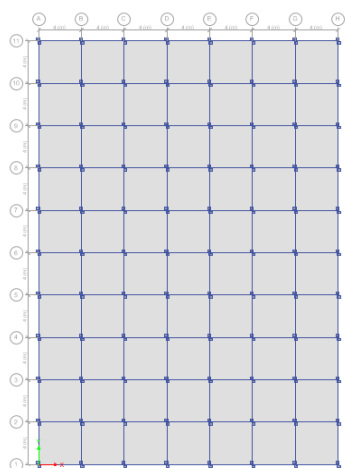


Fig 2.2 Plan of regular structure with Z column

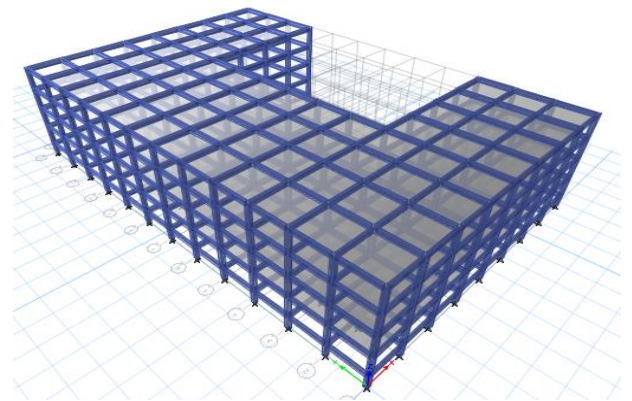


Fig 2.3 Isometric view of C structure

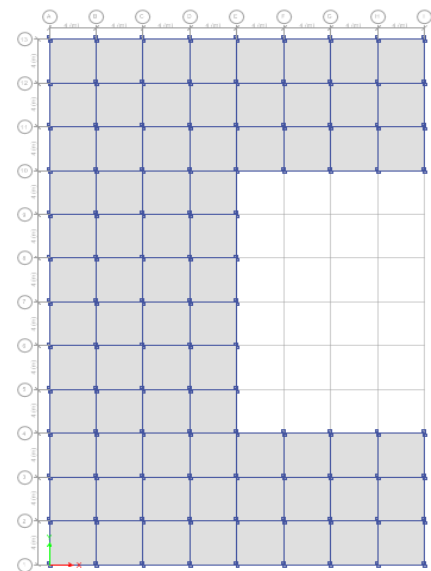


Fig 2.4 Plan of C structure with Z column

3.RESULT

3.1 Displacement

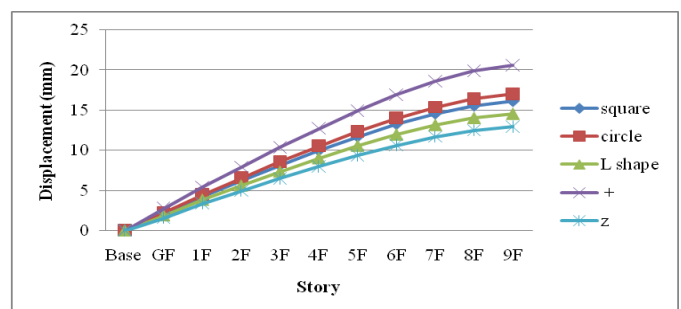


Fig 3.1 Displacement of 10 story regular structure in y direction

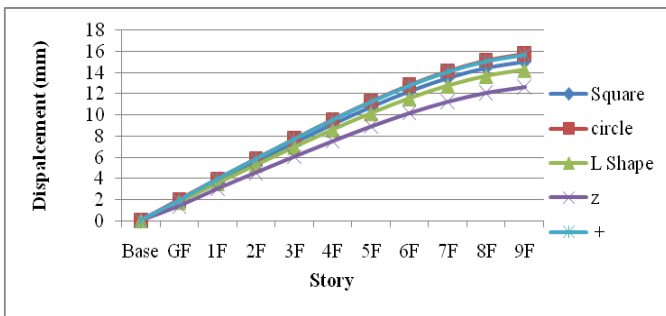


Fig 3.2 Displacement of 10 story irregular C shaped structure in y direction

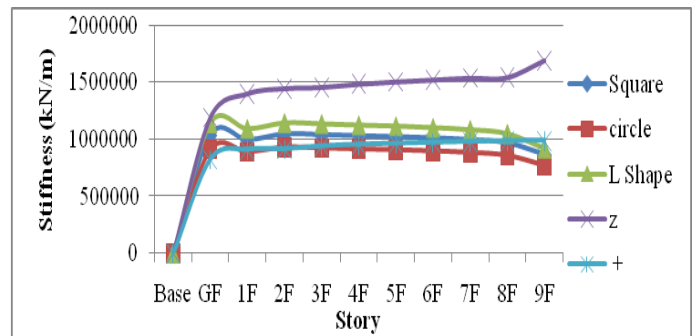


Fig 3.6 Stiffness of 10 story irregular C shaped structure in y direction

3.2 Story Drift

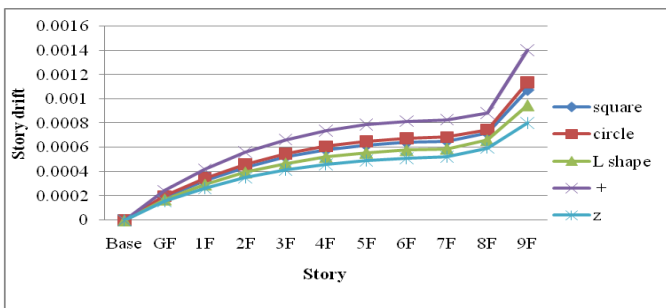


Fig 3.3 Story Drift of 10 story regular structure in y direction

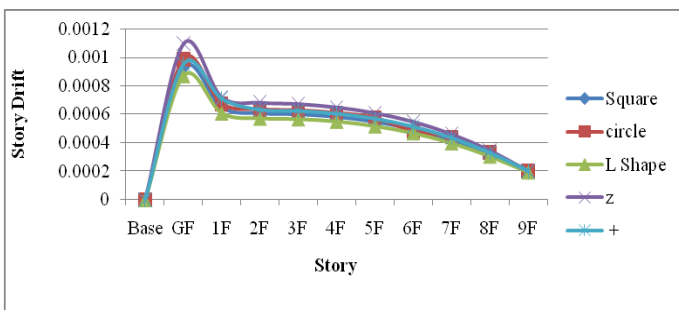


Fig 3.4 Story Drift of 10 story irregular C shaped structure in y direction

3.3 Stiffness

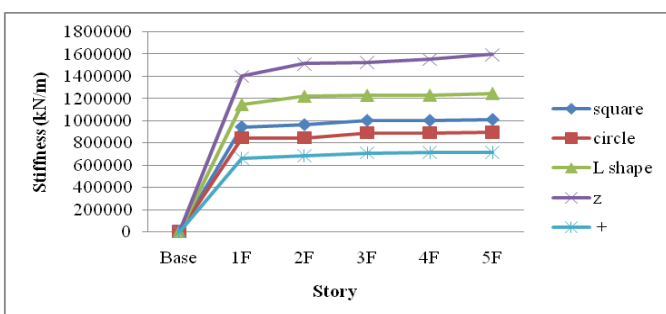


Fig 3.5 Stiffness of 10 story regular structure in y direction

4.DISCUSSION

1. The displacement for G+9 storey regular structure , Z column has less displacement while comparing to the square and circle column and other specially shaped column i.e. L and + shaped column. Similarly for irregular structures, Z column has less displacement while comparing to the square and circle column and other specially shaped column ie. L and + shaped column.
2. The displacement of the Z column in G+9, story building of a regular structure, i.e. 12.951 mm and 18.882 mm has decreased to 31% and 25% while comparing to the circular column i.e. 17.054 mm and 23.612 mm.
3. The displacement of the Z column in G+9, G+14 story building of a irregular C shaped structure, i.e. 12.642 mm and 20.847 mm has decreased to 20% and 15% while comparing to the square column i.e. 15.022 mm and 24.107 mm.
4. The story drift for G+4, G+9, G+14 storey regular structure , Z column has less story drift while comparing to the square and circle column and other specially shaped column ie. L and + shaped column. Similarly for irregular structures, Z column has less story drift while comparing to the square and circle column and other specially shaped column i.e. L and + shaped column.
5. The story drift of the Z column in G+9 story building of a regular structure, i.e. 0.000805 and 0.000718 has decreased to 33% and 34% while comparing to the square column i.e. 0.001073 and 0.000963.
6. The stiffness for G+4, G+9, G+14 storey regular structure , Z column has more stiffness while comparing to the square and circle column and other specially shaped column i.e. L and + shaped column. Similarly for irregular structures, Z column has more stiffness while comparing to the square and circle column and other specially shaped column i.e. L and + shaped column.
7. The stiffness of the Z column in G+9 story building of a regular structure, i.e. 1367530 kN/m has increased to 67% while comparing to the square column i.e. 924213.01 kN/m.
8. The stiffness of the Z column in G+9 story building of a irregular C shaped structure, i.e. 1194384 kN/m has

increased to 86% while comparing to the square column i.e. 1037818 kN/m.

5. CONCLUSION

The plan configuration of structure has significant impact on the seismic analysis of a structure in terms of displacement, storey drift and storey shear

1. The displacement for G+9 storey regular structure , Z column has less displacement while comparing to the square and circle column and other specially shaped column i.e. L and + shaped column. Similarly for irregular structures, Z column has less displacement.
2. The maximum displacement is decreased by 20% - 30% in specially shaped column while comparing with the equivalent square, circle column in G+9 stories.
3. The story drift for G+9 storey regular structure , Z column has less story drift while comparing to the square and circle column and other specially shaped column i.e. L and + shaped column. Similarly for irregular structures, Z column has less story drift.
4. The storey drift is decreased by 20% - 40% in Z shaped column while comparing with the equivalent square, circle column in G+9 stories.
5. The stiffness for G+9 storey regular structure, Z column has more stiffness while comparing to the square and circle column and other specially shaped column i.e. L and + shaped column. Similarly for irregular structures, Z column has more stiffness.
6. The stiffness is increased by 60% in Z shaped column while comparing with the equivalent square, circle column in G+9 stories.
7. Displacement and story drift of a frame reduces and also frame shows better performance under earthquakes due to provision of specially shaped columns (Z shaped column).
8. When yielding occurs in a structure during extreme earthquakes formation of a desired earthquake resistant mechanism does not in itself guarantee that repair cost would be tolerable. By controlling story drift we can reduce the expected damage and economic risk. It has been proved in many research works that adequate strength does not have a decisive influence on expected structural drift. Therefore, maximum displacements, rather than maximum stresses, represent the proper design criteria. On the basis of safety criteria, the lateral displacement, storey drift for an irregular space framed structure should be low as possible. The specially shaped Z column achieves these categories.

6. FUTURE SCOPE

1. Analysis the seismic performance of the structure with specially shaped Z column and compare the equivalent static analysis with time history analysis.

2. Analysis the seismic performance of a structure with specially shaped Z columns using response spectrum analysis.

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