Comparative Analysis of (G+11) R.C.C. Frame Structure with Flat slab & Conventional slab having different cross-sectional shape of columns

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Abstract - *Earthquake resistant design of structures deals with such a design which reduces or minimizes the effect of earthquake in a building. A ground motion is sometime strong enough to collapse a building, mainly in seismic zone 5 of India which is earthquake prone zone. Earthquake generate a wave of forces in the ground which may become dangerous for a building which is unable to resist the earthquake wave forces and result is failure of the structure. So, now a days each and every high-rise structure are designed to resist earthquake forces and successfully work under these condition. This paper deals with a brief comparative analyzation of (G+11) R.C.C. frame structure with different slab & cross-sectional shape of column in seismic zone 5 .The software used for this seismic analysis is ETABS 2016. All the loadings such as dead load, live load, wall load is given as per Indian codes for dead load IS 875 (PART1), for live load IS 875 (PART 2). We will check the model for various load combination recommended by Indian code IS 875 (PART 5). The parameters on which we are going to perform our analysis are Max. & Min Storey Displacement, Storey Drift, Storey Shear, Storey Stiffness.*

Key Words: **Max. & Min Storey displacement, Storey Drift, Storey Stiffness, Rectangular column, Circular column, Square column, Conventional slab, Flat slab, R.C.C. frame building.**

1. INTRODUCTION

A R.C.C. Frame structure is a combination of various parts such as Columns, Beams & Slabs, each one of them performing their own role in supporting the building. A Column is a vertical member and beam is a horizontal member of a building and slab acts as a platform. Here in this paper we are taking two types of (G+11) R.C.C. Frame building, one is having conventional slab and other one is having flat slab. In conventional slab R.C.C. Frame structure the load is transferred such as slab transfers its load to the beam and beam transfer it to the column and through column it transferred to the ground by footing. In case of flat slab R.C.C. Frame structure the slab directly transfer its load to the column because in flat slab there is no beam, that means slab is directly rested on columns. The depth of slab in both the R.C.C. Frame structure is provided in such a way that the volume of concrete in flat slab is equal to the volume of concrete in conventional slab and beam. We are using three shapes of column Circular, Rectangular & Square the size of column is selected in such a way that the volume of concrete will be equal in all of them. The types of R.C.C. Structure we are using for this comparative seismic analysis are as follows-

a) Conventional Slab with Circular column.
b) Conventional slab with Rectangular column.
c) Conventional slab with Square column.
d) Flat slab with Circular column.
e) Flat slab with Rectangular column.
f) Flat slab with Square column.

1.1 Objective

- To compare the seismic performance of all the (G+11) R.C.C. Frame structure and find out which combination of slab and column gives the better result.
- To find out Displacement, Storey Drift, Storey Shear and Storey Stiffness in (G+11) R.C.C. Frame structure.
- To conduct seismic analysis of Conventional slab model and flat slab model with different shapes of columns in seismic zone 5, which has been modelled in ETABS 2016 software.

1.2 Need for Study

As we know the slab and column are the very important part of the R.C.C. Frame structure. The main aim of this study is

- To decrease the Storey displacement of the building by using different slab and different shapes of column.
- To decrease the Storey drift of the building by using different slab and different shapes of column.
- To increase the Storey Shear of the building by using different slab and different shapes of column.

- To increase the Storey Stiffness of the building by using different slab and different shapes of column.

2. METHODOLOGY

All the modelling and analysis is carried out in ETABS 2016 Software. The data for which modelling is to be done are as follows-

Table 2.1 Geometry, Material and other Details of the Building Models

Building Dimension	20m x 20m
Conventional slab	150mm, M25 Grade concrete
Flat slab	200mm, M25 Grade concrete
Circular column	480mm, M30 Grade concrete
Rectangular column	600mm x 300mm, M30 Grade concrete
Square column	425mm x 425mm, M30 Grade concrete
Rebar	Fe415 Grade of reinforcement
Shear Wall	300mm, M30 Grade concrete
Floor height	3m
Type of soil	Medium soil
Importance Factor	1.0
Response Reduction Factor	5

Table 2.2 Loading Data

Below Terrace :-	
Live load on slab	2 KN/M²
Live load on staircase	3 KN/M²
Superdead load on slab	1.2 KN/M²
Superdead load on staircase	1.5 KN/M²
Wall loading on Exterior walls	14 KN/M
Wall loading on Interior walls	7 KN/M
On Terrace :-	
Live load on slab	1.5 KN/M²
Live load on staircase	3 KN/M²
Superdead load on slab	1.2 KN/M²
Superdead load on staircase	2 KN/M²
Parapet wall loading	2.5 KN/M
Brickcoba	4 KN/M²

Table 2.3 Load Combination

1- 0.9DL + 1.43EX
2- 0.9DL – 1.43EX
3- 0.9DL + 1.43EY
4- 0.9DL – 1.43EY
5- 1.2(DL+LL+EX)
6- 1.2(DL+LL-EX)
7- 1.2(DL+LL+EY)
8- 1.2(DL+LL-EY)
9- 1.5(DL + EX)
10- 1.5(DL – EX)
11- 1.5(DL + EY)
12- 1.5(DL – EY)

3. MODELS

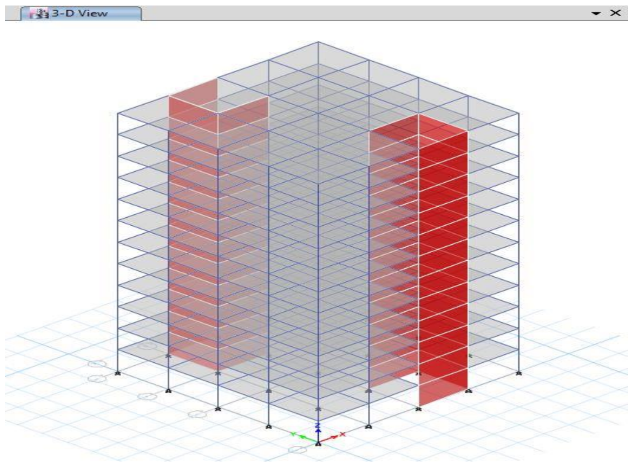

Diagram 3.1 (3D View of Building)

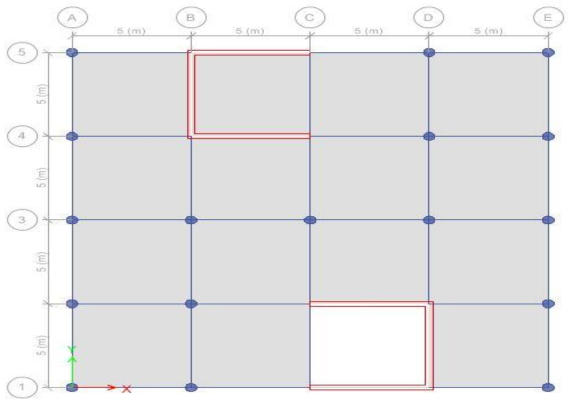

Diagram 3.2 (Plan with Circular Column)

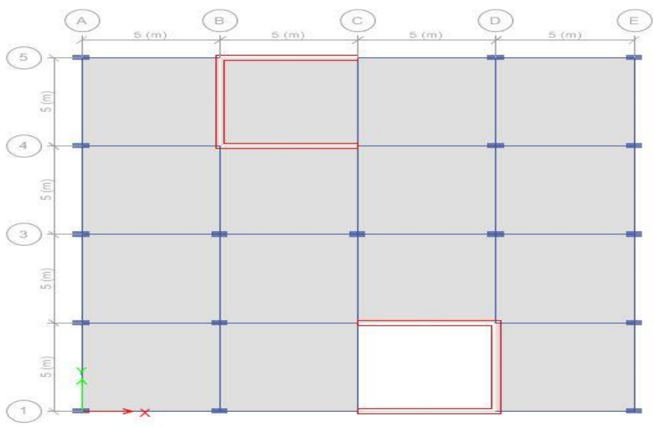

Diagram 3.3 (Plan with Rectangular Column)

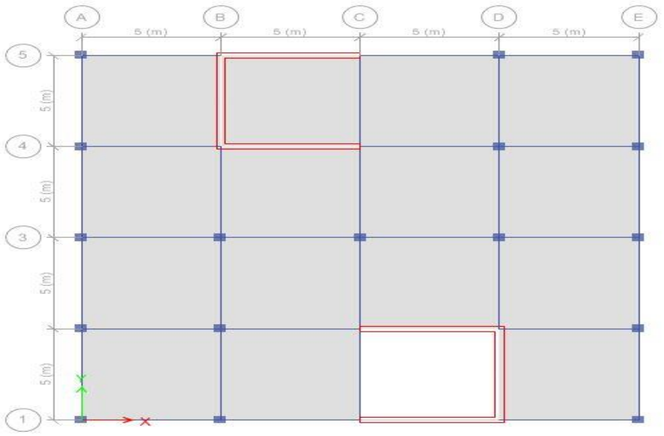

Diagram 3.3 (Plan with Square Column)

4. RESULT

4.1 Displacement

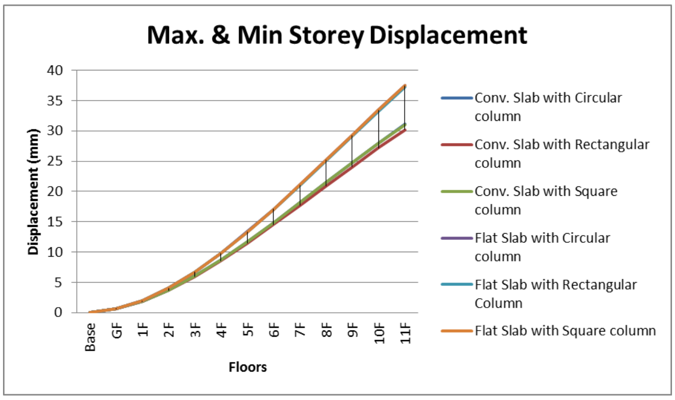

Fig 4.1 Displacement of (G+11) R.C.C. Frame Structure in X- Direction

4.2 Storey Drift

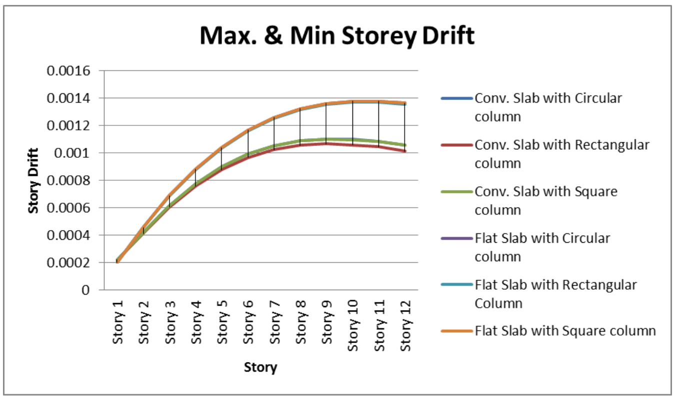

Fig 4.2 Storey drift of (G+11) R.C.C. Frame Structure in X- Direction

4.3 Storey Shear

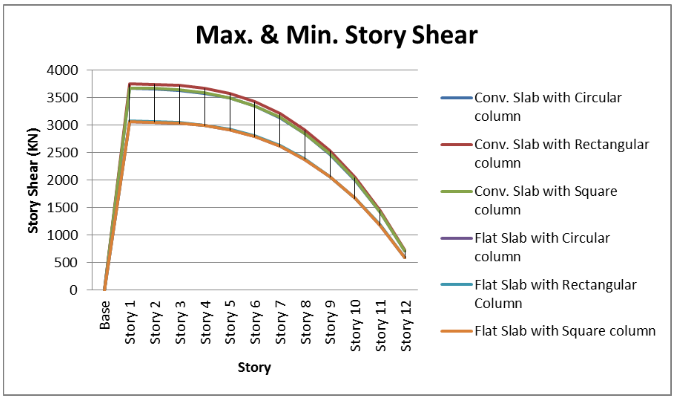

Fig 4.3 Storey shear of (G+11) R.C.C. Frame Structure in X- Direction

4.4 Storey Stiffness

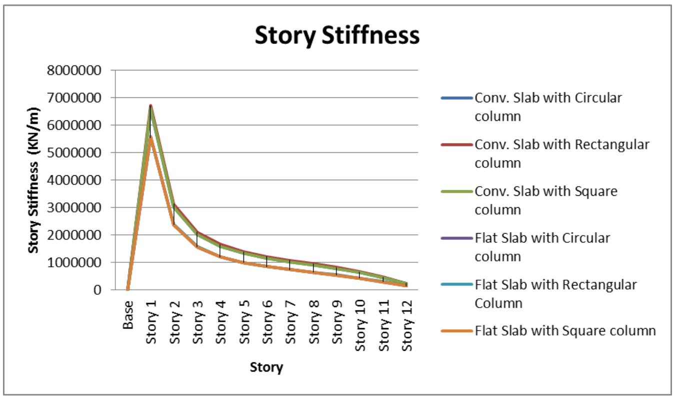

Fig 4.4 Storey Stiffness of (G+11) R.C.C. Frame Structure in X- Direction

5. DISCUSSION

1. Conventional slab with Rectangular, Circular and Square column has less displacement for (G+11) R.C.C. Frame structure while comparing to the structure having Flat slab with Rectangular, Circular and Square.
2. The displacement for conventional slab with Rectangle column i.e. 30.209 mm and 28.628 mm has decreased to 23% and 11% while comparing to the Flat slab with Rectangular column i.e. 37.289 mm and 31.802 mm.
3. Conventional slab with Rectangular, Circular and Square column has less Story Drift for (G+11) R.C.C. Frame structure while comparing to the structure having Flat slab with Rectangular, Circular and Square.
4. The storey drift for (G+11) R.C.C. Frame structure is minimum for Conventional slab with Rectangular column i.e. 0.001067 and 0.001001 has decreased

to 28% and 14% while comparing to the Flat slab with Rectangular column i.e. 0.001371 and 0.001144.

5. Conventional slab with Rectangular, Circular and Square column has more Storey shear for (G+11) R.C.C. Frame structure while comparing to the structure having Flat slab with Rectangular, Circular and Square.
6. The storey shear for (G+11) R.C.C. Frame structure is maximum for Conventional slab with Rectangular column i.e. 3751 KN and 3888 KN has increased by 22% and 9% while comparing to the Flat slab with Rectangular column i.e. 3072 KN and 3546 KN.
7. Conventional slab with Rectangular, Circular and Square column has more Storey stiffness for (G+11) R.C.C. Frame structure while comparing to the structure having Flat slab with Rectangular, Circular and Square.
8. The story stiffness for (G+11) R.C.C. Frame structure is maximum for Conventional slab with Rectangular column i.e. 6719695 KN/M and 5464899 KN/M has increased to 21% and 6% while comparing to the Flat slab with Rectangular column i.e. 5550333 KN/M and 5154211 KN/M.

6. CONCLUSIONS

The slab and columns of structure has significant impact on the seismic analysis of a structure in terms of displacement, storey drift, storey shear and storey stiffness

1. The displacement for (G+11) R.C.C. Frame structure is minimum for Conventional slab with Rectangular column while comparing to the Conventional slab with Circular and Square column and all the flat slab structures.
2. The maximum displacement for Conventional slab with Rectangular Column (G+11) R.C.C Frame structure has decreased by 23% and 11% while comparing the Flat slab with Rectangular column.
3. The storey drift for (G+11) R.C.C. Frame structure is minimum for Conventional slab with Rectangular column while comparing to the Conventional slab with Circular and Square column and all the flat slab models.
4. The maximum storey drift for (G+11) R.C.C. Frame structure is minimum for Conventional slab with Rectangular column has decreased to 28% and 14% while comparing to the Flat slab with Rectangular column.
5. The storey shear for (G+11) R.C.C. Frame structure is maximum for Conventional slab with Rectangular column while comparing to the Conventional slab with Circular and Square column and all the flat slab models.
6. The storey shear for (G+11) R.C.C. Frame structure is maximum for Conventional slab with Rectangular column has increased by 22% and 9% while comparing to the Flat slab with Rectangular column.
7. The storey stiffness for (G+11) R.C.C. Frame structure is maximum for Conventional slab with Rectangular column while comparing to the Conventional slab with Circular and Square column and all the flat slab models.
8. The story stiffness for (G+11) R.C.C. Frame structure is maximum for Conventional slab with Rectangular column has increased to 21% and 6% while comparing to the Flat slab with Rectangular column.
9. With the use of Conventional slab in R.C.C. frame building shows better performance under earthquake because it reduces the displacement and storey drift and increases the storey shear and storey stiffness.

7. FUTURE SCOPE

1. Analyze the Comparative seismic analysis of Conventional slab and Flat slab with various shapes of column is different seismic zones and compare the static analysis with time history analysis.
2. Analyze the Comparative seismic analysis of Conventional slab and Flat slab with various shapes of column is different seismic zones with response spectrum analysis.

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