ANALYSIS AND DESIGN OF MULTI-STOREY BUILDING USING WITH L-SHAPED COLUMN

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ABSTRACT

The behavior of irregular shaped reinforced concrete columns has been a constant concern to design a safe and economic structure buildings. In this project, we examine the performance of L-shaped columns by replacing normal columns. The L-shaped columns are used as corner columns in building. In this project we have analyzed the 3-storey commercial building with L shaped columns at corners. The analysis is done by using the software ETABS. The multi-storey building is designed using software AUTOCAD. Axial load and Moment capacity of normal column and L-shaped reinforced concrete columns have been done in this work and compared. Comparison between analysis with Normal column and analysis with L shaped column is done. The results shows that such new type L-shaped columns exhibited high axial strength. L shaped columns avoid prominent corners in the building which increases usable floor area. The L shaped columns in R.C. building gives better seismic performance than normal columns.

Keyword : - *L-shaped columns , ETABS, analysis.*

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1. INTRODUCTION

A structure is an assemblage of individual elements like pinned elements (truss elements), beam element, column, shear wall slab cable or arch. Structural engineering is concerned with the planning, designing and the construction of structures. Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the components that make up the structural system. The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

Special-shaped columns have been widely applied as the load-carrying portion at corner of rooms in multi-story buildings in recent years. The special-shaped columns have satisfied the requirement of the architects and save more space to earn economic benefits. As the rein-forced concrete (RC) structures are the most widely used in buildings, the special-shaped RC columns are firstly applied in structures. Special-shaped columns can be embedded into walls and thus help avoid column protrusion, making them beneficial from an architectural design viewpoint. L-, T-, cross- and Z-shaped reinforced concrete columns have frequently been employed in residential structures. However, such columns fail to meet the requirements of high-rise buildings with respect to heavy loads such as might occur during strong earth quakes. These problems have restricted the development of special-shaped columns, and addressing them requires further research.

1.1 RELEVANCE

The concrete special-shaped column structure system is a structural system composed of special-shaped columns instead of rectangular cross-section columns as vertical support members. When the rectangular columns are arranged, they often make the room appear edges and corners, which affects the appearance, and at the same time reduces the use area of the room. The special-shaped column structure system avoids these problems and brings flexibility and convenience to architectural design and actual use. These columns are easy to construct and cast, and the level of support they provide often makes them an excellent choice for buildings and other heavy structures. Construction workers can use these columns in corners of boundary walls. These are used for same purposes as the square and rectangle column. The L-shaped column model has better seismic behavior when loaded along various loading angles. Earthquake resistance of building with L shaped columns is better as compared to the building with normal columns. Therefore, it is suitable for the construction of buildings in high seismic areas.

2. LITERATURE REVIEW

A.Sivaji , N.Madhavan Reddy , T. Yeswanth Kumar, (2019) in the study on “Analysis & design of multi-story building using STAAD & E-TABS”, International Journal of Management, Technology And Engineering, shows the analysis of multi-storey building using Etabs and STAAD PRO. Building is designed manually as per IS 456. Building is designed as two-dimensional multiple frames and analyzed for the maximum and minimum bending moments and shear forces. Software’s used are STAAD PRO (V8i), STAAD foundation 5 (V8i), ETabs, AUTO CAD. Comparison between analysis using ETabs and analysis using STAAD PRO is done.

Bharat khanal and Hemchandra Chaulagain, (2020), Study on “Seismic elastic performance of L-shaped building frames through plan irregularities” , compared the seismic response demands of the different L-shaped buildings.
Irregular structures are damaged under strong ground motion. One regular and six L- shaped RC building frames were modeled for numerical analysis. The present study is focused to analyze the seismic performance of both regular and plan irregular RC buildings. To carry out the study of the seismic elastic performance of L-shaped building through plan irregularities, both symmetric and L-shaped plan asymmetric buildings have been modelled in finite element software ETabs 2015. Lateral-storey Displacement, inter-storey drift ratio, shear force, overturning moment, torsion moment along with building height and torsional irregularity ratio.

Huirong Chen, Lai Wang, Haitao Chen, Wenbin Cui (2021), studied the the seismic behavior of prefabricated L-shaped concrete-filled steel tube with rectangular multi-cell columns under different lateral loading directions In order to improve the seismic behaviour of traditional RC special-shaped columns, a prefabricated special-shaped concrete-filled steel tube with rectangular multi-cell (S-CFST-R) column was proposed for residential systems. The seismic test of prefabricated L-shaped concrete-filled steel tube with rectangular multi-cell (L-CFST-R) columns was conducted in this study. In this study, a prefabricated S- CFST-R column for residential system is proposed. The seismic behaviour of three full-scale specimens of L-CFST-R columns under different lateral loads was examined by a quasi-static test method under low cycle load, and the FE simulation method was used to make supplementary analysis.

3. METHODOLOGY

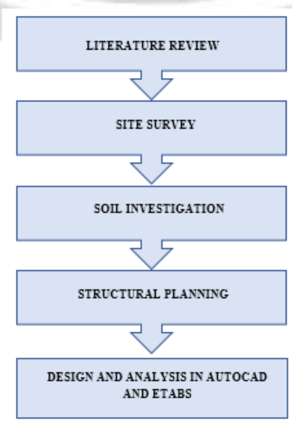

Fig.1: Methodology

The site for our project is located near Ettumanoor-Kottayam Road. The area of the plot is about 938 sq.mts. Site plan and bore hole details of the site are as follows;

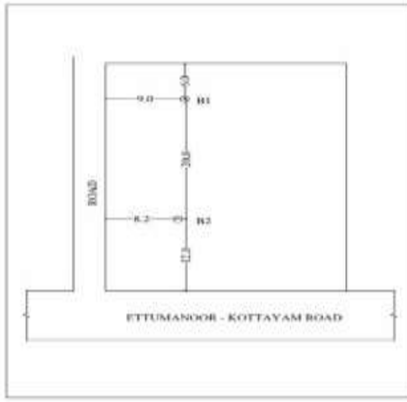

Fig.2: Site Plan

AXIS SOIL INVESTIGATION
COLLECTORATE.P.O. KOTTAYAM

Project : Commercial Building for Mr. Boby Sebastian
Site : Adichira
Bore Hole No: **BH/1**
Type of Boring: Rotary drilling

Date of Commence : 06-10-2021
Date of Completion : 06-10-2021
Ground Water Level : 1.50m

BORE LOG

Depth (m) below GL	Profile	Visual Description of Soil	Thickness of layers	Standard Penetration Test Data Depth (m)	15	30	45	N	RD / Consistency
1.0, 2.0		Brownish grey fine to coarse sand	2.00	1.00	2	2	2	**4**	Loose
3.0		Reddish brown and light grey clayey silty fine to medium sand with gravel	1.00	2.00	23	50/10cm		**>100**	Very Dense
4.0, 5.0, 6.0		Brownish grey and light grey clayey silty fine to medium sand	3.40	3.00	5	7	13	**20**	Medium Dense
				4.00	8	11	10	**21**	
				6.40	Rebound			**RB**	
7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0									
		Borehole terminated at 6.40m							

Fig.3: Bore hole details

4. STRUCTURAL PLANNING

In this project we have used the software AutoCAD for redrawing the plan with L-shaped columns. The normal columns on the corners are replaced by L-shaped columns in the structural planning.

4.1. AUTOCAD

The total built up area of the building is about 1391.00 Sq.mts. The ground floor has a built-up area of 439.90 Sq.mts. and consists of a main stair, a fire stai rand a disabled ramp. The first floor has a build -up area of 532.35 Sq.mts and consists of a main stair and a fire stair.The second flo or has a build-up area of 366.85 Sq.mts. The second floor consists of an open terrace, a main stair, and a fire stair.The plans of these floors are shown below;

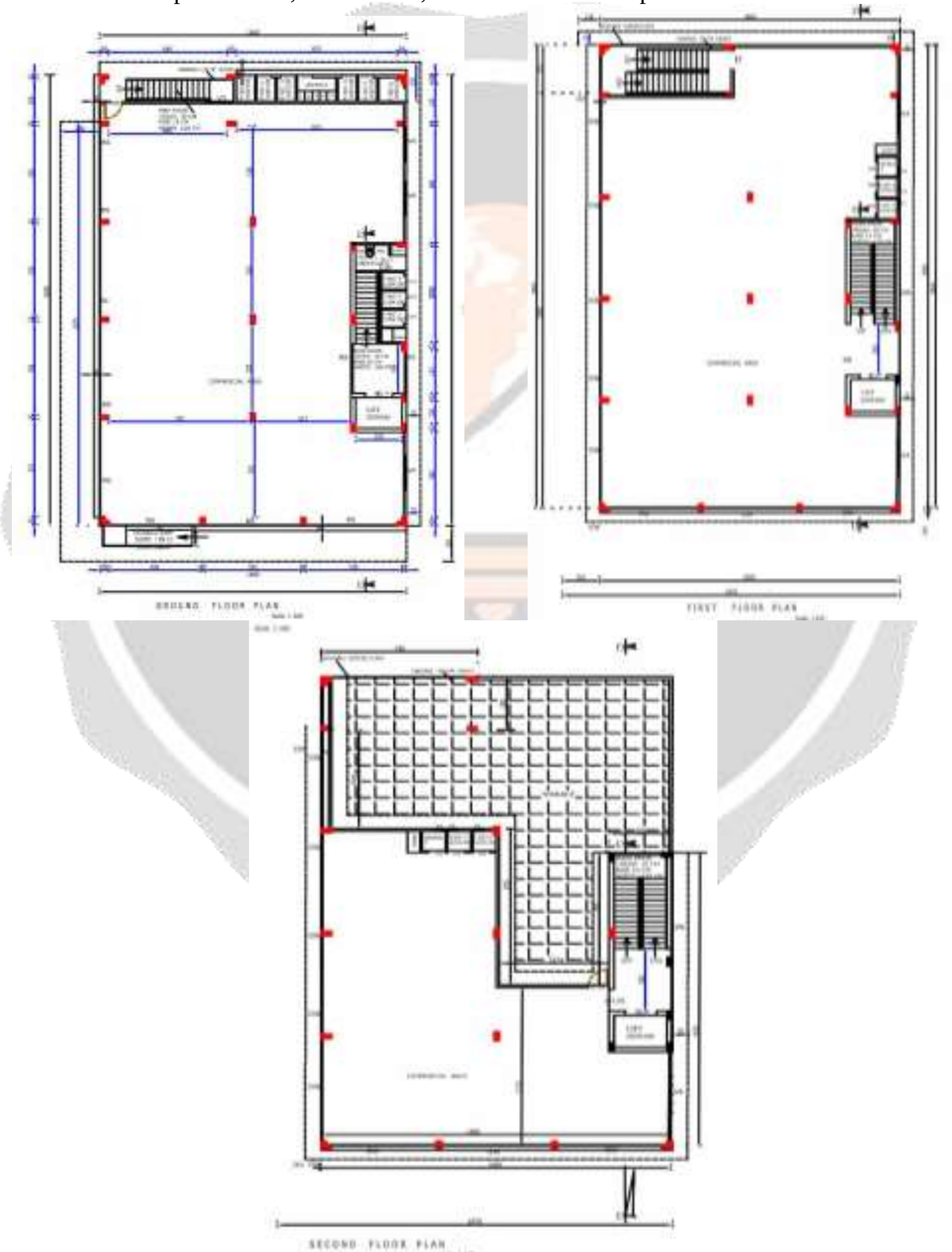

Fig.4: Floor plans of (a) Ground floor (b) First floor (c) Second floor

5. ANALYSIS AND DESIGN

Analysis and design is done using ETABS. ETABS has a wide selection of templates for starting a new model quickly. At this model template stage, you have the ability to define grid and grid spacing, the number of stories, the default structural system sections, default slab and drop panel sections, and uniform loads (specifically dead and live loads). Modelling done using ETABS is as follows;

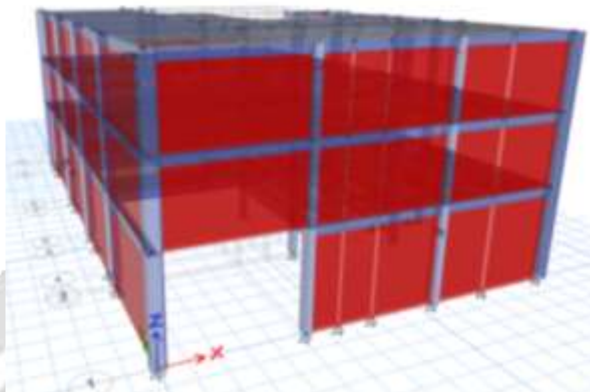

Fig.5: Model Using Etabs-L Shaped Column

5.1 AXIAL FORCE DIAGRAM

The axial force diagram of the building with normal column is shown in the fig.6. The maximum axial force of the normal column is -100.1296KN.

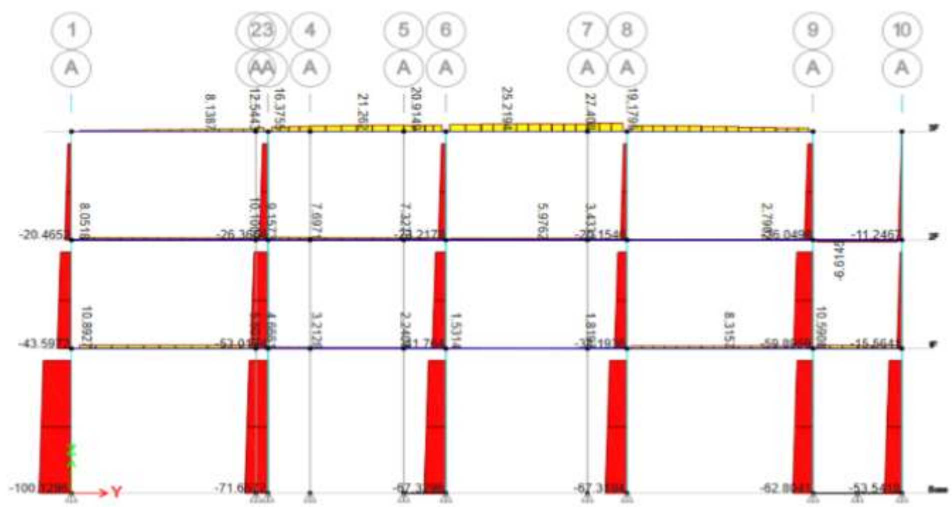

Fig.6: Analysis Using Etabs – Normal Column

The axial force diagram of the building with L-shaped column is shown in the fig.7. The maximum axial force of the L-shaped column is -144.6101KN

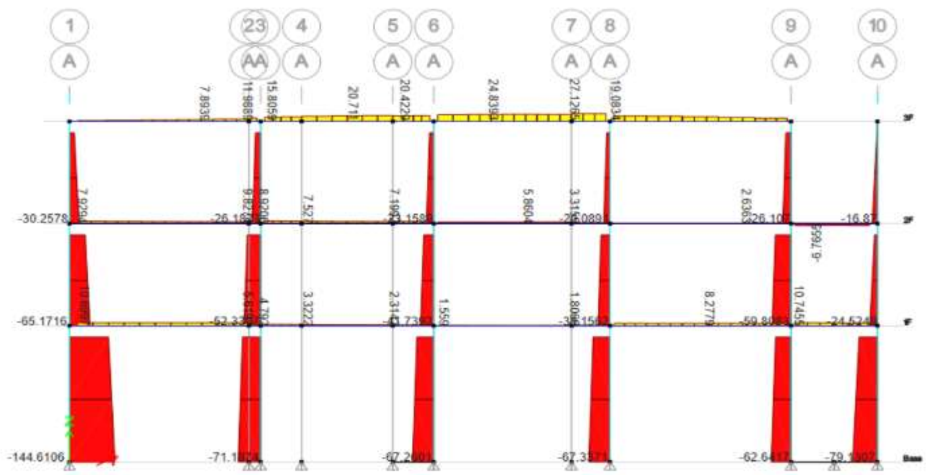

Fig.7: Analysis Using Etabs – L Shaped Column

5.2 DEFORMATION DIAGRAM

The deformation diagram of the building with normal column is shown in the fig.8. The maximum deformation of the normal column is in the 3rd floor. The value is 0.784629.

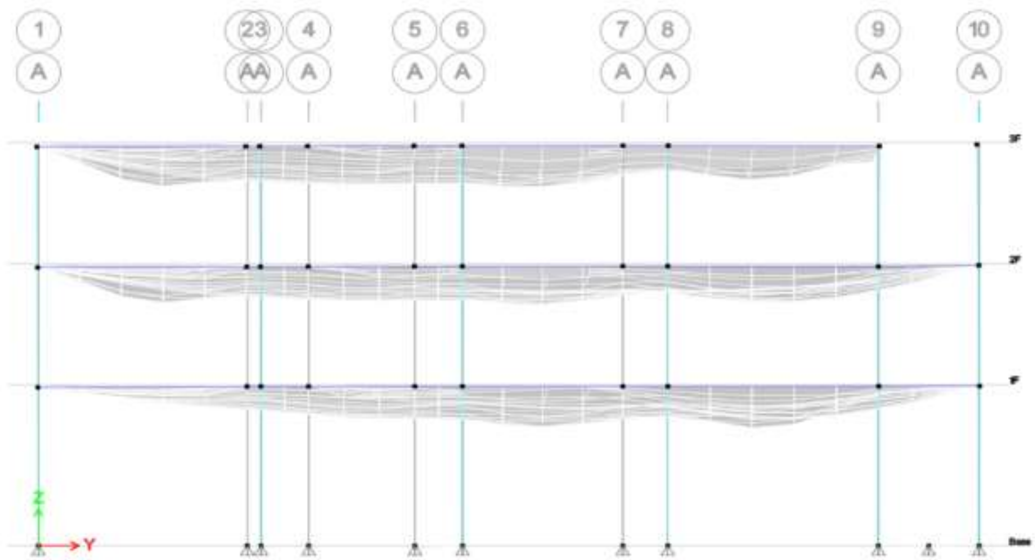

Fig.8: Analysis Using Etabs – Normal Column

The deformation diagram of the building with L-shaped column is shown in the fig.9. The maximum deformation of the L-shaped column is in the 3rd floor. The value is 0.784629.

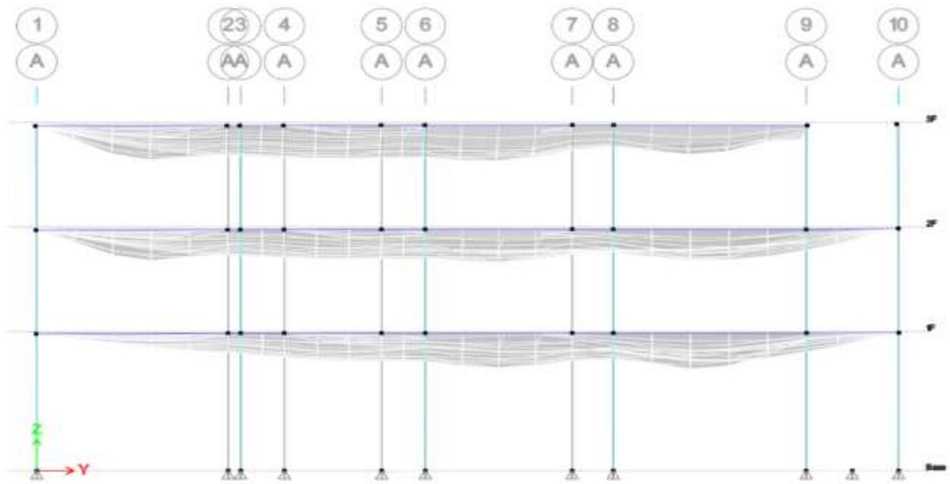

Fig.9: Analysis Using Etabs – L Shaped Column

5.3 BENDING MOMENT DIAGRAM

The bending moment diagram of the building with normal column is shown in the fig.10. The maximum bending moment of the normal column is 67.0440KNm

Fig.10: Analysis Using Etabs – Normal Column

The bending moment diagram of the building with L-shaped column is shown in the fig.11. The maximum bending moment of the L-shaped column is 80.936KNm.

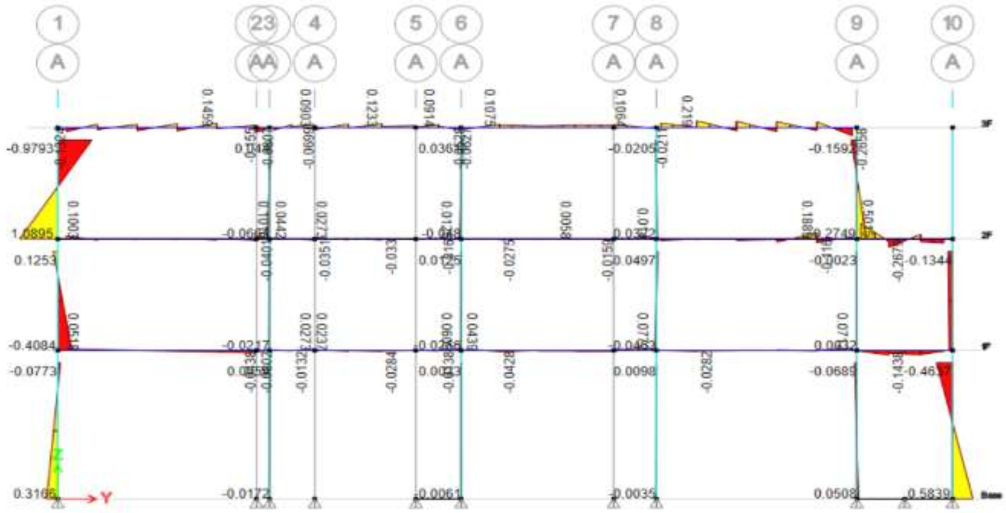

Fig.11: Analysis Using Etabs – L Shaped Column

5.4 SHEAR FORCE DIAGRAM

(Font-10, justify) The shear force diagram of the building with normal column is shown in the fig.12. The maximum shear force diagram of the normal column is 6.8856KN.

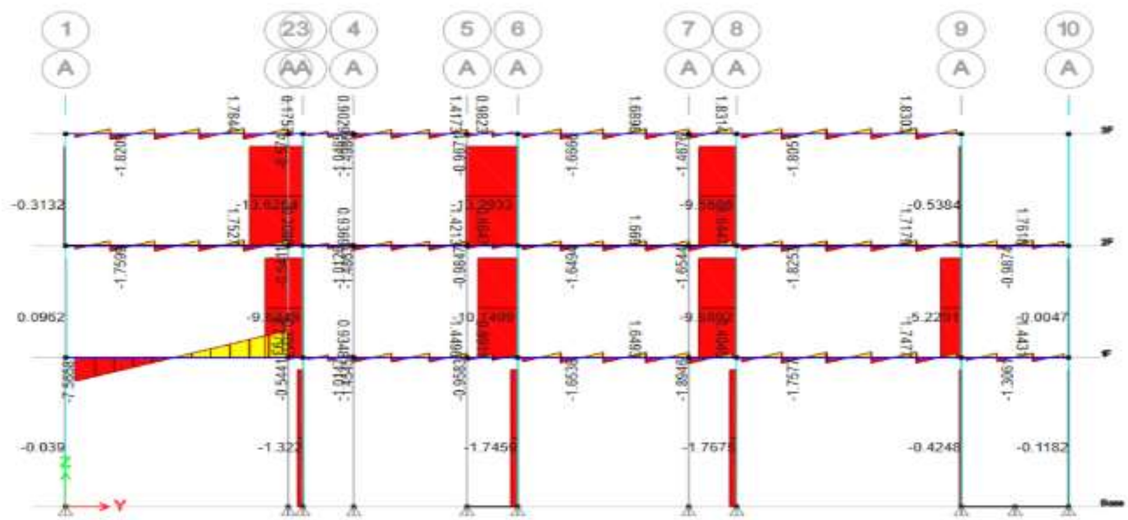

Fig.12: Analysis Using Etabs – Normal Column

The shear force diagram of the building with L-shaped column is shown in the fig.13. The maximum shear force diagram of the L-shaped column is 6.936KN.

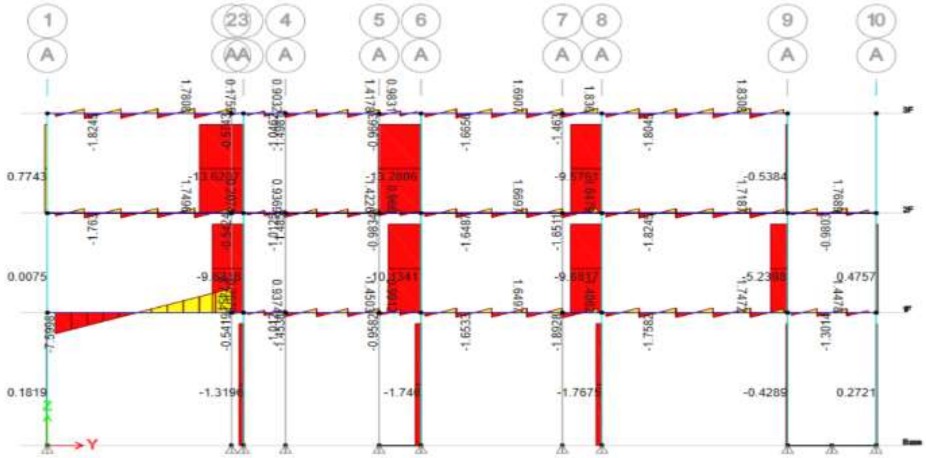

Fig.13: Analysis Using Etabs – L Shaped Column

5.5. DESIGN OF L-SHAPED COLUMN

The fig 14 shows the design of L-shaped column with spacing, clear cover, bar size 25mm and No of bars 17.

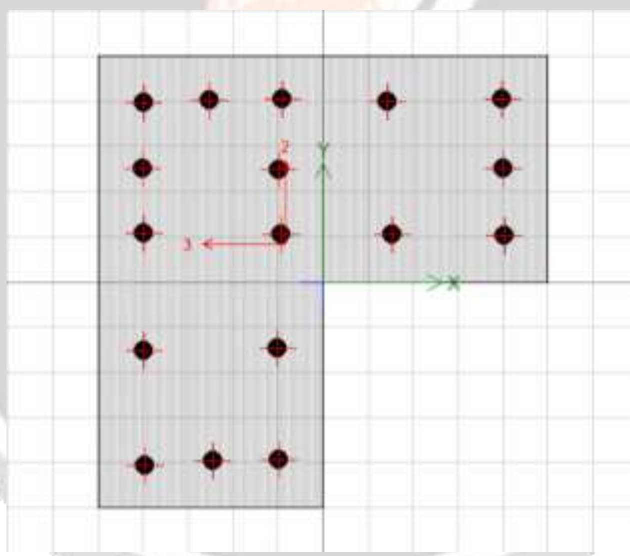

Fig.14: Design of L-Shaped Column

6. RESULTS AND DISCUSSIONS

L-shaped columns have the advantages of avoiding column protrusion, saving room space and good mechanical behavior. L-Shaped column has the advantages such as high bearing capacity, good ductility and high utilization rate of internal space of the building, thus avoiding the occurrence of column shearing in the indoor use space. Due to the lack of structural seismic damage data, it is very necessary to study the seismic performance of special-shaped column structures. For a regular concrete frame with special-shaped columns, the weak layer may appear in the lower part of the structure, and the damage belongs to the beam hinge mechanism. Axial force in normal column and L-shaped column has an approximate difference of 44KN. Bending Moment in normal column and L-shaped column has an approximate difference of 13KNm. whereas the deformation and shear forces are approximately equal in both the cases. As comparing to normal columns the characteristics of special-shaped columns are more complex than those of ordinary rectangular columns. Therefore an L-shaped column can be used instead of a normal column.

Table -1: Result

RESULTS OF ANALYSIS	NORMAL COLUMN	L-SHAPED COLUMN
AXIAL FORCE	-100.1296 KN	-144.6101KN
DEFORMATION	0.784629, 3F	0.784629, 3F
BENDING MOMENT	67.0440 KNm	80.936 KNm
SHEAR FORCE	6.8856 KN	6.936 KN

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