International Journal of Modern Developments in Engineering and Science
Volume 1, Issue 6, June 2022
https://www.ijmdes.com | ISSN (Online): 2583-3138

Comparative Analysis of Reinforced Concrete Oblique Columns and Y- Shaped Columns by Using ETABS

Harshada Ashok Targe[1*], Utkarsha Dilip Bhadane[2], Gauri Madhav Derle[3], Sakshi Sandip Mane[4], Sayali Satish Bahalkar[5]

[1,2,3,4]*Student, Department of Civil Engineering, Sandip Institute of Engineering and Management, Nashik, India*
[5]*Assistant Professor, Department of Civil Engineering, Sandip Institute of Engineering and Management, Nashik, India*

***Abstract*: Now a day's utility or floor area of Residential RC Structure is very costly. Any analysis and design approach which enhances the utility area of residential or commercial buildings is highly appreciable. Many researchers/design engineers attempted to achieve it. Strategies like floating columns, central core columns and cantilever beam structures are one of the usual techniques. In the present study, oblique columns and Y-shaped columns are adopted instead of conventional (rectangular or square) columns, 6 storied structures are considered for analysis and comparative study between oblique columns and Y-shaped columns is to be adopted. All the analysis and design work are conducted using ETABS 2013 version. It needs optimum design procedure to proceed for further studies and also for construction. The oblique columns and Y-shaped columns can be used for architectural purpose by giving the pleasing appearance to inclined support members, which increases the aesthetic appearance of the structure.**

***Keywords*: Columns, oblique columns, Y-shaped columns, equivalent static method, response spectrum method, displacement, storey drift, stiffness, base shear, time period.**

1. Introduction

There are several types of columns which are used in different parts of structures. Column is a vertical structural member that carries loads mainly in compression. It might transfer loads from a ceiling, floor slab, roof slab, or from a beam, to a floor or foundations. Commonly, columns also carry bending moments about one or both of the cross-section axes.

Columns are classified based on the several conditions which include:

1. Based on Types of Reinforcement
2. Based on Types of Loading
3. Based on Slenderness Ratio
4. Based on Shape
5. Based on Construction Material

Sophisticated construction industry is rapidly increasing due to the developments and demands for population. The new idea is that the columns are not vertical. We can build multi-storied building buildings with oblique columns. But the seismic performance should be studied to know whether these new construction techniques adaptable or not. Because, the performance of the high-rise, mid-rise and low-rise building will be different from each other for different angles under seismic loading. So, it is very important to study the seismic performance for different types of building and also compare with the conventional method of construction. If it is replaceable for the normal constructions and with more advantages, it will be a revolutionary change in civil engineering world. Thus, the statement of the Project is, *"Comparative Analysis of Reinforced Concrete Oblique Columns and Y-Shaped Columns by using ETABS"*.

A. Scope of the Study

The scope of this study is as follows:

1 RC building is considered.
2 Linear elastic analysis is to be done on the structures.
3 Column is modeled as fixed to the base.
4 Loading due to infill walls were taken into account.
5 Time History Analysis is to be done to obtain displacements.

B. Research Gap

In research work there is lack of study on oblique columns and Y - shaped columns. Comparison between oblique columns and Y - shaped columns is not done in any research paper. Hence study of oblique columns and Y - shaped columns is taken into account for the study. Also, there is lack of research work on seismic analysis of oblique columns and Y - shaped columns.

C. Significance of the Research

The research will encourage the design of new approach in oblique columns and Y - shaped columns. The study surely is a step forward in the right direction to achieve aims and objectives of the project work.

2. Research Methodology

A. Methods of Seismic Analysis

Seismic analysis is a major tool in earthquake engineering

*Corresponding author: harshadatarge@gmail.com

which is used to understand the response of buildings due to seismic excitations in a simpler manner. In the past the buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent.

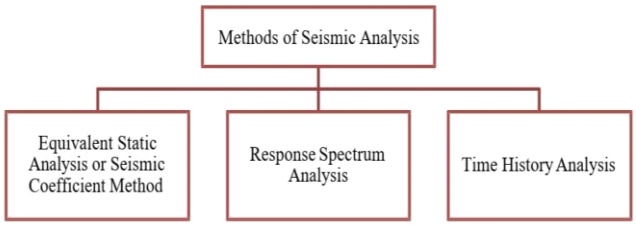

Fig. 1. Methods of seismic analysis

1) Equivalent Static Analysis

All design against seismic loads must consider the equivalent linear static methods. It is to be done with an estimation of base shear load and its distribution on each story calculated by using formulas given in the code. Then the displacement demand of model must be checked with code limitation. Equivalent static analysis can therefore work well for low to medium-rise buildings.

2) Response Spectrum Analysis

The representation of the maximum response of idealized single degree freedom system having certain time period and damping, during past earthquake ground motions. The requirement that all significant modes be included in the response analysis may be satisfied by including sufficient modes to capture at least 90% of the participating mass of the building in each of the building's principal horizontal directions.

3) Time History Analysis

It is an analysis of the dynamic response of the structure at each increment of time, when its base is subjected to a specific ground motion time history. Recorded ground motion data base form past natural earthquakes can be a reliable source for time history analysis.

4) Configuration of the Model

In the current study, buildings are modelled using the finite element software ETABS. The analytical models of the building include all components that influence the mass, strength, stiffness and deformability of structure. The building structural system consists of beams, columns, and slab. The non-structural elements that do not significantly influence the building behaviour are not modelled. Modal analysis and seismic coefficient analysis are performed on models. It is proposed to study the effectiveness of oblique columns and Y-shaped columns.

The beam and column are modelled are two nodded line element with 6 DOF at each node. The slab is modelled using 4 nodded area elements.

In present work, reinforced concrete G + 5 storied buildings with oblique columns and Y- shaped columns are taken which has situated in zone V (very severe zone), is taken for the study. Structural data is assumed for both structures.

Details of models are shown below:

Model 1: G + 5 storied RC structure with Oblique columns

Model 2: G + 5 storied RC structure with Y-shaped columns

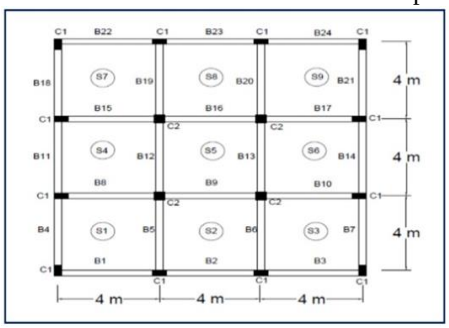

Fig. 2. The plan of model of G+5

Table 1
Assumed structural data for both models

Sr. No.	Description	Specification
1	Type of Structure	G + 5 Storied RC Structure
2	Structure Type	Plan Regular Structure
3	Plan Dimensions	12 m X 12 m
4	Total Area	144 sq. m
5	Bay Width in Longitudinal Direction	4 m
6	Bay Width in Transverse Direction	4 m
7	No. of Bays in Longitudinal Direction	3 bays of 4 m length
8	No. of Bays in Transverse Direction	3 bays of 4 m length
9	Height of Building	19.2 m (G + 5)
10	Height of Each Storey	3.2 m
11	Plinth Height	1.2 m
12	Depth of Foundation	2 m
13	Size of Beams	230 mm X 450 mm
14	Size of Columns	C1 = 300 mm X 600 mm, C2 = 450 mm x 450 mm
15	Thickness of Slab	150 mm
16	External Wall thickness	200 mm
17	Internal Wall thickness	100 mm
18	Height of Parapet Wall	1 m
19	Density of Concrete	25 kN/m^3
20	Concrete Grade	M30
21	Grade of Steel	Fe 500
22	Unit Weight of Concrete	25 kN/m^3
23	Unit Weight of Steel	78.5 kN/ m^3
24	Density of Brick Masonry	20 kN/ m^3

Table 2
Comparative analysis results of oblique columns and Y-shaped columns

Sr. No.	Parameter	Values of Model 1 Oblique Column	Values of Model 2 Y-shaped Column	Difference	Percentage Increase or Decrease in Value
1	Maximum Storey Displacement	6.3 mm	50.27 mm	43.97 mm	697.94
2	Maximum Storey Drift	0.000162 mm	0.000248 mm	0.00008mm	53.08
3	Base Shear	831.2117 kN	1096.680kN	265.468kN	32.07
4	Maximum Storey Stiffness	1757254.595 (kN/m)	733562.715 (kN/m)	1023691.88 (kN/m)	58.25
5	Time Period	0.5 sec	0.5 sec	0	0

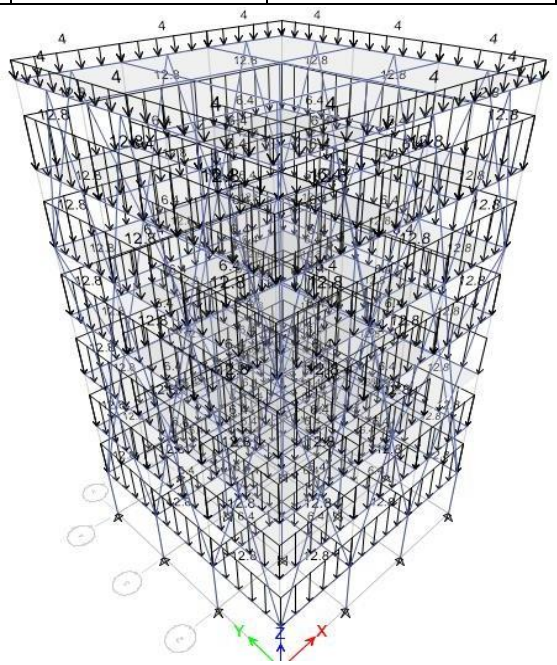

Fig. 3. Loading on Model 2 in ETABS software

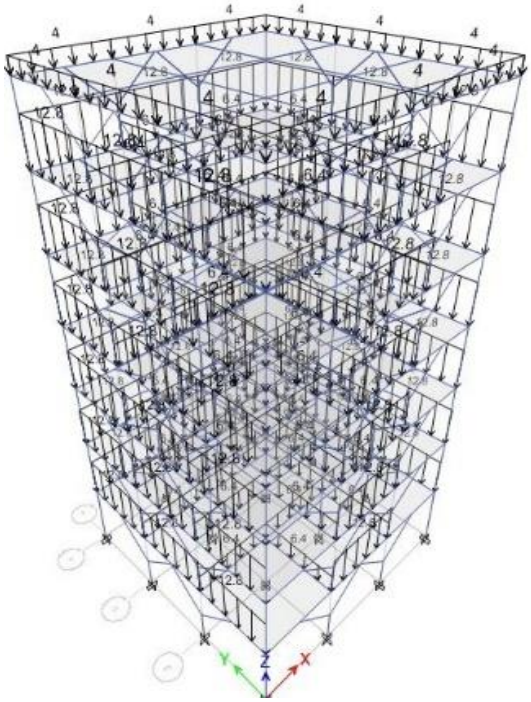

Fig. 4. Loading on Model 1 in ETABS software

3. Conclusion

1. Maximum Storey Displacement in oblique columns is 6.3 mm and in Y-shaped columns is 50.27 mm. Results show that maximum storey displacement is increased in Y-shaped Columns by 43.97 mm. It means maximum storey displacement is increased in Y-shaped columns by 697.94%. Hence oblique columns give better results in storey displacement.
2. Maximum Storey Drift in oblique columns is 0.000162 mm and in Y-shaped columns is 0.000248 mm. The difference of maximum storey drift between oblique columns and Y-shaped is 0.000086 mm. Maximum Storey Drift in Y-shaped columns is increased by 53.08 % as that of oblique columns.
3. The lower base shear is getting in oblique columns and the higher base shear is getting in Y-shaped columns. Base shear in oblique column is 831.22 kN while 1096.68 in y-shaped column. It means that base shear value is increased by 32.07% in Y-shaped column as compared to oblique columns. The joint of the Y-shaped holds to be weak under seismic loading. Necessarily requires the strengthening the joins of Y-shaped column.
4. Maximum Storey Stiffness in oblique columns is 171757254.595 kN/m and 733562.715 in Y-shaped columns. Results of maximum storey stiffness show that stiffness gets deceases in y-shaped columns as compared to oblique columns. It is decreased by 58.25%. Oblique columns offer best resistance to lateral loads. Hence, it needs optimum design procedure to proceed for further studies and also for construction.
5. In time period, there is no change in both oblique columns and Y-shaped columns. It remains same 0.5 sec in both columns.
6. By the analysis it is concluded that the overall performance of structure is increased when the oblique shaped columns are used for construction instead of y-shaped columns. Hence, oblique column structure is more sustainable than y-shaped structure.

References

[1] Thuy-Anh Nguyen, Hai-Bang Ly, Hai-Van Thi Mai and Van Quan Tran, "Using ANN to Estimate the Critical Buckling Load of Y-Shaped Cross-Section Steel Columns", Scientific Programming, Volume 2021.

[2] Sridhara K. S. and G. V. Sowjanya, "Seismic Response of Multi-Storey Building with Oblique Columns", International Research Journal of Engineering and Technology, Volume 08, Issue 01, pp. 868-877, January 2021.

[3] Nikha Santhosh and Gayathri Krishna Kumar, "Seismic Performance of Oblique Columns in High Rise Building", National Conference on Structural Engineering and Construction Management, Proceedings of

SECON 2020, pp 131-139, Lecture Notes in Civil Engineering, Volume 97, Springer, Cham., November 2020.

[4] Abhilash A. S. and Keerthi Gowda B. S, "A Comparative Study of Multi-storey RC Structures with Y-Shaped Columns", International Conference on Trends and Recent Advances in Civil Engineering – TRACE 2016, ResearchGate, pp. 551-557, August 2016.

[5] IS 875, "Indian Standard Code of Practice for Design Loads (Other Than Earthquakes) For Building and Structures Part 1: Dead Loads –Unit Weights of Building Materials and Stored Materials", Second Revision, Bureau of Indian Standards (BIS), New Delhi, 1987.

[6] IS 875, "Indian Standard Code of Practice for Design Loads (Other Than Earthquakes) For Building and Structures Part 2: Imposed Loads", Second Revision, Bureau of Indian Standards (BIS), New Delhi, 1987.

[7] IS 875, "Indian Standard Code of Practice for Design Loads (Other Than Earthquakes) For Building and Structures Part 3: Wind Loads", Third Revision, Bureau of Indian Standards (BIS), New Delhi, 2015.

[8] IS 1893: 2002, "Indian Standard Criteria for Earthquake Resistant Design of Structures, Part 1 General Provisions and Buildings", Draft of Fifth Revision, Bureau of Indian Standards, New Delhi, 2002.