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# "Comparative Study of Y-Column and Rectangular Column Structures: Performance and Efficiency Analysis"

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***Abstract :*** In modern area availability of floor area is one of the biggest concern in high raised structure. As the structure is taller the availability of floor area will be decreasing. as the height of the structure increases the column and beam dimension will increase. Hence, the availability of floor area will also decrease. In modern construction technology finding alternative for rectangular column is one of most demanding topic. In modern era of construction technology, there were so many attempts made to replace the conventional rectangular column. some of the examples are replacing rectangular column with floating column and also replacing rectangular column with Y type column. In this comparative study three different 12 storied models are prepared, on model consist of only conventional rectangular columns and one model contains only Y type columns and the other model contains of both Y type column and rectangular column. And for all these three models efficiency analysis is done for floor utility area and for also amount of concrete usage. For the modelling, analysis and the designing part ETABS 2019 software is used. Once after the modelling and design procedure is completed, it is found that the model with Y column is more efficient in terms of floor utility area when compared to other two models. So Y column can be more efficient rather than conventional rectangular column. Also in this study the area efficiency is also calculated. It is found that utility area acquired from Y column is more when compared to that conventional rectangular column. In this study it also proved that number of column in Y column structure is less when compared to that conventional rectangular column.in thus study it is also found that the amount of concrete required for Y column structure is less than when compared to that of conventional rectangular column. The main objective of this study this study is to prove the efficiency of Y column structure.

***Index Terms*** **– Y column, Rectangular column.**

## 1.INTRODUCTION

The column is the most crucial and important part in an RC structure. So proper design and analysis must be carried out while designing column. But if the geometrical condition of the column varies, in such case the parameters will not be corrected only through code books and guidelines. They require different experimental approach. Basically column is a structural member, in an RC structure. Which is designed to carry the compressive loads. The main function of the column is to carry all the axial load from the structure and transfer the loads to the foundation. The behaviour of the column will be different fir the both the loadings namely dynamic loading as well as static loading condition. In the place where seismic activity is high the dynamic load conditions are must and should. The ductility and strength approaches are made when seismic loads are considered. Some building with different geometric condition and irregularities. The design approach cannot be done directly through codal provisions. For these cases different experimental and design approaches are made. In some cases, architectural conditions are different. the conditions force the architect to think about different shapes of columns and beams. The author Minyang as given different approaches and different design for beams and columns. As changing the shape of the column artistically, they finally arrived at the three types of column namely V column, T column and Y column. These three types of column are derivatives from the tree concept as shown in the figure. From these types of columns, the number of column required for an RC structure can significantly reduce. In this project we are using Y column for comparison with rectangular column.

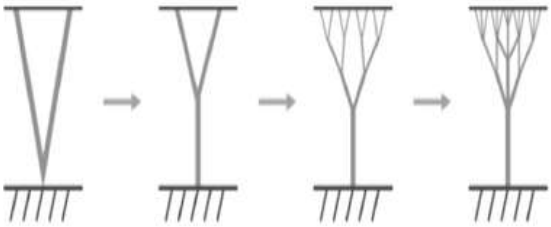

**Figure 1.1: Evolution of Y column**

## 2. LITERATURE REVIEW

1. Shivaranjitha T.H and Naveen Kumar (2016): In this journal, they made a detailed comparative study between structures having Y columns and conventional rectangular columns. In this journal, they performed a complete analysis of a G+10 story structure consisting of Y columns, and they discussed which column is more economical. They also proved that a Y column structure can decrease the number of columns compared to a conventional rectangular column.
2. Harshada Ashok Targe, Utkarsha Dilip Bhadane, Gauri Madhav Derle, Sakshi Sandip Mane, Sayali Satish Bahalkar (2022): In this journal, we can see the detailed comparison between two structures, one with oblique columns and the other with Y columns. This research mainly focused on using oblique and Y columns for construction purposes rather than conventional rectangular columns.
3. Lallawmkimi, Pankaj Kumar (2023): This journal is about the effect of floating columns on high-rise buildings. In this research, we see the seismic analysis of a G+10 building consisting of floating columns.
4. Abhilash A.S and Keerthi Gowda B.S. (2016): In this research paper, the comparssion is done in between the two strutures .one structures contains Y column and other structure contains convential rectangular column. Hence efficiency analysis is done in between these strutures.
5. Pu Yang, Hongxing Liu, and Zongming Huang (2008): this research papers is regarding different type of column. In this study the conventional rectangular column is replaced with columns with different shape and comparative study is also done.
6. Prof. Anand Bankad, Hombanna Mani, Chirag Payannavar, Abhishek Munavalli & Shambulinga Drakshi (2022): this research paper is regarding composite column. As RC structure is good in compression and weak in tension. The research is done to improve the tension resisting strength of RC column by adding steel to the column.
7. Rohan Singh, Vikas Prabhakar (2020): In this journal, they conducted a detailed analysis of a G+10 structure RC building with oblique columns. They used the response spectrum method and time history analysis.
8. Badgire Udhav S., Shaikh A.N., Maske Ravi G. (2015): This journal addresses floating columns. In this research, they replaced conventional columns with floating columns and conducted a detailed analysis of a G+10 structure.
9. S.B. Waykule, Dr. C.P. Pise, C.M. Deshmukh (2016): This study investigates the behavior of floating columns for seismic analysis of multi-story buildings. In this journal, they conducted seismic analysis on structures with floating columns in different zones. From this journal, we can conclude that floating columns can replace conventional rectangular columns.
10. Marsimoyi Terefe Bango (2022): In this journal, they considered circular, square, and rectangular composite columns and conducted numerical analysis under axial and torsional loads. They compared all the column shapes and found that even circular and composite columns can sustain heavy loads and transfer axial loads to foundations.
11. Atickur Rahaman1, Asif Mostafa Anik, N. H. M. Kamrujjaman Serker (2018): The main goal of this journal is to evaluate the lateral force resistance in different types of columns. A special comparative analysis is made between structures with conventional rectangular columns and structures with L and Tee columns. The lateral force resistance is compared for the structures with conventional rectangular columns and those with L and Tee columns.
12. A. Shaikh, R.M. Sawant (2017): In this journal, different types of columns are used to replace conventional rectangular columns in the structure. A total of 8 structures have been modelled and compared with each other. This study shows that the structure with L plus rectangular columns has the least lateral displacement.

## 3.OBJECTIVES

Aim of the study: To compare the three types of buildings (G+10 storey) in terms of economy related to columns and available utility area, we will analyse the conventional rectangular column structure, the Y-column structure, and the hybrid structure (which uses both Y-columns and rectangular columns). The following are the primary objectives for each scenario

1. The goal is to explore the impact of replacing conventional rectangular columns with Y-columns, specifically focusing on reducing the total number of columns in the structure.
2. To calculate the total amount of concrete needed for the columns in each of the three structures and assess their economic efficiency based on concrete usage.
3. To determine the floor area occupied by columns in all three structures, assessing how much usable floor space is occupied by column placement.
4. To calculate the usable floor area available after accounting for column space in each of the three structures and then compare which structure provides the most economical use of floor utility area.
5. To conduct a static analysis on all three structures to calculate the maximum displacement (or deflection) of each structure at the highest story, comparing their structural performance under applied loads.
6. This task involves conducting a static analysis on each of the three structures to calculate the maximum story drift of each structure at the highest story, comparing their structural performance under applied loads.

## 4. METHODOLOGY

4.1 MODELLING AND ANALYSING USING ETABS SOFTWARE:

Modelling and analysing is done by following steps:

- Setting up the grid lines

- Defining materials and section properties
- Drawing beams, column and slabs
- Defining load patterns
- Defining load combination
- Assigning loads
- Assigning diaphragm
- Model check
- Analysis

## 5. RESULTS AND DISCUSSION

Here we have considered three model, one with conventional rectangular column and with Y column and other with structure both rectangular column and Y column. And we have calculated the amount of concrete for both the model. And we have also calculated the area acquired by the column in both the model. Hence to calculate the maximum utility area.

Table:5.1 Concrete quantity.

| Model | Quantity of concrete In $m^3$ | Quantity of concrete In % |
|---|---|---|
| Conventional model | 504 | 1 |
| Y Column | 483 | 0.95 |
| Y and Conventional column | 623 | 1.2 |

Table:5.2 Area utility.

| Model | Area acquired in In $m^2$ | Area utility In % |
|---|---|---|
| Conventional model | 175.68 | 1 |
| Y Column | 120 | 37.66 |
| Y and conventional | 180 | 1.02 |

Table:5.3 Number of columns.

| Model | Number of columns |
|---|---|
| Conventional model | 440 |
| Y Column | 220 |
| Y and conventional | 360 |

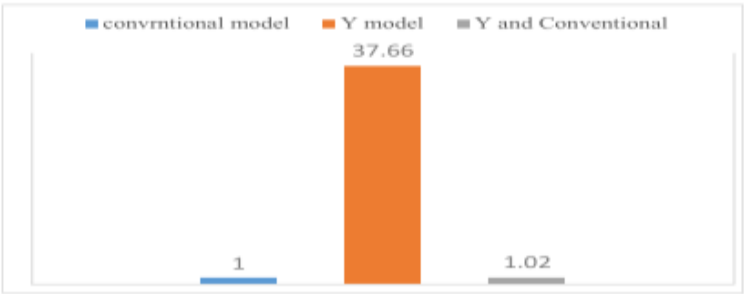


Figure 5.1: floor utility area in %

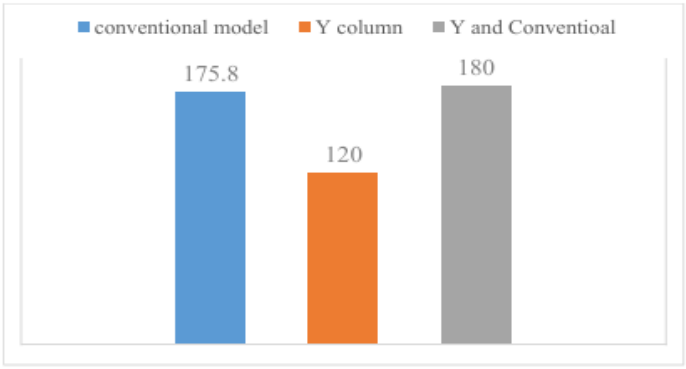


Figure 5.2: floor utility area in $m^2$

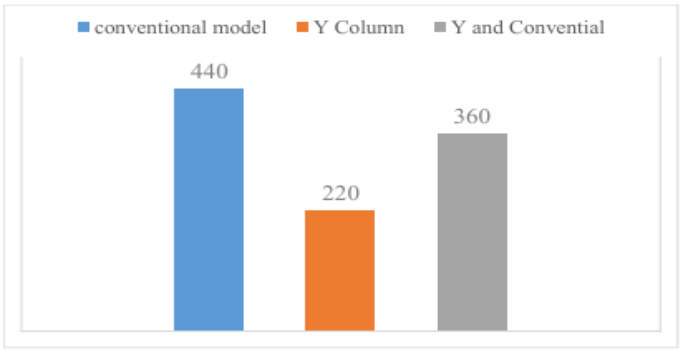


Figure 5.3: Number of columns

## 6. CONCLUSION

Using ETABS 2019 software we have created two models, one with conventional rectangular column and one with Y- column. While comparing these two model following results were obtained.

1. The primary objective of this project is to reduce the number of columns. As you can see from the above result, by obtaining the Y-column we can reduce the columns up to 40% we can clearly see that. By reducing the number of column we can free up the space. This will help in the free movement of vehicles in parking lot.
2. By the above comparative study, we can conclude that quantity of concrete required by the structure with Y-Column is less when compared to other conventional structure. Hence Y-column is more economical in terms of concrete.
3. Hence according to above result we can conclude using Y-column in the construction, we can increase the floor area up to 13% when compare conventional rectangular column. Hence maximum floor area can be utilized in y-column model.
4. The slanted support elements of the Y-shaped column are under increased moments as they carry the axial forces to the middle of the vertical section of the columns. The beams will face the resulting forces as axial loads at the point of intersection. At the same time, for any substantial structure, the beams must withstand greater axial forces, which are mandatory to take in consideration.
5. The Y-shaped columns serve an architectural function by enhancing the attractive look of slanted support elements, thereby boosting the visual appeal of the structure.
6. Economy in the footing construction can be seen as the number of the columns will reduce, construction can be made easier rather than conventional column.

## SCOPE FOR FUTURE WORKS

1. Y column can be used where floor area is more concerning.
2. As Y column is visually pleasing, it can be used for attractive architectural plan.
3. The buildings where column requirement is low, Y column can be used

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