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Comparative Study of Y-Shaped Columns With Conventional Rectangular Shaped Columns

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Abstract - *This dissertation work deals with the comparative study of behavior of Y-shaped RC column with that of conventional rectangular column for a multi-storey commercial building. Now a days utility/floor area of Residential RC Structure is very costly. Any analysis and design approach which enhances the utility area of residential/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 Y-shaped columns are adopted instead of conventional (rectangular or square) columns, 8 storied commercial structures are considered for analysis and comparative study between regular and Y-shaped columns. All the analysis and design work is conducted using ETABS 2015 version. Obtained results showed that, by adopting Y-shaped columns about 20.53% of floor area is increased. Hence Y-shaped column can be successfully adopted to increase the utility or floor area of residential/commercial structure.

Key Words: Conventional column, Y-shaped column, linear static analysis, ETABS-2015.

1.INTRODUCTION

Structural design is a science and art of understanding the behavior of structural members subjected to loads and designing them with economy along with safety, serviceability and as a durable structure. The present dissertation work will be dealing with such a study of structural members made of RCC as it is widely used because of its adaptability.

Column is basically a structural member assigned for carrying compressive loads. It carries axial loads from beams and transfers it to footing. The columns are distinguished in many ways and many types are observed. Based on the slenderness ratio columns are called as short or long columns. The short column fails by crushing and long column fails by buckling. Considering the loading pattern there are axially loaded column, axial column with uniaxial bending, axial column with biaxial bending.

Columns behave differently under static and dynamic loading conditions. The dynamic load consideration is must for places where the seismic activity is high. Therefore when seismic loads are considered the combined approach of ductility and strength must be applied. The wind loads, snow loads, creep, shrinkage and temperature effects are considered where they are necessary. The snow load consideration varies on country to country, and region to region. It has to be considered as per relevant design codes of relevant codes. The consideration of wind loads mainly depends on altitude of structure and the direction and speed of the wind in the region .The columns shouldbe designed to carry the wind loads in such conditions. Some of the complex geometric conditions and building irregularities requires experimental and analytical approaches for different material properties and sectional properties. Such parameters cannot be directly covered by the design code books and guidelines.

The architectural requirement leads the designer to think about different shapes and cross sections of the beams, columns, plates etc. This led to different cross sections of columns based on location and function such as L-shape, T-shape, C-shape, +shape etc. Even the different shapes of columns are also in practice such as spindle, trapezoid, tower and lattice. All these columns should be design and cast with safety, economy and aesthetic appearance. Usually the different cross sections of columns such as L-shape, T-shape, C-shape, cross shape have made a transformation in structural engineering by which they provides the easy solution for locations in special cases.

1.1 OBJECTIVES OF STUDY

The main objective of the proposed work is

- Reducing the number of columns, hence increasing the utility/floor area.
- To study the structural behavior of Y-shaped column compared to conventional structure with respect to its location.

2. MODEL DESCRIPTION

In the present study, two different structures have modelled for the same building layout of 34m×16m. The columns provided are rectangular shape for one model and another model with Y shaped columns.

Table -1: Geometrical dimension of building

Sl. No	Parameter	Model	
1	Utility of building	commercial building	commercial building
2	Model Size(m)	34×16	34×16
3	No of stories	G+7	G+7
4	Type of construction	RC framed structure	RC framed structure
5	Types of walls	Brick wall	Brick wall
6	Beam(m) Column((m) Inclined members(m) Floor to floor height(m) Height of Plinth (m) Slab(m)	0.3×0.45 0.3×0.7 NILL 3 1.5 0.125	0.3×0.45 0.3×0.9 0.3×0.45 3 1.5 0.125
7	Reinforced Concrete of grade Reinforcement bars of grade Unit weight (kN/m^3) Poisson's Ratio	M30 Fe-500 25 0.15	M30 Fe-500 25 0.15

2.1 Conventional model:

The Conventional rectangular column model (fig 1) Is a building with G+7 stories. Dimensions of beams being fixed at 300mm x 450mm and that of columns being taken as 300mm x700mm. The buildings were subjected to the usual dead and live load sets as per the Indian standards. The building location assumed falls under seismic zone 2 as per IS 1893-2002 (part 1) and as per IS 875 wind load is not designed since Earthquake load exceed wind load.

2.2 Y-model:

In the Y-model model columns(fig 2) are modified into Y shape by providing 2 symmetrical Inclined members on either side of the column at a depth of 1m from the ceiling of all floors, at plinth level they are provided at a depth of 1.5m.Remaining all parameters are similar to conventional model.

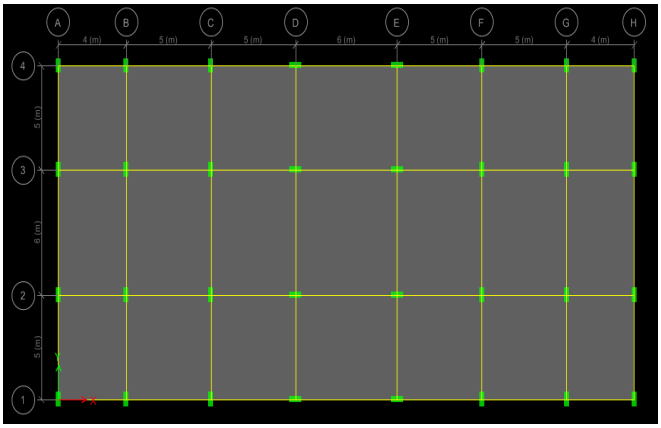

Fig.1(a): Plan of Conventional model

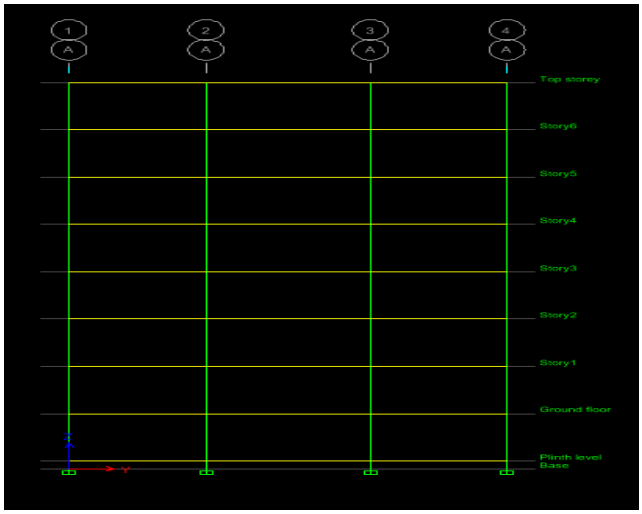

Fig.1(b): Elevation of Conventional model

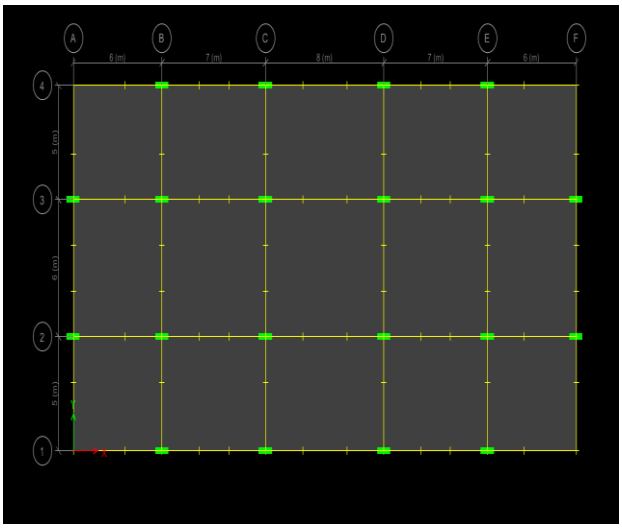

Fig.2 (a): Plan of Y- model

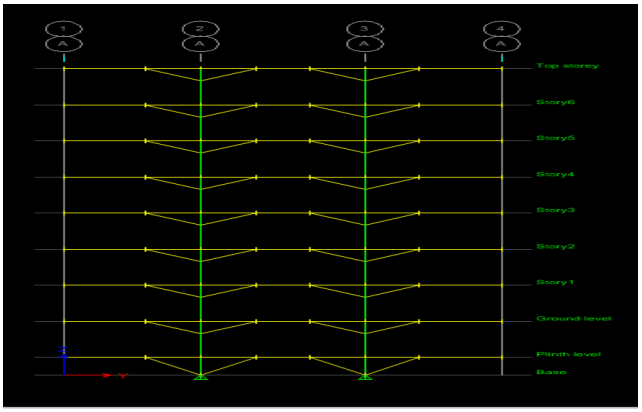

Fig. 2(b): Elevation of Y- model

3. COMPARISION

Table 3.1 Calculation of Quantity of concrete

Model	Quantity of concrete (m^3)	Quantity of concrete (%)
conventional model	409.41	1
Y model	443.11	8.23

Table 3.2 Calculation of Area of floor acquired

Model	Area of floor acquired (m^2)	Area utility (%)
conventional model	60.48	1
Y model	48.06	20.53

Table 3.1 shows quantity of concrete required for conventional model and Y-shaped models, meanwhile table 3.2 shows floral area acquired by columns. As we deduct the total area acquired by columns from total area of building layout we can obtain area utility.

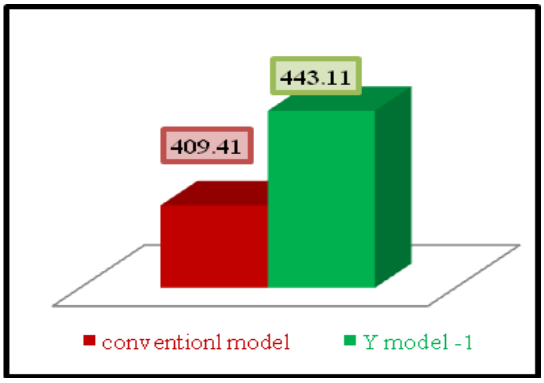

Fig 3.1 Quantity of concrete (m^3)

Graphical representation of comparison between concrete quantities of conventional and Y- model is shown in Fig. 3.1& 3.2. This shows the quantity of 409.41m^3 and 443.11m^3 of concrete is required for conventional and Y model respectively. Y model consumes 8.23% more concrete than that of conventional model.

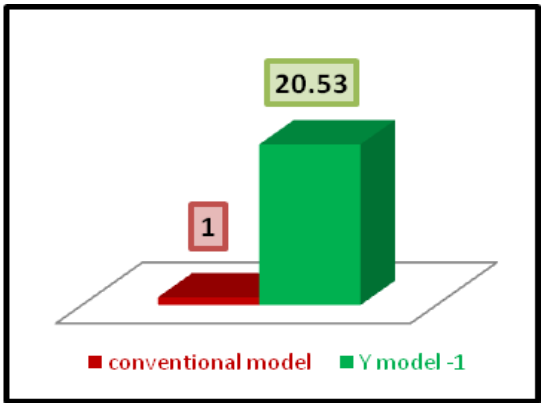

Fig 3.2 Quantity of concrete (%)

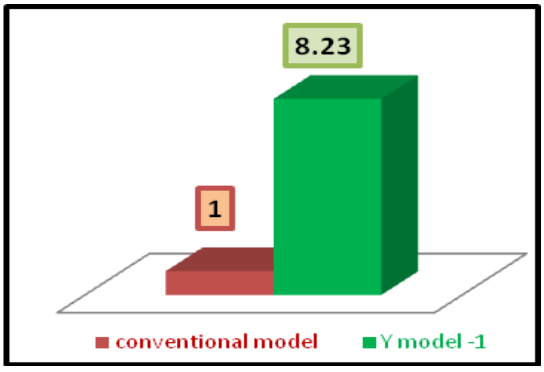

Fig 3.3 Comparison of number of columns/floor

Graphical representation of comparison between number of columns/floor in conventional and Y- model is shown in Fig. 3.3, which shows that 32 columns of conventional model can be reduced as 20 columns in Y model.

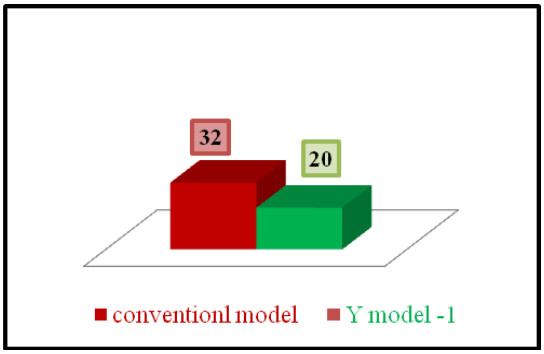

Fig.3.4 Floral area conserved (%)

Graphical representation of comparison between area available for utility of conventional and Y- model is shown in graph 3.4 where Y-model conserves 20.53% more area than conventional model.

4. CONCLUTIONS

1. As the main objective of the present dissertation work is to reduce the number of columns is achieved. By this we can conclude that the number of columns is reduced by almost 40% as we can clearly state that, more columns free area can be obtained by reducing the number of columns. It helps to the free movement of vehicles in parking lot.
2. Obtained results showed that by adopting the present approach, about 20.53% of floor area increased. Hence Y-shaped column can be successfully adopted to increase the utility or floor area of residential/commercial structure.
3. The inclined support members of Y-shaped column are subjected to higher moments while transferring the axial loads to centre of vertical portion of columns. The beams will experience the resultant forces in the form of axial loads at the junction. Meanwhile for any heavy structure the beams have to be counteracted to higher axial loads which should be aware of.
4. By introducing the inclined support members which will be supported at some intermediate level of the vertical portion of the column other then floor level, it causes the higher moments. If they are not properly balanced along both sides of the column, it makes the design complex. For this reason balanced cantilever ideology is applied in the present dissertation work. The position of inclined support members from both the faces should be balanced by considering loading pattern.
5. The 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.
6. As the number of columns reduced economy in construction of footing for columns can be achieved.

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BIOGRAPHIES

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