

**SEISMIC ANALYSIS OF IRREGULAR RC FRAME BUILDINGS WITH
SPECIAL COLUMNS**¹Anju NayasPG Student, Civil Engineering Department
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Abstract— Irregular buildings constitute a major portion of the modern urban infrastructure. The group of people involved in constructing the building facilities, including owner, architect, structural engineer, contractor and local authorities, come up with the overall planning, selection of structural system, and its configuration. This may lead to building structures with irregularities in their mass, stiffness and strength along the height of building. When such buildings are located in a seismically active area, the structural engineer's role becomes more challenging. The analysis of the seismic response of irregular buildings is complex due to nonlinear and inelastic response and more difficult than that of regular buildings. Therefore, the structural engineer needs to have a complete understanding of the seismic response of irregular structures. The effect of shape of column and orientation of column will have a major influence on the structure when the structure is subjected to a lateral load such as earthquake load.

The objective of this study is to carry out the seismic analysis of irregular RC frame using special shaped columns considering both plan and stiffness irregularity. This study also finds out the effects on various parameters of RC buildings under seismic occurrence due to special shape of columns. The parameters considered are lateral displacement and story drift. The software used for modelling and analysis is ETABS 2015.

Index terms—Special columns, ETABS 2015, Story drift, Lateral displacement

I. INTRODUCTION

Earthquakes are the most unpredictable and devastating of all natural disasters, which are very difficult to save over engineering properties and life. Hence in order to overcome these issues we need to identify the seismic performance of the built environment through the development of various analytical procedures, which ensure the structures to withstand frequent minor earthquakes and produce enough caution whenever subjected to major earthquakes, so that can save as many lives as possible. There are several guidelines all over the world which has been repeatedly updating on this topic. The behavior of a building during an earthquake depends on several factors, stiffness, and adequate lateral strength, and ductility, simple and regular configurations. The buildings with regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damage when compared to buildings with irregular configurations. But nowadays the need and demand of the latest generation and growing population has made the architects and engineers inevitable towards planning of irregular configurations. Hence earthquake engineering has developed the key issues in evaluating the role of building configurations. One such development is the provision of special columns in buildings. Some special shapes of columns are L-shaped, Tee-shaped and cross (+) shaped which are not commonly used but gives more indoor space than commonly used shapes of column. Special shaped columns avoid prominent corners in a room which increases the usable floor area.

Research Significance

The plan irregularity can be defined as per IS 1893-2002, that plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction. Buildings with large re-entrant corners, (i.e., plan shapes such as L, V, +, Y, etc.) show poor performance during seismic events. Each wing of such a building tends to vibrate as per its own dynamic characteristics, causing a stress concentration at the junctions of the wings. So these buildings are unsafe in seismically active areas. This study aims to create awareness about these issues in earthquake resistant design of multi-storied buildings.

SPECIAL COLUMNS

Special-shaped columns are those in which the column section is L-shaped, Tee-shaped or crisscross-shaped as shown in figure 1. In recent years, special-shaped columns won the national attention and love of the owners and engineers because of its equal thickness of columns and wall, excellent architectural appearance and high room rate. In 2006, Ministry of Construction of the People's Republic of China has issued "Technical specification for concrete structures with specially

shaped columns" (JGJ149-2006), which has been implemented since August 1, 2006. Accordingly, there have been a lot of research on ordinary reinforced concrete (RC) frame structure with special-shaped column, and this type of the structure has received quite extensive application because of its great architectural functions and pleasing appearance. Therefore special columns can be provided in re-entrant corners of plan irregular buildings.

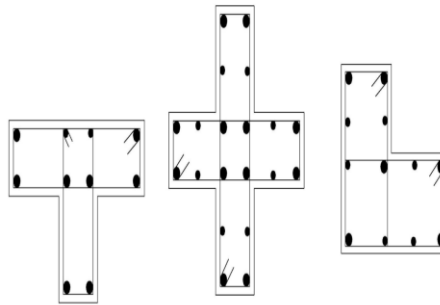


Figure 1: special columns

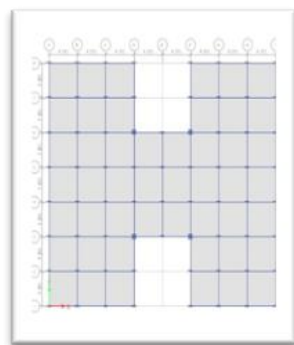
II. OBJECTIVES OF PRESENT STUDY

- To analyse RCC frame with special columns with different irregular configuration.
- To perform response spectrum analysis considering both plan and stiffness irregularity.
- To study and compare story drift, and lateral displacement
- To find out the best shape and best column which resist the displacement and drift effectively.

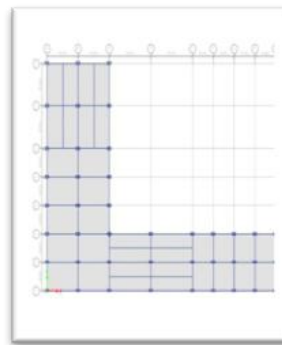
III. MODELLING OF THE BUILDING

The study is carried out on a (G+19) building having different plan irregular configurations. The plan irregularities considered are H, L and Tee shape configurations. Stiffness irregularity is also included. The buildings are considered to be located in Zone III as per IS 1893:2002. The building is modeled using the software ETABS 2015. The dimensions of the beams, columns and slabs ,the loads applied and other details are summarized in Table1.

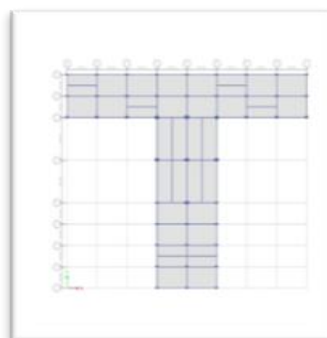
CONFIGURATIONS OF PLAN IRREGULARITY CHOSEN



Model 1



Model 2



Model 3

Table 1:Details and dimensions of building models

Type of structure	Ordinary moment resisting RC frame
Grade of concrete	M40
Grade of steel	Fe 415
Plan area	896 m ²
Floor height	3 m
Beam size	230x600mm 230x500mm 300x650mm 250x700mm
Column size	230x600mm 600x900mm 450x800mm
Tee shape column	B=D=750mm t _f =t _w =200mm
L shape column	B=D=750mm Thickness-200mm
Cross shape column	B=D=750mm t _f =t _w =200mm
Slab thickness	150 mm
Live load on floor and roof	3kN/m ² and 1.5kN/m ²
Plan irregularity	H,L and T

IV. ANALYSIS

Response spectrum analysis is carried out on models considering plan irregularity and for models with both plan and stiffness irregularity. After assigning the loads to the structure, seismic analysis is done to evaluate the story drift, base shear and lateral displacements.. After the analysis the behaviour of the buildings are compared in terms of story drift, displacement and base shear.

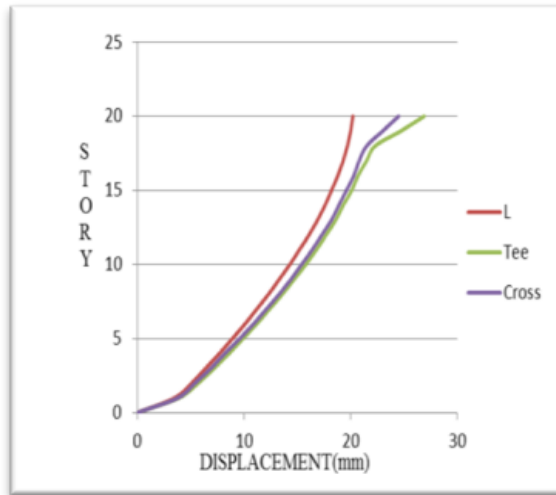
Response Spectrum Analysis

Response spectra are curves plotted between maximum response of SDOF (single degree of freedom) system subjected to specified earthquake ground motion and its time period (or frequency). Response spectrum can be portrayed as the locus of maximum response of a SDOF system for a given damping ratio. Response spectra helps in obtaining the peak structural responses under linear range, which can be used for obtaining the lateral forces developed in the structure due to seismic events and thus facilitates in earthquake-resistant design of structures.

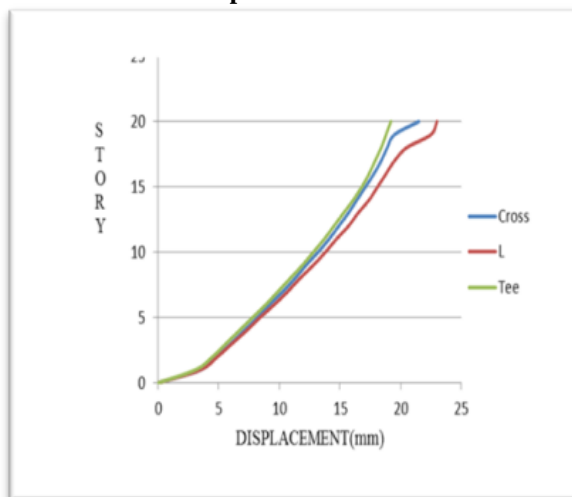
V. RESULTS AND DISCUSSIONS

By the application of lateral loads in X direction the structure can be analyzed for various load combinations given in IS 1893:2002. For the given load combinations the lateral displacement and story drift for each shape of building and column is noted in X direction and are graphically represented below.

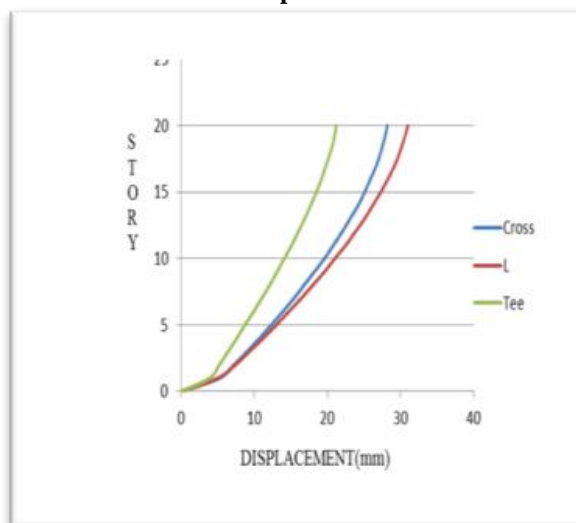
- 1) From response spectrum analysis story displacement for all structural models with plan irregularity only are obtained from ETABS 2015 and the results are graphically presented below:



H shape model

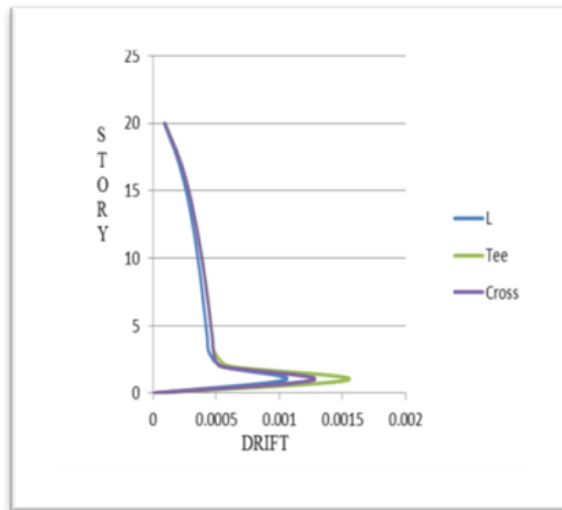


L shape model

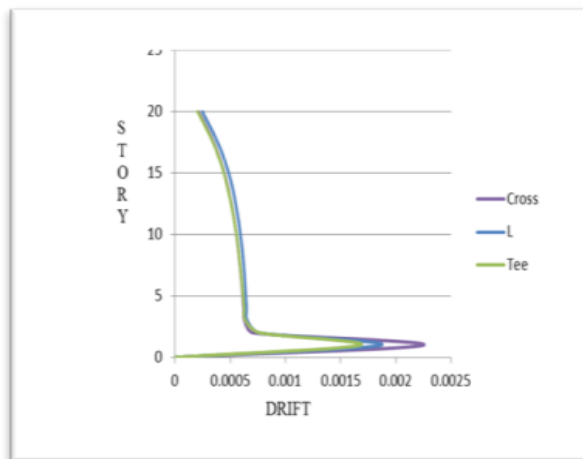


Tee shape model

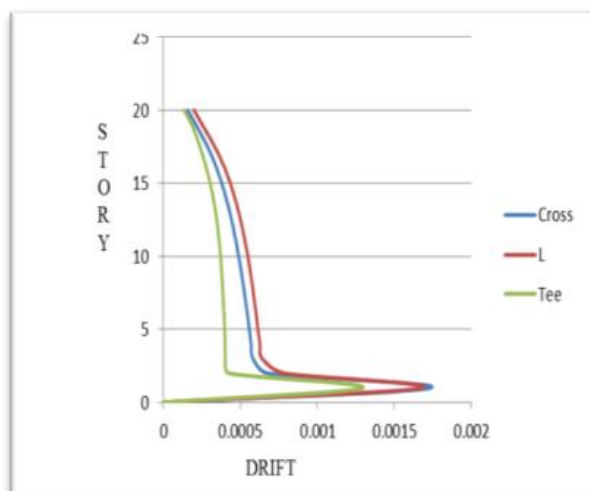
- 2) From response spectrum analysis, story drift for all structural models are obtained from ETABS 2015 and the results are graphically presented below



H shape model

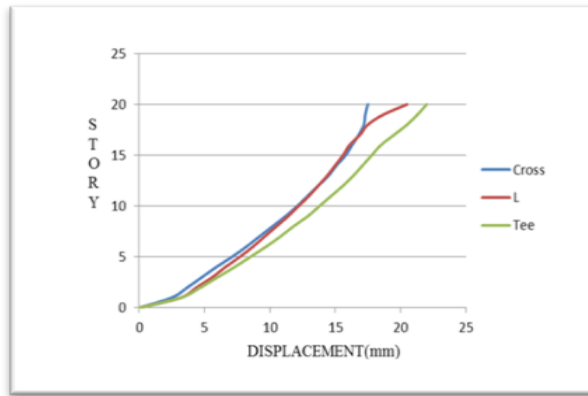


L shape model

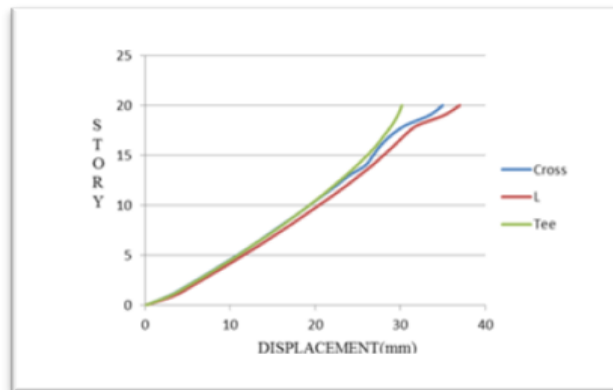


Tee shape model

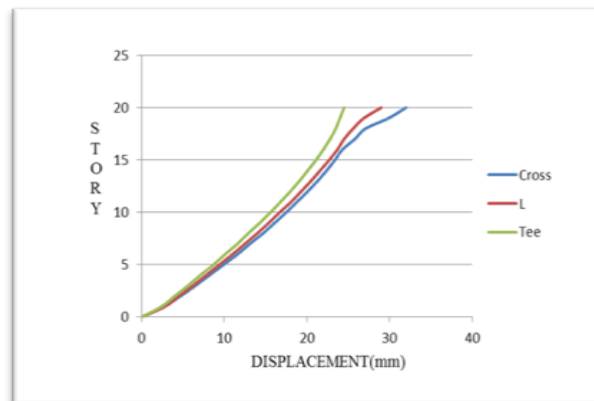
- 3) From response spectrum analysis story displacement for all structural models with both plan and stiffness irregularity are obtained from ETABS 2015 and the results are graphically presented below:



H shape model

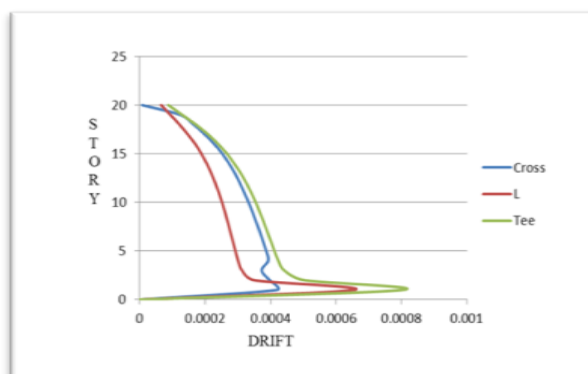


L shape model

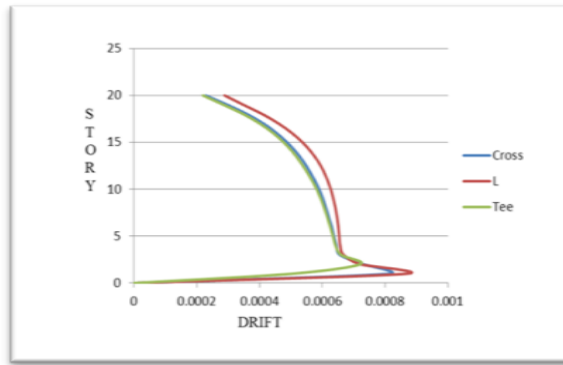


Tee shape model

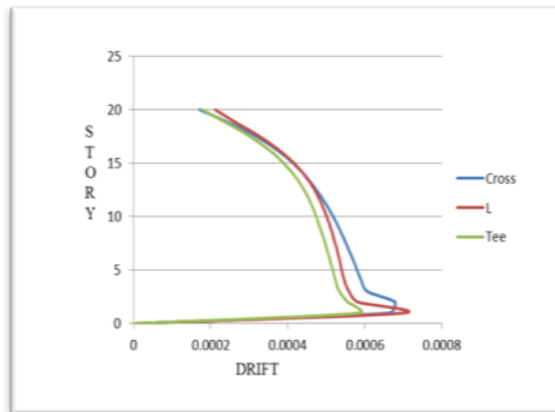
- 4) From response spectrum analysis story drift for all structural models with both plan and stiffness irregularity are obtained from ETABS 2015 and the results are graphically presented below:



H shape model



L shape model



Tee shape model

VI. CONCLUSIONS

The main conclusions obtained from the analysis are summarised below:

For models considering plan irregularity only

1. The lateral displacement and story drifts were lower for H shape model with L shape column when compared with the models with Tee and Cross shaped columns.
2. The lateral displacement and story drifts were lower for both L and Tee model with Tee shaped column when compared with the models with L and Cross shaped columns.

For models considering both plan and stiffness irregularity

3. The lateral displacement and story drifts were lower for H shape model with Cross shaped column when compared with the models with Tee and L shaped columns.
4. The lateral displacement and story drifts were lower for both L and Tee model with Tee shaped column when compared with the models with Cross and L shaped columns.

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