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SEISMIC ANALYSIS OF FRAME TUBE STRUCTURE

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Abstract- The Frame tube structure is analysed .The frame tube structure take more of lateral load dThe efficiency of this system is derived from the great number of rigid joints acting along the periphery, creating a large tube. Exterior tube carries all the lateral loading .Structurally, the framed-tube is superior to a rigid frame because it places material on the exterior of the building. The entire interior structural system is secondary -designed to carry only gravity loads to the ground level. The tube buildings leave the interior floor plan relatively free of core bracing and heavy columns, enhancing the net usable floor area .The reduction of material makes the buildings economically much more efficient. These new designs opened an economic door for contractors, engineers, architects. This study is focused on seismic behaviour of tube structure for varying zones in India for the parameters like displacement, story drift, and time period

KEY WORDS: Frame tube structure,seismic, Analysis.

INTRODUCTION

Among the natural phenomenon that human kinds have worried about that, earthquakes are the most distressing ones. The place and the time of occurrence of earthquake are unpredictable and therefore this makes earthquake as disaster phenomenon. The scale of designing in conventional building codes is to design structures to resist moderate earthquakes without significant damage and avoid collapse during major earthquakes. The primary emphasis is on life safety. Recent earthquakes have clearly demonstrated that conventional construction, even in technologically advanced countries, is affected to destruction The most feared effects of earthquake are collapse of structures especially due to high displacement of stories .The main goals of any structural design are safety, serviceability and economy. Achieving these goals for the design of structures in seismic regions is very important and difficult for different type of system. Uncertainty and unpredictability of when, where and how an earthquake will be happen, will increase the overall difficulties. There are different type of Structural systems of high rise buildings such as Rigid frame system, Braced frame and shear-walled frame systems, Outrigger systems, Braced-tube systems, The Tube systems consist of three types as Frame tube system, Tube in Tube system, Bundled-tube system.

The efficiency of this system is derived from the great number of rigid joints acting along the periphery, creating a large tube. Exterior tube carries all the lateral loading .Structurally, the framed-tube is superior to a rigid frame because it places material on the exterior of the building. The entire interior structural system is secondary -designed to carry only gravity loads to the ground level. The tube buildings leave the interior floor plan relatively free of core bracing and heavy columns, enhancing the net usable floor area .The reduction of material makes the buildings economically much more efficient. These new designs opened an economic door for contractors, engineers, architects. This study is focused on seismic behaviour of tube structure for varying zones in India for the parameters like displacement, story drift, acceleration, base shear, and time period

EARLIER RESEARCH

Myoungsu Shin, Thomas H.-K. Kang, & Benjamin Pimentel (2010) - The primary objectives of this study are to investigate effects of varying design parameters on the tube action and shear lag behavior of a typical reinforced concrete frame-wall tube building, and propose optimal design approaches for similar tube structures. A parametric study was conducted with selected key design variables on the performance of a 55-storey hotel building planned in New York City. The lateral force resistance of the case study building is primarily exerted by exterior shear walls in one direction and by exterior moment frames in the other direction. The performance of each model was assessed in terms of overall and critical (maximum) storey drifts, force distributions between various lateral force-resisting members and shear lag behaviour

Kang-Kun Lee, Yew-Chaye Loo, and Hong Guan (2010) - Framed-tube system with multiple internal tubes is analysed using an orthotropic box beam analogy approach in which each tube is individually modelled by a box beam that accounts for the flexural and shear deformations, as well as the shear-lag effects. The method idealizes the tubes-in-tube structure as a system of equivalent multiple tubes, each composed of four equivalent orthotropic plate panels capable of carrying axial loads and shear forces. By simplifying the assumptions in relation to the patterns of strain distributions in external and internal tubes, the structural analysis is reduced to the mere solution of a single second order linear differential equation. A 3-D frame analysis program and two existing approximate methods are also included in the comparative study

Richard A. Ellis and David Pillington (2003) - The exterior columns have narrow spacing and the windows are recessed, creating the illusion of solid tubes.. Here, perimeter columns are spaced at 5.5 feet on centers and the spandrels between columns at each level are about 2 feet deep. The close column spacing expresses the idea of a solid tube perforated by holes that create the windows. The entire interior structural system is secondary -designed to carry only gravity loads to the ground level The innovations represent the creative genius of engineers like Fazlur Khan, Myron Goldsmith, and Leslie Robertson who devised structural systems that had functional superiority and were financially competitive

Modeling of Frame Tube Structure

The model prepared for the purpose of obtaining the loading is generated using commercially available software ETABS. The building is analyzed for dynamic load using Response Spectrum Method and Time History Method

Section properties

Following table shows the detail of various building component .Table No. 1.1: Summary of sizes of columns, shear wall, beams and slabs

Sr. No.	Member	Levels	Size (mm.)
1	Inner periphery Tube Columns sizes	Foundation level- Ground	1200X1200
	Inner periphery Tube Columns sizes	Story1to Story 25	1100X1100
	Outer Periphery Tube column	Foundation to 25th Story	600X600
2	Shearwall-around staircase	Foundation level to Story 25	450Thick
3	Beams-All main beams	All floors	500X800
	Beams-All secondary beams	All floors	500X1200
4	Slabs-All slabs	All floors	300 Thick

Material properties

Grade of concrete: M60 & M50

Grade of steel: Fe500

Unit weight of RCC: 25 KN/m3

Loading

Dead loads according to IS 875: Part I

Live loads according to IS 875: Part II

Dead load:-

Floor finish = 2 kN / m2

Partition wall load = 1.5 kN / m2

Live load:- = 2 kN / m2

Wind load is considered as per IS: 875. (Part III)

The maximum top storey displacements for wind in X & Y directions are 10 & 12 mm respectively. The maximum top storey displacements for earth quake in X & Y directions are 10mm and 10 mm respectively. Here is the 3d model of superstructure which is analyzed in ETABS software.

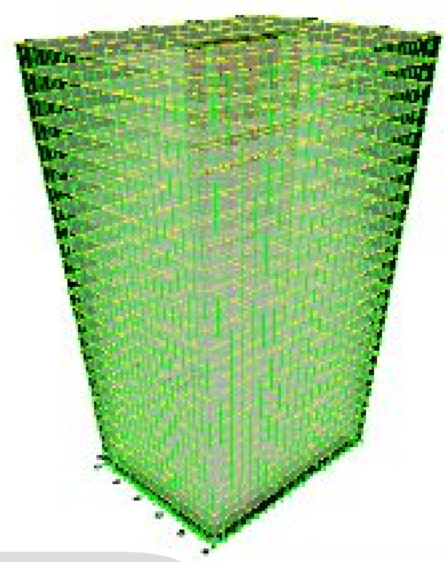

Fig. 1.1 3-D model of Frame tube structure

In ETABS software Frame tube structure is modelled and Conventional structure is modeled. The model is of Ground + Twenty -five storey. There are various parameters which are to be taken into account. For a twenty-five storey building, the size of the plan is 40m × 30m. For this structure, the outer periphery size of column is taken as 600×600 mm and inner periphery column size is taken as 1000 x1000 mm. The beam size is taken as 500 x 800 mm for outer periphery and 500 x 1200 for inner periphery. . The various parameter for which structure is analysed are as follows:- Diaphragm Displacement, Story shear, Story Drift, Time Period, Column elongation, Percentage of component

The Frame Tube model is analyzed for different type of slab as shown above such as membrane, shell, and shell without beam. The respective models are also analyzed for different zones such as II, III, IV .The same model with various type of slab and varying zones is analyzed for conventional structure also with restraint assigned as fixed .The frame tube structure with Membrane, shell, shell without beam are analyzed

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Figure-1.2 The Flow chart of Frame -Tube structure

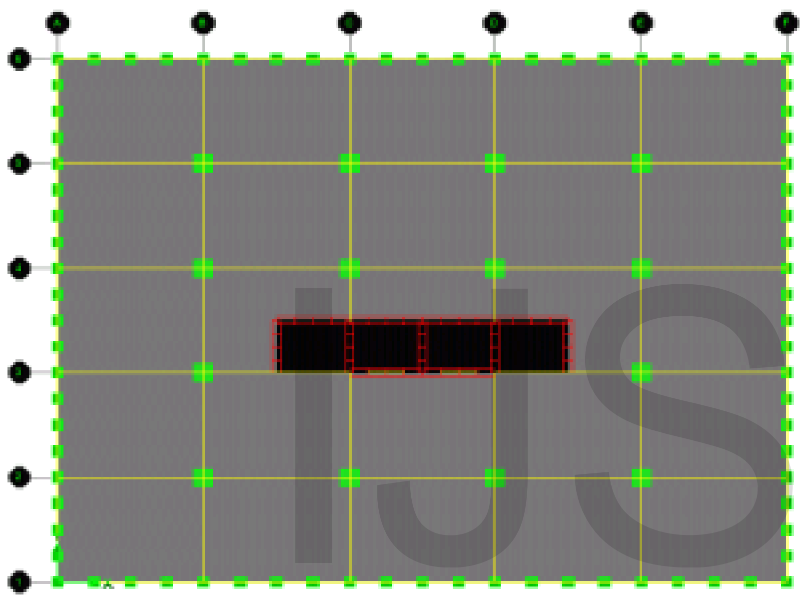


Fig 1.3 Layout of Plan of frame tube -structure

RESULTS AND DISCUSSION

For twenty-five storey frame Tube Structure is modelled with rigid diaphragm. The model is analyzed for various type of slab like membrane, shell, and shell without beam and also for the varying zones. The Zone designated are III, IV, V .The following observation are made. The distribution of value of diaphragm displacement are shown in Figures for load case Ex and E y

Effect of Diaphragm displacement on Frame Tube Structure

- Ø Diaphragm displacement graphs for different model with zones III for load case Ex

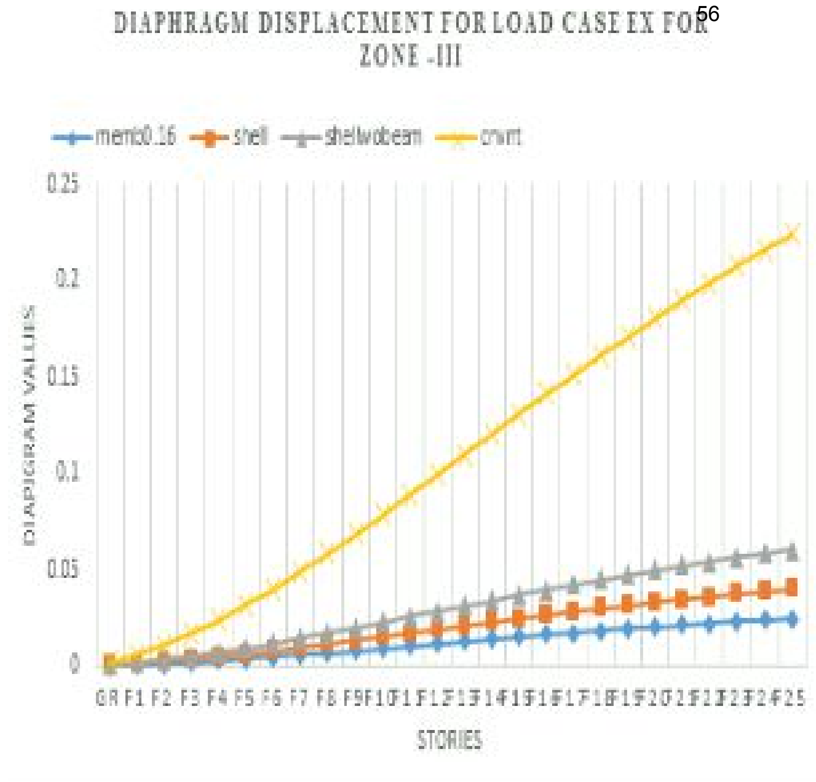


Fig no - 1.4 Graph shows diaphragm displacement values along the stories for Ex for zone III

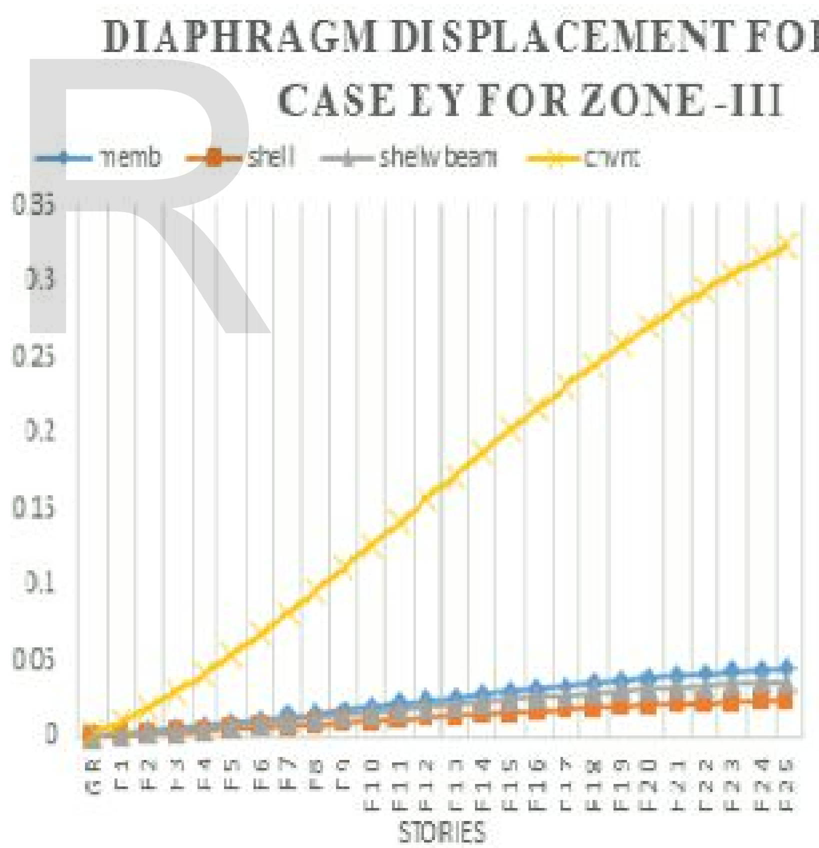


Fig no 1.5 - Graph shows diaphragm displacement values along the stories for load case Ey for Zone III

Effect of Story Drift on Frame Tube Structure

- Ø Story Drift graphs for different model with zones III for load case

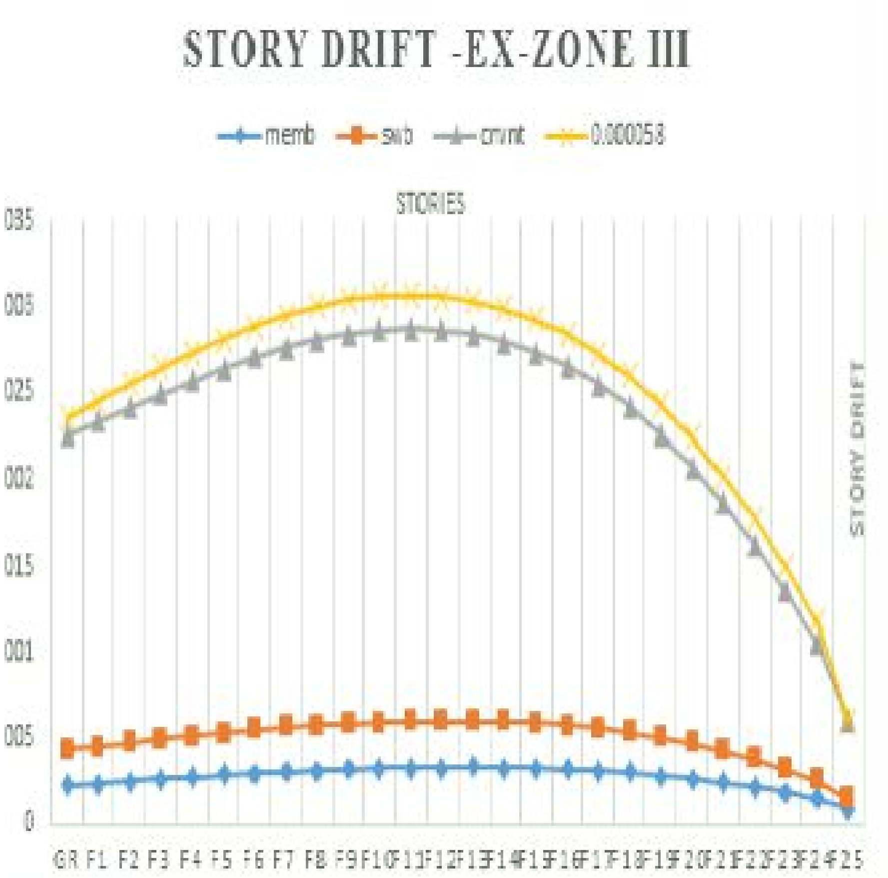


Fig no 1.6 - Graph shows diaphragm displacement values along the stories for load case Ey for Zone III

- Story Drift graphs for different model with zones III for load case Ex

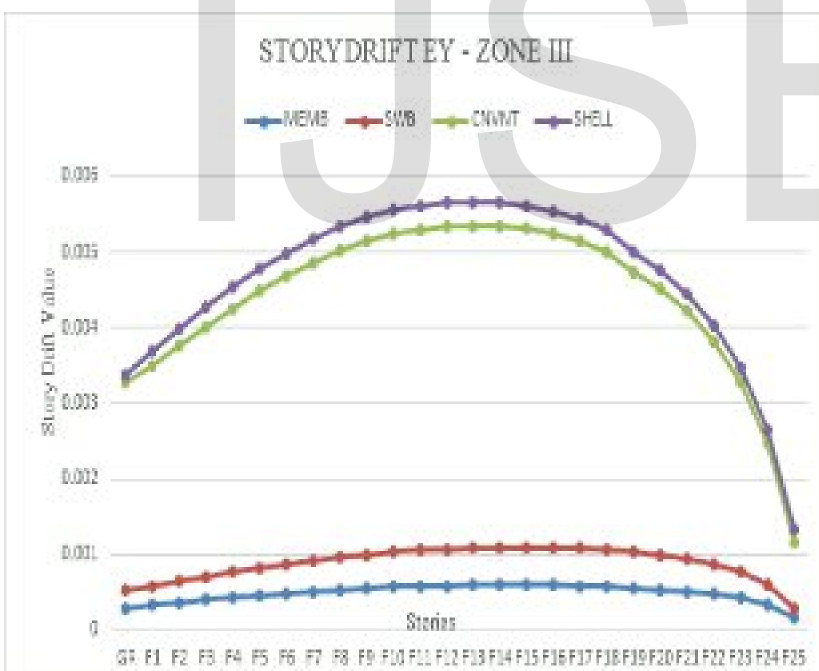


Fig no 1.7 - Graph shows diaphragm displacement values along the stories for load case Ey for Zone III

Effect of Story Shear on Frame Tube Structure.

- Story Shear graphs for different model with zones III or load case Ex

Fig no 1.8 - Graph shows diaphragm displacement values along the stories for load case Ey for Zone III

- Story Shear graphs for different model with zones III for load case Ey

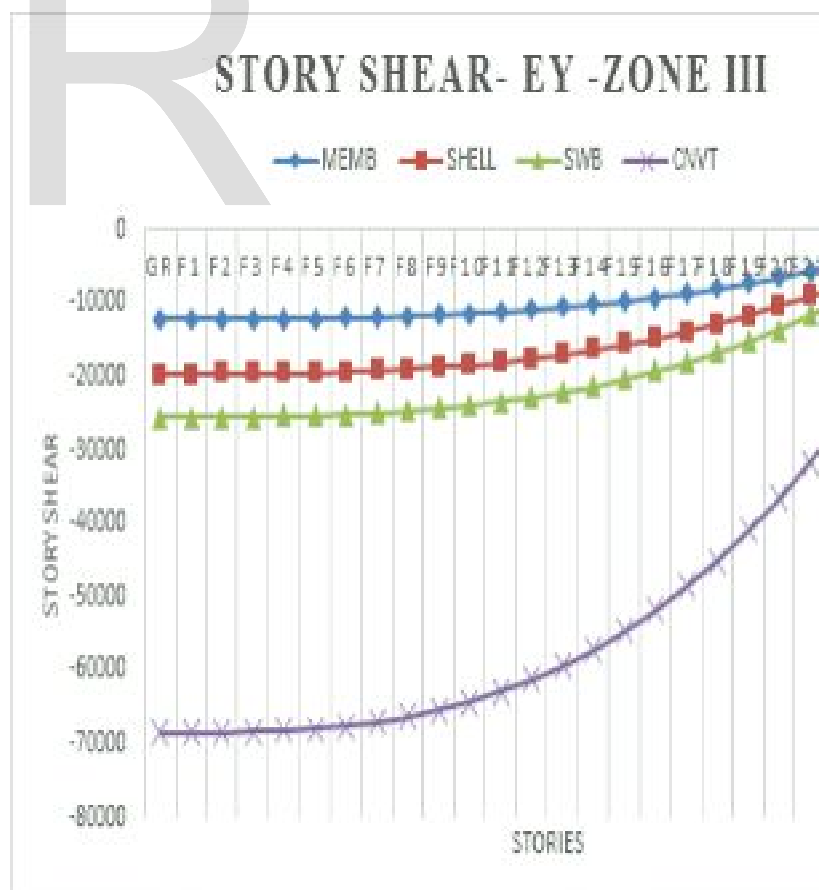
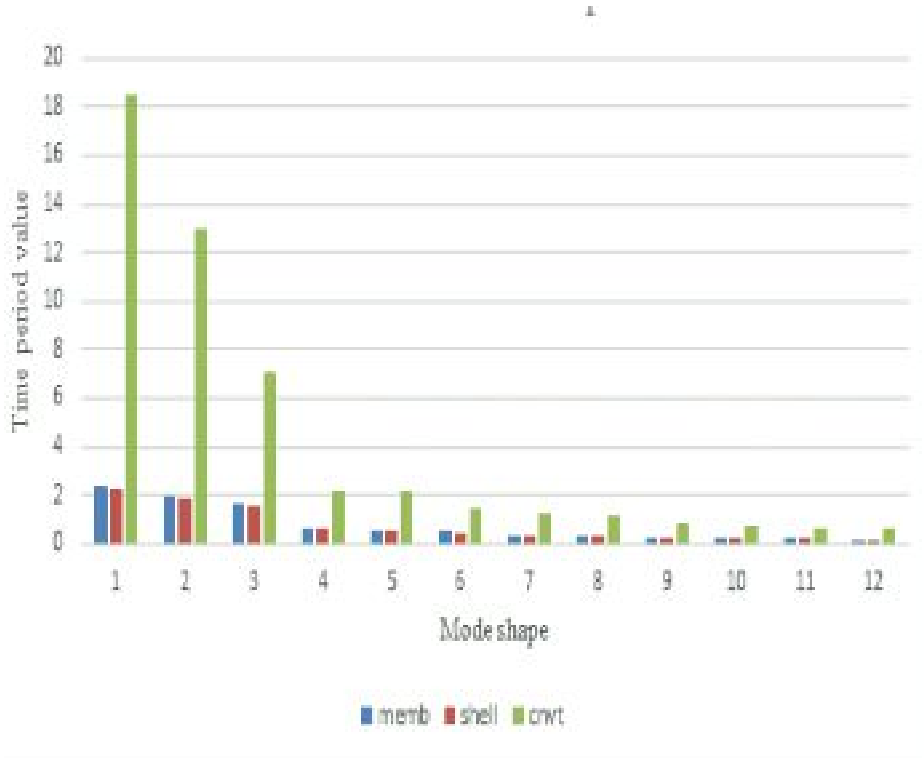


Fig no 1.9 - Graph shows diaphragm displacement values along the stories for load case Ey for Zone III

- Effect of Time Period on Frame Tube Structure.



CONCLUSION

The studies indicate that Frame Tube Structure concept has significant advantages in comparison to Conventional Structure. From the studies, the following points have been observed.

• The parameters such as story drift and story shear are reduce effectively in Frame Tube Structures in comparison to Conventional structure

• The Diaphragm displacement in Frame tube structure is lesser in Comparison of Conventional Structure

• The Time period for the first three modes is appreciably reduced in Comparison of Conventional Structure and which is eligible when it falls under High rise committee norms

• The Membrane slab for tube structure is most efficient slab for tube structure in comparison of other slabs tube model as story shear, and story drift is reduced effectively.

• There is 75 to 85 range of percentage reduction which is remarkable in Comparison of Conventional Structure.

The Tube structure can resist more lateral load and further tube -in tube or bundled tube structure can also be used for more earthquake prone areas. The fixed -butt restraint shows the most practical behavior and response spectrum analysis is more efficient in comparison of time history analysis

•It is been observed that percentage of Lateral load such as Earthquake in X and Y direction taken by Tube of the Tube structure is more in Comparison of Conventional Structure.