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# Comparative Study of Tube in Tube System and Bundled Tube System for High Rise Building

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**ABSTRACT:** In India, reinforced concrete frames are the most popular kind of construction. High-rise buildings have grown extremely popular in India as a result of the country rapid urbanization, which has led to an increase in land prices and the need for agricultural land. High-rise buildings must support loads other than only gravity, Lateral forces as well, since many significant Indian cities are located in seismically active areas, buildings must be strengthened. It is crucial for lateral forces. The purpose of this study is to examine the efficient, cost-effective, and safe structure between the Bundled tube system and the Tube in Tube system, The Tube in Tube and Bundled Tube ETABS versions, For analysis, the G+30 stories. These multiple-story structures can be converted into tall buildings that use less space but have more floor space land area. Tubular buildings have become more prevalent in recent years, becoming a typical component of towering buildings. structural tubes are especially appropriate for all tall constructions. In the planning of in towering buildings, lateral loads are a major factor. Wind and earthquake loads are examples of loads. seismological analysis is utilizing the equivalent static approach. The simulation Etabs software is used for analysis. Bare frame, Tube in Tube and Bundle tube Structure is Modelled structures are used. Compared and interpreted for three different models.

**KEYWORDS:** Tube in tube structure, Bundle Tube structure, Seismic analysis, RCC Building model, Response spectrum analysis, Earthquake.

## I. INTRODUCTION

### 1.1 General

India is a devolving country with large amount of population, the tall buildings are essentially required due to heavy land scarcity so people are going for tall building structure for their basic needs and necessities. Devolving the vertical structures, the consumption of land and transfer of electricity can be minimized and the green area is saved and ecology of the system get balanced. There is a huge support of technology, analytical system, structural system and material to develop high rise buildings. High rise building structural system analysis is done when they are subjected to lateral loads such as seismic and wind loads.

The installation of a lateral force resisting system is crucial for making the structure earthquake resistant. Significant horizontal stresses are imposed on the structures during an earthquake, severely damaging the structural components and ultimately leading to structure failure. The application of lateral force helps prevent damage from horizontal forces like earthquake and wind forces. Therefore, it is crucial that the structure has enough strength to withstand vertical stresses in addition to having enough stiffness to withstand lateral loads. The analysis of structures with lateral force-resisting systems, such as Tube-in-tube and Bundled tube systems, which are subtypes of Tubular structural systems, is the focus of this work.

### 1.2 Research Methodology

#### Classification of Tall Structure

The classification of tall buildings based upon their lateral load resisting system like shear frames, interacting system. Tubular system etc., their sub system classified based upon their height of the structure, shape, aspect ratio, load condition, stability of the structure and site conditions etc.,



Structural system is broadly classified into two systems;

1. Interior structural system
2. Exterior structural system

Exterior lateral load resisting system

1. Tubular system
2. Diagrid system
3. Buttressed core system
4. Exo-skeleton system
5. Super frame system
6. Hybrid system

Types of tubular system

1. Framed tube
2. Braced tube
3. Tube in tube
4. Bundled tube

**Tube in tube system/ hull core system** this system consists of two categories exterior framed system and internal core system, exterior and interior hull system is made up of closely spaced columns connected with spandrel beam or girder which acts as lateral force resistance system, Providing the tube in tube to the structural system increases the stiffness, shear lag, displacement of the structure when they are lateral forces. The exterior frame and internal hull core system are connected horizontally like framed structure which acts lateral force resistance system, wall structure acts as extra load resistance system.

**Bundle tube system** the word bundle tube says that the connection of two or more tube frames from a bundle to structure the world largest building in chicago is constructed using a bundle tube structure system it is connected nine number of tubes formed a bundle tube. By providing bundle tube to the structure there will be an even distribution of forces, Due to that their less shear lag in the structure when compared to other tubular system.

### 1.3 Code Provisions:

1. Code of practice for plain and reinforced concrete IS456:2000
2. Dead loads: IS 875:1987 (Part-I)
3. Imposed loads: IS 875:1987 (Part-II)
4. Seismic loads: IS 1893:

### 1.4 Objectives of the study

The main objectives of the present study on a

1. To determine the effect of lateral loads on buildings with tube-in-tube and bundle tube system.
2. To study the lateral storey displacement, story drift and base shear of tube-in-tube and bundle tube system.
3. To summarize the advantages of tube-in-tube and bundle tube frames under different geometry using obtained results.
4. To identify the most vulnerable building among the model considered for seismic action.

## II. LITERATURE REVIEW

### 2.1 General

In order to comprehend the significance and necessity of the current study in consideration of lateral resistant design, the following technical publications from various journals are analysed.

**Sanket Hanjage, Savitribai Phule, Muzhir Chause, Ajith Kurey 2020;** The present study, for high-rise structure of G+20 has been carried out for comparative evaluation of 'Tube-in-tube' and 'Framed tube' structural system. By using response spectrum method, the structure located in zone V is analysed for static and dynamic seismic load. For different structural parameters comparison has been made viz. base shear, lateral story displacement, story drift, time period and shear lag.



**Mohan K T, Virendra kumara K N Rahul Yand 2017;** In this analysis, a G+59 story reinforced concrete skyscraper was taken into consideration. For the about 316.8-foot-tall towers, gravity and lateral load calculations can be made directly by SAP. Based on IS: 456-2000 and IS 1893 (part1):2002, the load combinations. Comparing the square frame tubed structure, two different analysis methods were used to determine equivalent static and response spectrum analysis. The tube in tube structure reduced displacement by 43.45%. Rectangular, triangular, and hexagonal constructions had greater displacements of 34.8 percent, 62.72 percent, and 43.34 percent, respectively, when compared to the two square frame tubes in the tube structure.

**Basavanagoudapatil 2016;** With 88 floors that are each 3.6 metres high, the study's tall steel construction has a total height of 316.8 metres. The modal is examined with the aid of ETABS software. ETABS is used to model the tube-in-tube structure of various forms, such as square, rectangular, etc., and static and dynamic time history analysis is carried out. Results are significantly inferior to those of the high rise structural system; hence, dynamic analysis is preferred. It is clear from the overall findings and discussion that the construction is preferred for tall buildings over the traditional beam column moment resistant steel system.

### III. METHODOLOGY

#### 3.1 The Following methodology is adopted to analyse the different tubular system.

1. Multi storey buildings having Tubular structural system and traditional system having same floor plan modelled.
2. RCC, Tube in tube system and Bundle tube system are considered, models with same plan and bay size with same storey height.
3. The design of RCC and Tubular system dead load, live load, seismic load is carried out for 30 storey building models.
4. The response spectrum analysis & wind analysis for all the models using ETABS.
5. The results considered for each analysis are story displacement, story drift, Base shear, shear lag for each model.
6. Comparative study and interference is made for above obtained Results.

**Table 1: Description of models**

Serial no.	Model name	Description
1.	M1	Bare frame structure
2.	M2	Tube in Tube structure
3.	M3	Bundle Tube structure

#### 3.2 Primary Data

Sr. No	Parameters	Values
1	Concrete grade	M 35
2	Rebar size	Fe 550
3	Modulus of Elasticity of Steel	210 GPa
4	Modulus of Elasticity of Concrete	27000 MPA {as per IS 456:200, Cl.No.6.2.31}
5	Beam size	800x800mm,700x700mm,470x470mm
6	Column size	360x470mm
7	Slab thickness	150 mm
8	No of Stories	G+30
9	Height of each story	3 m
10	Density of Concrete	25kN/m <sup>3</sup>
11	Location	Mangalore
12	Seismic Zone	III
13	Importance Factor	1.5





14	Response Reduction Factor	53{OMRF}
15	Damping ratio	5%
16	Site Condition	II
17	Seismic Zone Factor	0.36 (IS 1893:2016, Cl. No6.4.2)
18	Diaphragm	Rigid
19	Maximum Storey Displacement	H/500
20	Storey Drift Limitation	0.004h

Table 2: Parameter considered in Etabs

4.3 Load consideration in this plan are;

Table 3.3: Load calculation for Model

Sr. No	Parameters	Values
1	Live load on each floor	4 KN/m
2	Live load on roof	1.5 KN/m
3	Floor finish on each floor	1.2 KN/m
4	Floor finish on roof	1.75 KN/m

Modelling and analysis

Model A

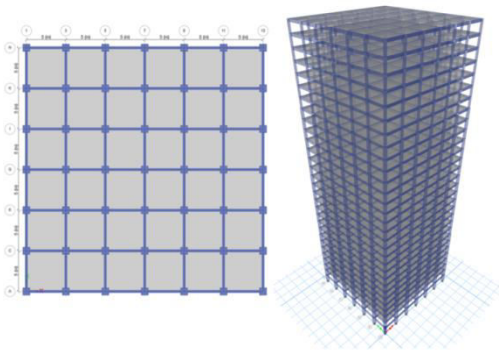


Fig:- 4.1 Model A plan and 3D view

Model B

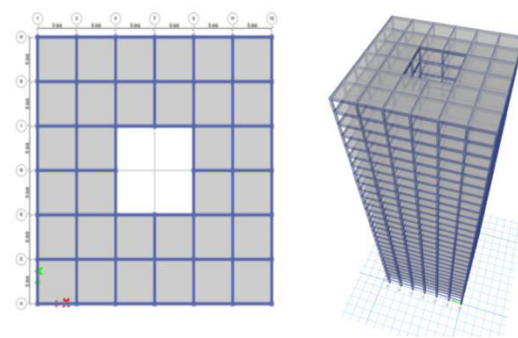


Fig:- 4.2 Model B plan and 3D view

Model C

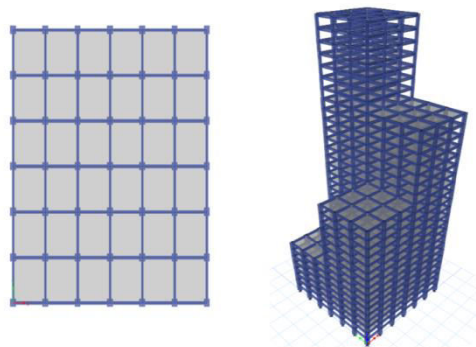


Fig:- 4.3 Model C plan and 3D view



**V. EXPERIMENTAL RESULTS**

The comparative study of displacement is carried out for three different structure for which the modelling and analysis is carried out using etabs software.

**Maximum story displacement**

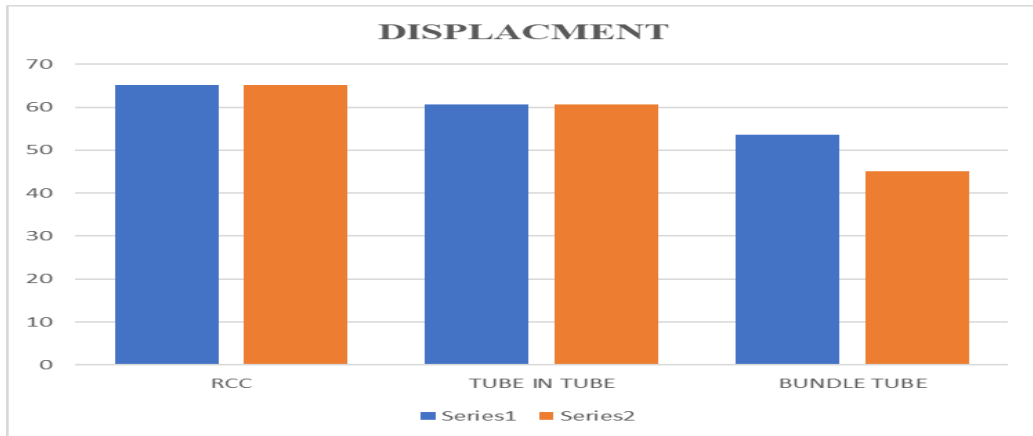


Fig-4.1 Max story displacement along X and Y direction of all models

**Maximum story drift**

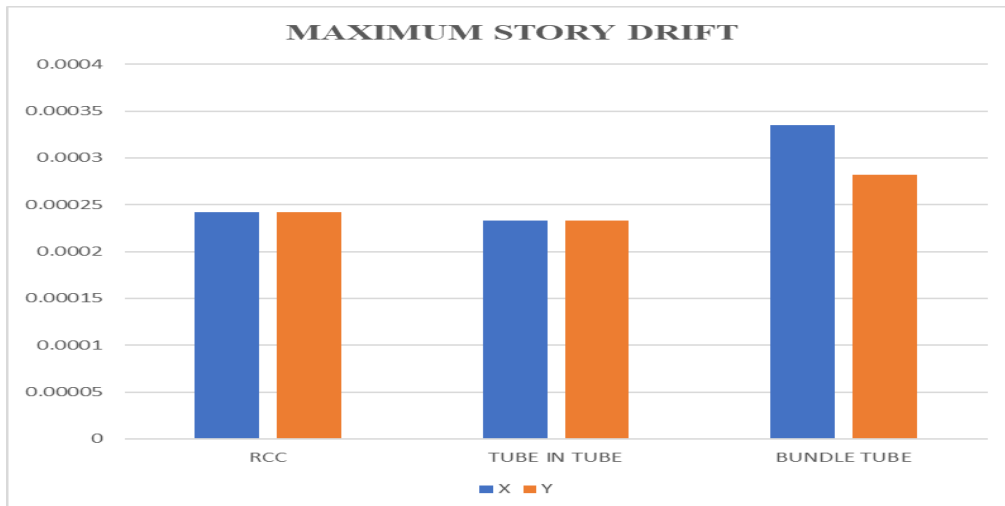


Fig-4.2 Max story drift along X and Y direction of all models

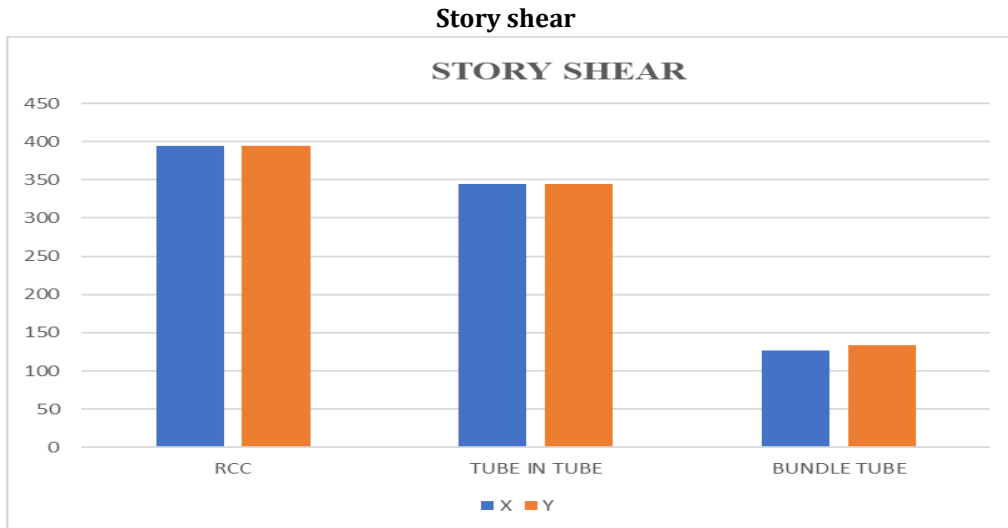


Fig-4.3 Story shear along X and Y direction of all mode

**Story stiffness**

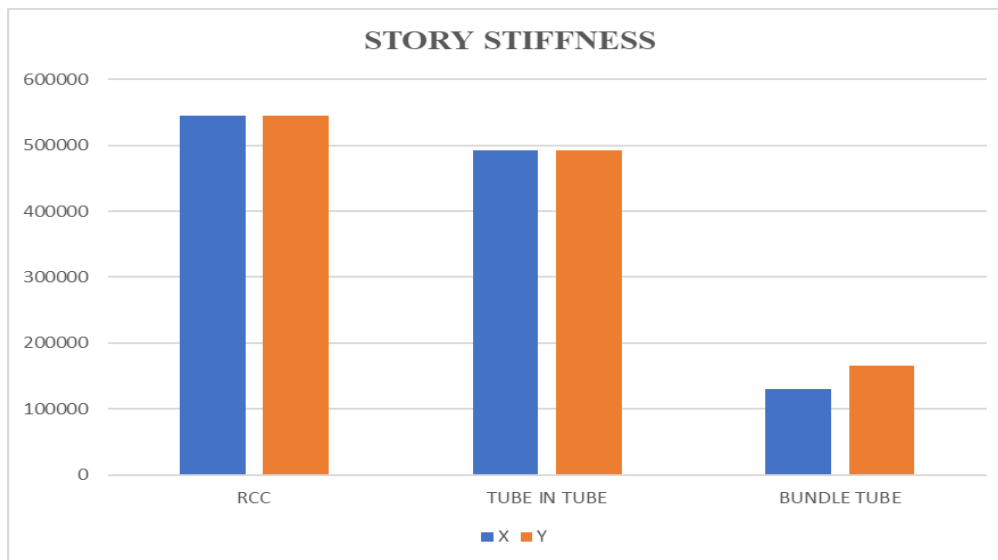


Fig-4.4 Story stiffness along X and Y direction of all 4 models

**VI. CONCLUSION**

- Using the results, it is concluded that the ideal geometric configuration for tall tubular structures, which summarizes the impact of geometric configurations on the behaviour of tall tubular structures.
- When creating tall buildings, additional safety precautions need to be taken into account. For example, the structure's foundation type, seismic and wind factors, and lifespan all need to be taken into account.
- For all geometric configurations, the effectiveness of tall tubular concrete buildings is determined with regard to base shear, story displacement, drift, and time.
- According to the study, the RCC frame exhibits greater story displacement than the Tube-in-Tube construction and Bundle tube construction.
- Additionally, it is evident that when the construction is bundle tube, tube-in-tube frame rather than RCC frame, narrative drift is within limit.
- Additionally, it should be noted that the RCC frame has a higher story shear than the tube-in-tube structure and Bundle tube structure.



7. According to the study's findings, the amount of concrete used in Bundle tube structures is lower than it was for RCC structures, and there is also a lower proportion of steel employed.
8. Tall buildings are more susceptible to lateral loads; therefore, we must take into account the building's parameters in order to withstand the loads. This study is based on the tubular concept, which provides more accessible spacing and is more lateral load resistant. This type of structure allows us to choose high-rise buildings.

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