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ANALYTICAL STUDY ON TALL BUILDING WITH BUNDLE TUBE STEEL STRUCTURE

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Abstract- Tall buildings are designed with Architectural, structural and mechanical design approaches. In the structural approach method for the structural members are further classified as interior structural resistance method and exterior structural resistance method. The perimeter of the tall building has a significant effect for lateral load resistance; hence in the latter, structural classification the most of the lateral load resisting systems are concentrated on the perimeter of the structure. A bundled tube is a cluster of individual tubes connected to act as a single unit bundle tube. Tube systems can be used in several geometrical forms like rectangular, square, triangular, circular and even free-forms in the plan. The most advantage of the bundle tubes is, it is free to create the tubes of different heights in the system and to control the aspect ratio. The primary objective of this study is to present a general comparative review of the performance of steel structure, tube structure and bundle tube structure subjected to Equivalent static analysis and time history analysis.

Key Words – Steel structure, tube structure and bundle tube structure

I.Introduction

In present world human's social activity has seen rapid development, especially in tall buildings. Its availability for International Metropolitan cities is gradually towards improving larger density, higher depth and more developed architectural images. Therefore, the various type of structural system of tall building has come up to meet the availability. Tall buildings are in practice nearly from twenty years of construction. To resist the lateral loads of high rise buildings, the structural systems like tube-in-tube structure, the framed tube structure, the tube structure have been commonly used. However, lateral rigidity of these types of structural systems cannot be able to satisfy their requirement when the volume or the depth of the high rise building becomes large degrees to some extent.

In this condition, the bundled tube structural system can be preferred because of strong load bearing capacity and higher lateral stiffness. In addition to this it has the good elastic performance and ductility. So it is a good prospective structural system for super high rise buildings. In the architecture view, more space is given by bundled-tube structure with very high altitude above 100 floors a skyscraper can be provided. For eg. Shear building adopted the bundled tube structural system in Chicago, America which becomes a good representative with improvised significance since it's economical and reliability efficiency gives a good balance.

However the reports and research paper are very hard to see at present on the analysis of the bundled-tube structural system because the bundled-tube structure belongs to big scale complex structural system i.e. its depth, flexibility and the design of structural system are slight different from those of the common structure. So its structural design and stressed performance are much more difficult compared to the conventional structural system.

[2] Shruthi L & S Vijaya studied on "Seismic Analysis of Latticed shell tube" and concluded that X bracing has shown significant variation. This system of lateral load resisting system is more efficient as it resists the displacement and hence the inter storey drift very effectively.

[6] Karthik A L, Geetha K studied on "Dynamic Analysis of Bundled Tube Steel Structure with Belt-Truss and Mega Bracings" and concluded Bundled tube steel structure with belt-truss and mega bracings system is stiffer than other frame in terms of displacement, storey and storey shear.

The objective of the present work is:

1. To analyze the three model i.e. Normal steel structure, tube structure and bundled tube steel structure and compare it analysis results.
2. To evaluate the above models w.r.t Equivalent static analysis (ESA – for Zone 5 and soil type – 1, 2 & 3) & time history analysis.
3. To determine the dynamic characteristics of steel structure this includes time history and base shear.
4. To determine parameters such as storey drift, storey shear and displacement.

II. Methodology

The below steps were followed to achieve the mentioned above objectives:

1. Modeled a Normal steel, tube & bundle steel tube structure of G+ 110 storey.
2. Built up column, ISMB beam and 200 mm deck slab are used for modeling.
3. ETABS software is used for analyzing and modeling of the structure
4. Building is analyzed for equivalent static and time history analysis.

III. Modeling

For analysis and the process of modeling the following assumptions were made:

1. It is considered that diaphragms are rigid for the floor slab of the building inside their own plane. At each floor level there will be a negligible lateral displacement between tubes.
2. In the panels and joint areas there will be no local buckling.
3. Throughout the building height there is uniform spacing of the column and beam.
4. The cross section of the column and beam is uniform throughout the building height.

Various parameters such as load intensities, material properties, dimension of the structural member and the seismic data considered in the modelling of the three different types of buildings considered for analysis are mentioned below.

Table 3.1: General details of buildings

No of storey	G+110
Building type	Steel
Seismic Zone	Zone 5
Soil Type	Soft, Medium and Hard (Type I, II & III)
Storey Height	3m
Response Reduction Factor	5
Importance Factor	1

Table 3.2: Structural members of buildings

Thickness of slab	0.2 m

Column	Built up section
Beam	ISMB
Wall thickness	Glazing load is considered

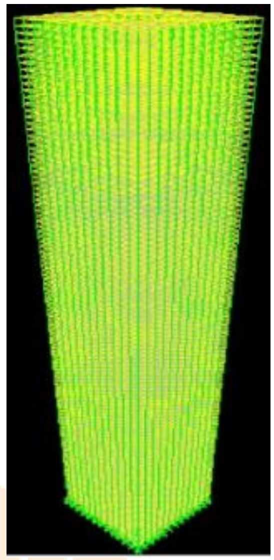

Fig 3.1: Steel Structure

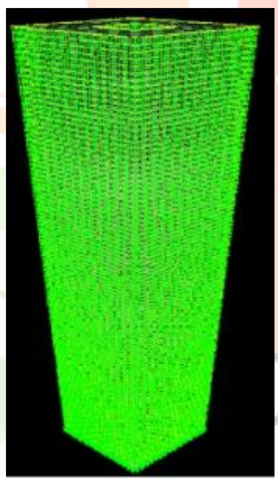

Fig 3.2: Tube Structure

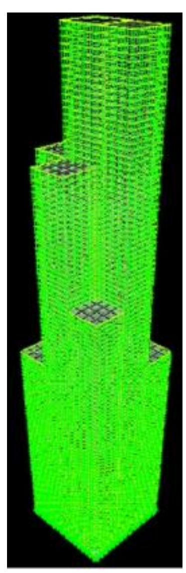

Fig 3.3: Bundled Tube Structure

Table 3.3: Material properties of buildings

Grade of concrete	M30
Grade of Steel	Fe 350
Density of concrete	25 kN/m^3
Young's Modulus of Elasticity	27386 x 10^3 kN/m^2
Poison's ratio of concrete	0.2

Table 3.4: Load intensities of buildings

Roof	
Live load	4 kN/m^2
Typical Floors	
Super Dead Load	1.5 kN/m^2
Live load	4.0 kN/m^2

IV. Results and discussions

Below Fig (4.1, 4.2, 4.3) shows displacement along X axis for 3 different soil types (type 1, 2 & 3). Here soil type 1 represents Hard soil; Soil type 2 represents Medium soil and soil type 3 represent Soft soil. Model 1, 2, 3 indicates normal steel structure; Model 4, 5, 6 indicates tube structure and Model 7, 8, 9 indicates Bundled tube structure. It is observed that for hard soil displacement is less and it increases by 400mm for medium soil and increases by 600mm for soft soil. The bundle tube structure has half of the displacement value compare to other structure. It indicates that the bundle tube structure is more effective and stiffer and its displacement is comparatively less than other structure.

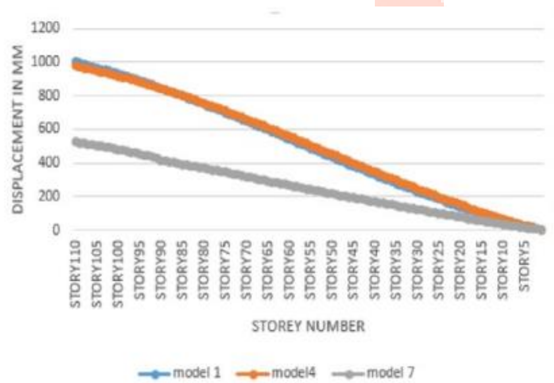

Fig 4.1: Displacement along soil type 1

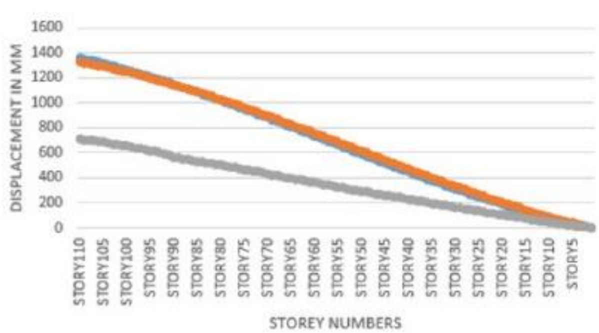

Fig 4.2: Displacement along soil type 2

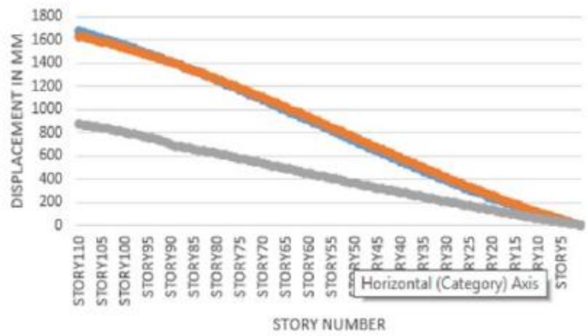

Fig 4.3: Displacement along soil type 3

V. Conclusion

1. From the above analysis and results the performance of bundled tube structure is acceptable than normal steel structure and tube structure.
2. It has been observed from the analysis that the bundle tube structure is more effective and provides better stiffness when compared with other 2 types of structure. Bundled tube structure is convenient to structure above 60 storey.
3. Displacement, storey drift and Base Shear of bundled tube structure obtained in time history analysis were lesser than Equivalent static analysis.
4. For time history analysis displacement along X and Y axis found to be maximum for hard soil and reduces for soft soil.
5. Structure analyzed by time history method is more efficient than equivalent static analysis method, since the results obtained by time history analysis is more accurate.

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