Design And Analysis of RC Tube in Tube Structure using ETABS Subjected to Wind Load

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Abstract:- **In recent years, tubular constructions have become increasingly prevalent in tall buildings. Tube in tube structures are ideally suited for any tall structures. A tube-in-tube structure consists of a framed peripheral tube and a core tube that are joined by floor slabs. The overall structure resembles a large tube with a smaller tube in the center. Both the inner and outer tubes share lateral loads. This paper includes an investigation of the vulnerability of different tubed structures to large wind loads when built as tube-in-tube structures and bundled tube structures. Tube-in-tube structures and bundled tube structures are unique and novel tubular structure concepts. In this project, ETABS software was used to conduct a comparison of tube- in-tube structure and bundled tube structures. Using ETABS, the modelling and analysis are performed.**

Keywords— Tube in Tube structure, Wind analysis, ETABS

I. INTRODUCTION

In recent years, tall buildings and structures have become slenderer, which increases the likelihood of excessive sway compared to older tall buildings. This creates additional difficulties for the engineering sector in resisting both lateral loads, such as wind and earthquake loads, and gravity loads. In the past, engineers primarily considered gravity loads when designing structures, but in recent years, due to the growth in height and seismic zone, they also consider lateral loads caused by wind and seismic forces. The height of tall structures is a comparative word. There is no globally applicable, precise definition for tall constructions. From a structural engineering standpoint, all tall structures must withstand both gravity and lateral loads. Due to the influx of a large population, towns and cities are expanding at a rapid rate. This phenomenon can be observed on every continent. The lack of available land for construction, especially in the world's biggest cities, is a widespread issue that has led to the vertical rather than horizontal development of structures. Today, high-rise commercial structures are symbols of modern society.These represent the strength of commerce in the current global economy. These also give the city a third dimension. Additionally, on a micro level, having a commercial space in a beautiful high-rise structure provides the firm with additional benefits in terms of increased client confidence and brand recognition. Globally, major towns and cities are constructing high-rise buildings with a very large number of stories, and India is not an exception to this trend. Tall structures comprised of a framework with multiple stories are flexible and vulnerable to the effect of wind forces.

To resist the effect of lateral loads on the buildings, several structural systems must be employed. There are tube structures, rigid frame structures, braced frame structures, shear wall frame structures, outrigger systems, and braced frame structures.The tubular systems are widely employed and are regarded as the superior lateral structural solutions for high-rise buildings. The tubular constructions are subdivided into frame tube, braced tube, bundled tube, tube inside tube, and tube mega frame structures.Tube-in-tube structures and bundled tube structures are unique and novel tubular structure concepts. In towering buildings, tube-in-tube constructions will be increasingly utilized.In the subject of tubular constructions for tall buildings, bundled tube structures are the new concept.

1.1 TubularStructure

The framed tube is one of the most significant modern structural innovations for tall buildings. The tube frames are composed of columns with a 2- to 4-meter center- to-center distance that are linked by deep girders. It resembles a hollow cylinder that is cantilevered perpendicular to the sky and supported by the ground. The tube system may be made of concrete, steel, or a combination of both. The objective is to produce a tube that functions as a continuous perforated chimney or stack. The lateral resistance of framed tube constructions is supplied by extremely rigid moment-resisting frames that create a tube around the building's perimeter. This structural design offers an efficient, easily manufactured framework suitable for 40- to 100-story structures.

1.2 Bundled TubeStructures

Instead of a single tube, the bundled tube system consists of numerous separate tubes coupled to produce a multi-cell tube.Together, they resist the lateral forces and rotational moments. The increase in the structure's rigidity is evident.This method permits the largest height and floor space. Not only is this technique economically efficient, but it also allows for more adaptable building designs, with buildings adopting unusual shapes and being grouped in dynamic clusters as opposed to being boxy skyscrapers.

1.3 Wind Effect

Since the wind varies over time, the wind spectrum and natural frequencies can be used to describe the difference in wind-related structural design of a typical high-rise building. In general, wind pressure and the resulting structural response are regarded as stationary random processes in which the time-averaged or mean component is separated from the fluctuating component. Tall buildings

are bluff bodies, and when wind blows against them, vortices are generated that result in an alternating force perpendicular to the direction of the wind. When the phenomena of vortex shedding occur along a substantial portion of the building's height, it can result in high forces and amplitudes.Wind loads linked with gustiness or turbulence produce substantially higher building responses than steady application of the same loads. Therefore, wind loads must be analyzed as though they were inherently dynamic.The intensity of wind load depends on its rate of variation and the structure itself.
According to IS 875 part III, the Dynamic effects of wind loading are described as flexible thin structures and structural elements being evaluated to determine the wind-induced oscillations or excitations along and across the wind direction.

II. OBJECTIVE

1. To investigate the unique building approach and comparison of tube-in-tube structures and bundled tube structures.
2. Analyze and compare the impact of wind loads on tube-in- tube and bundled tube structures.
3. To assess the performance of buildings constructed with tube-in-tube against bundled tube-in-tube conditions.
4. To examine the effectiveness of tall tubular concrete buildings in relation to the base shear, storey displacement, and storey drift determined for all models.
5. Using the acquired results, summaries the benefits of tube- in-tube and bundled tube structures under various situations.
6. To determine the most vulnerable building model among those studied for wind actions.

I. SOFTWAREUSED

The 2018 version of ETABS (Extended 3D (Three-Dimensional) Analysis of Building Systems) was used for modelling and analysis. ETABS is software for structural analysis and design. It can be used for linear, nonlinear, static, and dynamic analysis, as well as the design and detailing of any sort of structure and its components.

II. ASSUMPTIONS

Several significant modelling and analytic techniques utilized in the parametric study are outlined below.

- Both beams and column sections are uniform throughout the height of the building.
- Joints between slabs and beams are considered to be stiff.
- T-beam action is disregarded.
- Concrete floors are modelled with rigid diaphragms.
- The building is modelled as a prismatic cantilever beam.

III MODELING

TABLE 1 PARAMETERS OFSTRUCTURE

Sl. No.	Particulars	Data
1	Number of Stories	G+39
2	Storey height	3.5m Ground 3m for all other story
3	Column Size	1000x800mm
4	Beam Size	800x800mm
5	Slab Thickness	250mm
6	Grade of Material and Concrete	M30- Beam & slab M40- Column Fe415- Reinforcement bar

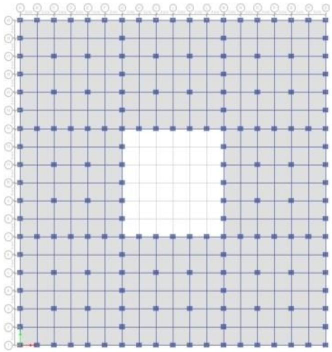

Figure 1 Plan

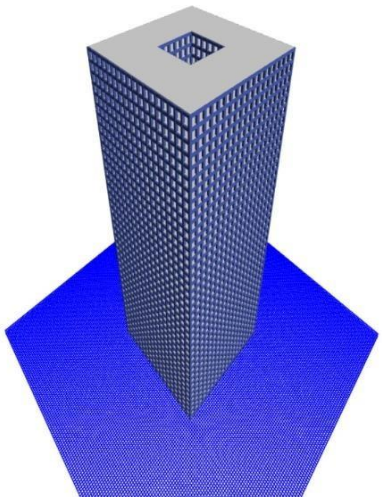

Figure 2

Rendered view of tube in tube structure

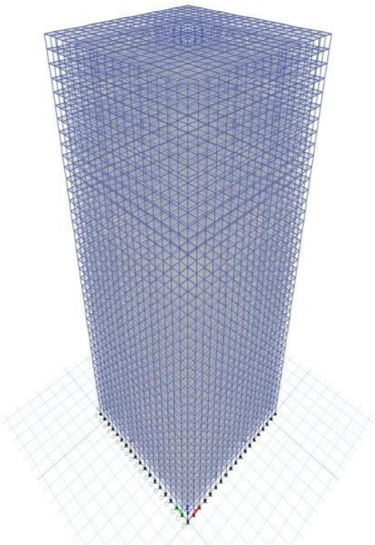

Figure 3 Grid system

TABLE 2 SEISMIC PARAMETERS CONSIDERED

Zone	III
Zone factor	0.16
Soil type	Medium
Importance Factor	1.5
Response Reduction Factor	5

TABLE 3 LOAD CALCULATION

Live Load	4KN/m^2
Dead Load	
Self-weight	6KN/m^2
Floor Finish	1KN/m^2
Total dead load on slab	7KN/m2

TABLE 4 WIND PARAMETERS CONSIDERED

IS	875-part III- 1987
Speed	39m/s
Terrain cat.	3
Structure Class	B
Topography factor	1

III. RESULT AND DISCUSSION

From the results obtained from Etabs analysis along with wind analysis for each models the results can summaries as follows.

TABLE 5 AVERAGE REDUCTION IN STOREY RESPONSES

Configuration	Storey displacement (%)	Storey Drift (%)	Base shear (%)
Tubular structure	40.34	28.58	18.74
Tube in tube structure	35.25	22.74	17.96

VII. CONCLUSION

From the present investigation, the following conclusion may be drawn:

1. For tubed in tube frames, storey displacement, storey drift, and storey shear are more than for tubular frames.
2. Tube in tube is a superior structural solution for tall buildings than tubular construction.
3. The tube-in-tube structural structure is among the most effective against large lateral loads.
4. It is evident from the results above that tube-in-tube systems can withstand the enormous lateral loads of a whole skyscraper.
5. The study concludes that by incorporating a shear core into the middle area of a structure, its performance can be enhanced. Therefore, it will behave as a tube-in-tube configuration.

6.A piece of the inner tube core can be utilised for super or double-decker elevators, which are needed for extremely tall structures.

7.Connecting the inner tube to outer mega columns enables variable aesthetic and architectural articulation in the facade system of supertall structures, so eliminating the primary disadvantage of closed-form tubular systems.

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