ANALYSIS AND DESIGN OF SKYSCRAPER BUILDINGS

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Abstract: There is an increasing need in the construction industry to travel in the vertical direction as high as possible because of several constraints. Every piece of land serves as a wonderful resource for our ever growing needs for residential as well as commercial purposes. A structure providing large column free space ensures us the flexibility to inhibit it for mixed use. The linear static analysis on the tall buildings reveals the critical frame elements with linear response under static excitation. Design sections are obtained from critical frame elements. Implementation of symmetrical layout reduces the crookedness of the structure. The obtained sway is checked whether or not in the acceptable limits.

Keywords* — *Tube in tube, Shear wall, Skyscraper

I. INTRODUCTION

The buildings of height varying between 23m to 150 m can be termed as a high rise building and the buildings of height greater than 150m are termed as skyscrapers. The outward appearance of tallness of building is a relative matter. Mostly, the skyscraper is a building with height-to-width ratio greater than about 5 i.e., the building is slender. A building having height more than 15m is called a High Rise Building as per National Building Code (NBC) 2005, India. A high-rise should be higher than 21 m as per United States General Laws.

There is no consensus on what constitutes a tall building or at what height, number of stories, or proportion a building can be called tall. Perhaps the dividing line should be drawn where the design of the structure moves from the field of statics into the field of structural dynamics. In addition to “tall buildings”, there are also designations for “Supertall” buildings and “Megatall” buildings. According to the Council on Tall Buildings and Urban Habitat (CTBUH), a Supertall building is defined as a building over 300 meters in height, and a Megatall building is defined as a building over 600 meters in height.

A. Structural systems

They have a profound influence on the aesthetics, design and resources. They include Shear frames, interacting systems, partial tubular systems and tubular systems. The frame, the wall and the core form the basic entities upon which the other structural systems can be fully evolved. The tubular structure can be viewed from the top and it resembles a tube with core at the centre and bulk of the other stuff at the circumference. All the utilities, elevator and stairwells are centralized in the core. The core can also be dangerous, when a part of the core is damaged, everything above that section will be cut off from ground access. The tube in tube system is preferred because of its diversified advantages. There will be a provision for lateral resistance by stiff moment resisting frames that form the tube around the perimeter of building. The gravity loading is shared by the inner core and outer tube. The system behaves like giant flange frames and perpendicular web frames. Flange frames normal to the wind carry axial loads and web frames parallel to the wind carry shear.

II. MODELLING

The layout of building is laid by considering the drag coefficients of different shapes. The value of drag coefficient is only 1.2 for triangular shape as against 1.4 for octagon, 1.5 for rhombus, 2.2 for circle and square. The plan shape of a framed tube structure greatly affects its efficiency, since the transfer of shear between the flange frame and web frame (the sides of the building analogous to the flange and web of a hollow cantilever beam) is crucial. The greater the angle between the flange and web frames at their point of connection, the greater the loss in web frame lateral resistance, as well as shear transfer. In addition, if the width of the flange frame is significantly larger than that of the web frame, or vice versa, shear lag is greatly increased. The closer the framed tube plan is to a square, the better is the performance.

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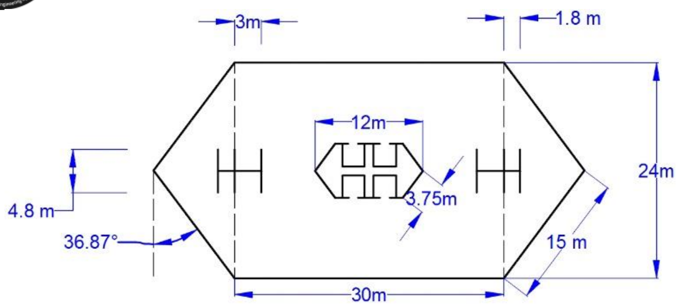

Fig-1: Layout of the building

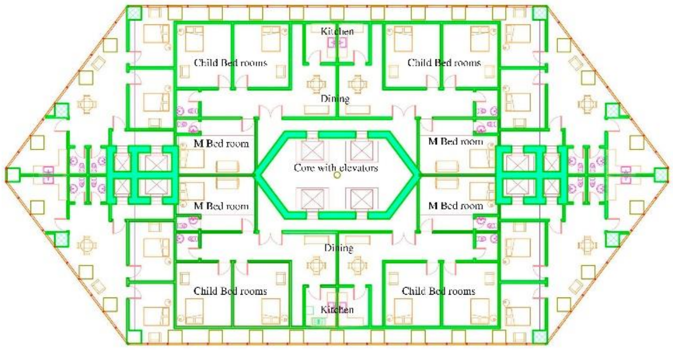

Fig-2: Functional plan of the building

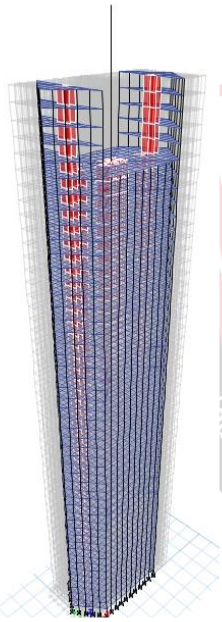

Fig-3: Fifty storey tube-in-tube structure

In addition to the dead and live loads, wind load is applied as per IS 875(Part 3): 1987 taking the terrain category as 4, class of structure C, life of structure N as 100 yrs. and wind zone 5. The earthquake load is applied as per IS 1893(Part 1): 2002 provided location in Vijayawada city. The critical/maximum earthquake and the wind loads are not supposed to act simultaneously.

III. RESULTS AND DISCUSSIONS

In the columns, critical combination is 1.5(DL+FFL+EQ$_y$); maximum axial force is developed in storey 1 and its value is 86,769.8 kN. Maximum moment is developed in storey 8 and its value is 5717.6 kN-m. In the beas, critical combination is 1.5(DL+FFL-EQ$_x$); maximum values of shear and moment are respectively 2595.34 kN and 6265.50 kN-m. The cross-sectional dimensions of beam are 1m X 1m and that of composite column with embedded I section W 40 X 593 are 1.5m X 1.5 m.

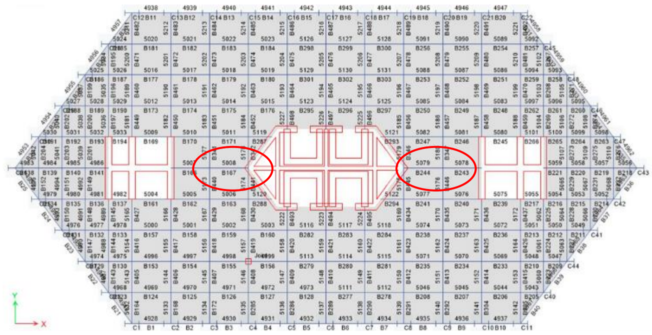

Fig-4: Location of critical beams

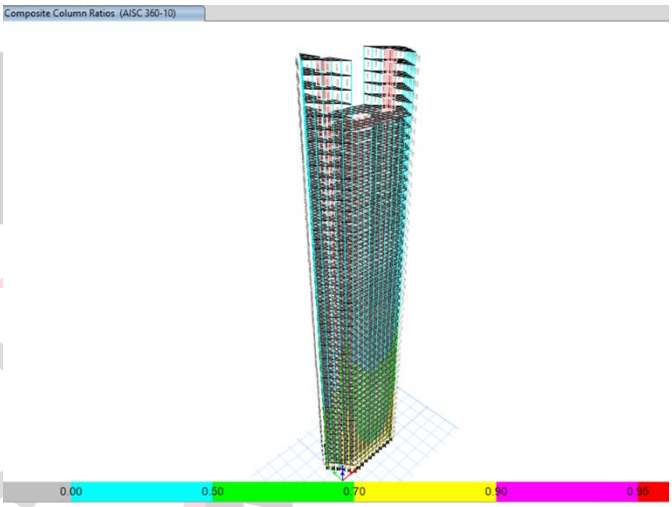

Fig-4: Colour coding for composite column ratios

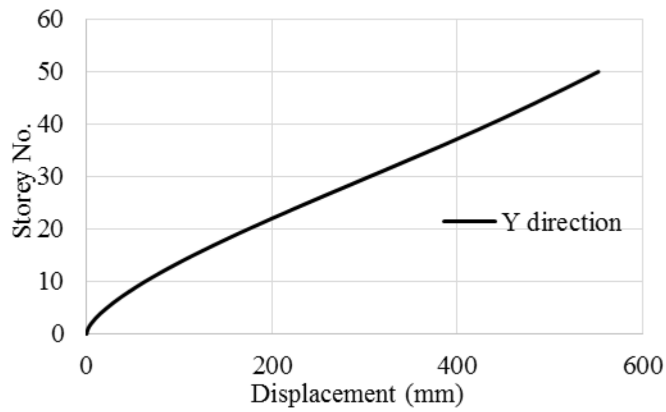

Fig-4: Max storey displacement

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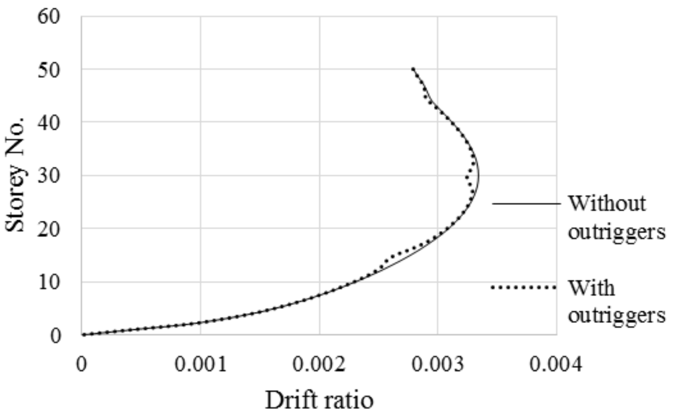

Fig-4: Storey drift ratio

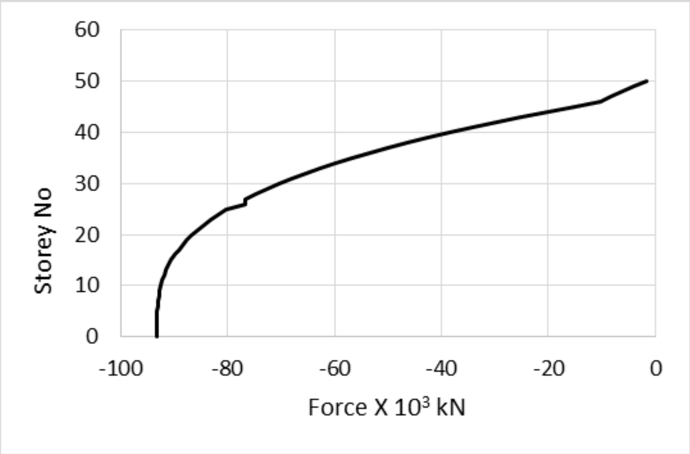

Fig-4: Storey shear force

IV. CONCLUSIONS

- Torsional moment became negligible (<0.01 kN-m) in frame elements because of the symmetry
- The lateral sway is 44% less than that of maximum value of permissible range.
- The lateral drift is far less than the value of 0.1 which indicates its high margin of safety.
- The lateral drift is only 0.28% satisfying the limitation of 0.4% from IS 1893 (part 1): 2002.
- The drift is 86% lesser compared to that of threat to value of threat to human safety

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