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Comparative Study of Conventional Steel Structure and Tubular Steel Structure

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Abstract - *Many steel structures are made of standard steel sections designed and built in the traditional way. It leads to complex and expensive structures. Tubular steel sections are the best choice of conventional ones with useful properties and relatively good. In this study analysis and design of 13 story industrial steel structure with conventional sections and tubular sections. A irregular floor plan at each floor is considered. For modelling and analysis of structural members STAAD PRO V8i software is used. All structural members are designed as per IS code considering all load combinations. Static analysis and Time history analysis considered for seismic analysis and design of the structure. Comparison of analysis results on the basis of base shear, top story displacement, weight of structure. From the above study of analysis of conventional and tubular structure. It is understandable that tubular section is highly effective than conventional section that are subjected to lateral loading, to resist overall displacement and overall economy around 12 - 15% is achieved.*

Key Words: **Tall steel building, Time-history analysis, Static analysis, Conventional section, Tube section, STAAD Pro V8i**.

1. INTRODUCTION

Population growth in urban societies and the continued constant pressure of land have led to the emergence of very high-rise buildings. Tall buildings are considered a symbol of civilization. From a structural point of view, these are structures where their height will be affected by lateral forces due to wind loads and earthquakes until such power will play a major role in the design method. The construction of high-quality buildings is a challenging undertaking by professionals and engineers. In order to build a tall structure, one has to think about a project to build its own design based entirely on limited design and analytical analysis.

As high-rise buildings have greater prestige around the world, their impact on society and the economy is felt worldwide. Over time, new barriers to high-rise construction are accompanied by growing demands for efficiency, efficiency, and economic structure. Designers are concerned about choosing construction plans that can carry extra loads as well as the availability of service and comfort requirements. The economic life of tall buildings depends largely on the usability and ease of living as a requirement. Typically, tall buildings are constructed to withstand extremely strong winds over a long period of time. The chances of catastrophic failure are slim; however, studies of wind movement and effects on high-rise buildings are important from a service and economic perspective. The performance of tall buildings under wind is usually measured by the amount of side displacement and acceleration. Excess lateral removal can cause structural and non-structural damage, while excessive acceleration can lead to improper posture of occupants.

Common methods of construction have been found in the past, which restricted buildings to up to five storeys. These small structures are often considered to be their strength to withstand horizontal loads and are designed for gravity. However, in tall buildings the gravitational load system cannot withstand horizontal force effectively. There was a need for such a type of structural system that could meet the requirements to withstand all types of liability from an economic point of view.

1.1 Conventional Structures

The conventional steel sections in India are very common in industrial construction. Conventional buildings are buildings that are built using the standard methods of construction. It involves traditional construction materials and stays within a particular set of parameters. Conventional steel structure are often fabricated on site. Conventional steel structures are a very common industrial construction. Hot rolled sections are used as primary members, twist and buckling is less likely to occur for a well-designed structure. Due to this structures have simple connections which makes steel structure design easy. Hot rolled sections in many segments are much heavier than what is actually required as per design. Cost is higher due to higher consumption of steel.

1.2 Tubular Structures

The tube is the name given to the systems where in order to resist lateral loads like wind, seismic, etc. A building is designed to a three-dimensional tube, perpendicular to the ground. Fazlur Rahman Khan introduced this system. Tube frame construction was first used in the DeWitt-Chestnut Apartment Building, designed by Khan and completed in Chicago in 1963. The system can be constructed using steel, concrete, or both steel and concrete (composite construction). It can be used for office, apartment and mixed-use buildings.

2. AIM AND OBJECTIVE

The aim of this paper is to improve the structural performance and cost effectiveness in design of tall steel building.
The dissertation work is done to achieve the following objectives.

1. Modeling two tall building using StaadPro software.
   a) By using convictional sections.
   b) By using tube sections.
2. Study the structural behavior of steel building under different load condition like gravity load, wind load and seismic load as per IS-875 (2015) part 1 to 4 and IS-1893 (2016) part 1 & 4.
3. Study the influence of lateral loads on the performance of tall building.
4. Result comparison of building.

3. MODELLING AND ANALYSIS

3.1 Modelling Work

In this present study, (G+13) story Steel Industrial Tall Building. The modeling work is done in STAAD PRO V8i. The building is situated in Seismic Zone II with the following seismic, sectional and material properties. The model consists of various elements such as beams, columns, for checking the performance against the acceptance criteria.

Table -1: Details of Tall Steel Building

Name of parameter	Specification
Height of building	37.4m
Type of structure	Steel
Length of structure	10m
Width of structure	8.4m
No. of column	9
Location	Koppal, KA
Seismic zone	II
Zone factor	0.1
Importance factor	1.5
Response-reduction factor	4
% Damping	2 %
Wind speed	39 m/s

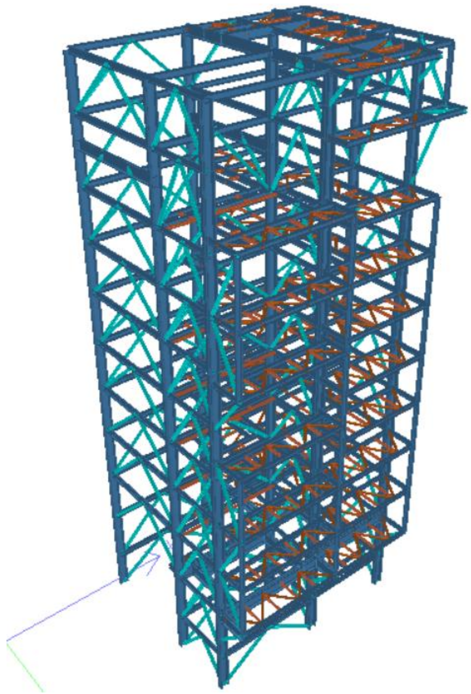

Fig -1: 3D view of structure

3.2 Analysis Work

The analysis and design of 13 story industrial steel structure with conventional sections and tubular sections. A irregular floor plan at each floor is considered. The STAAD PRO V8i software is used to model and analyze structural components. All members of the structure are designed according to IS 800: 2007 consider all load combinations. Time history analysis and static analysis considered for seismic analysis and design of the structure. Comparison of analysis results on the basis of base shear, top story displacement, weight of structure.

4. RESULTS AND DISCUSSION

4.1 Base Shear Results – Static Analysis

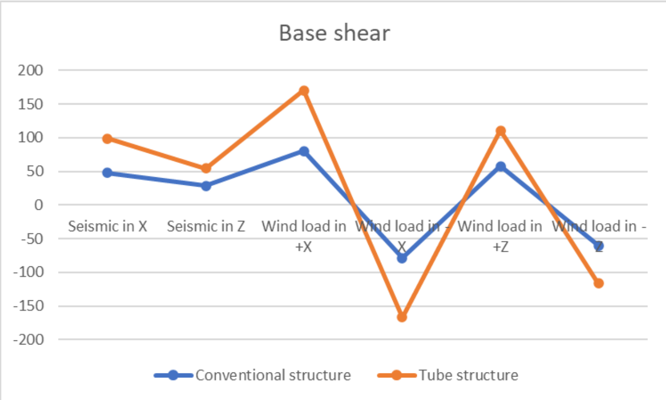

Chart -1: Base Shear – Static Analysis

Base Shear (KN)			
Sr. No.	Load case	Conventional structure	Tube structure
1	Seismic in X	57.281	85.562
2	Seismic in Z	43.451	29.862
3	Wind load in +X	80.26	89.776
4	Wind load in -X	-78.661	-88.176
5	Wind load in +Z	57.716	52.946
6	Wind load in -Z	-60.332	-56.229

Table -2: Base Shear Values – Static Analysis

4.2 Base Shear Results – Dynamic Time History

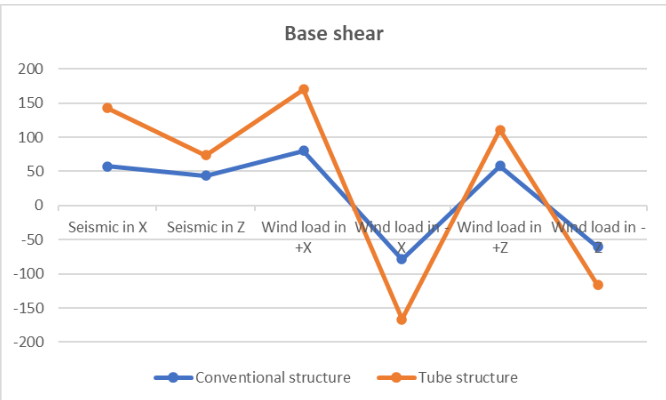

Chart -2: Base Shear – Dynamic Time History

Base Shear (KN)			
Sr. No.	Load case	Conventional structure	Tube structure
1	Seismic in X	47.469	51.144
2	Seismic in Z	28.632	25.716
3	Wind load in +X	80.26	89.776
4	Wind load in -X	-78.661	-88.176
5	Wind load in +Z	57.716	52.946
6	Wind load in -Z	-60.332	-56.229

Table -3: Base Shear Values – Dynamic Time History

4.3 Maximum Story Displacement – Static Analysis

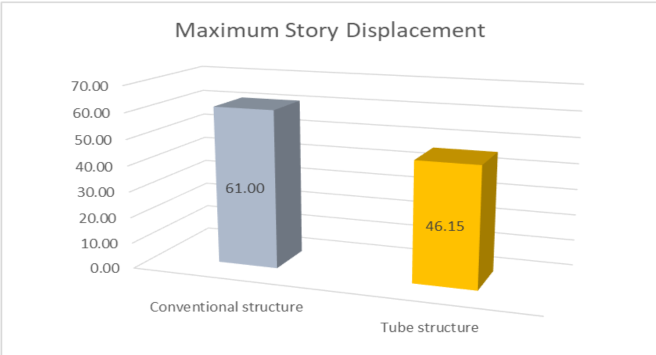

Chart -3: Maximum Story Displacement – Static Analysis

Peak Displacement Values (mm)			
Sr. No.	Permissible limit	Conventional structure	Tube structure
1	99.08	61.00	46.15

Table -4: Maximum Story Displacement Values – Static Analysis

4.4 Maximum Story Displacement – Dynamic Time History

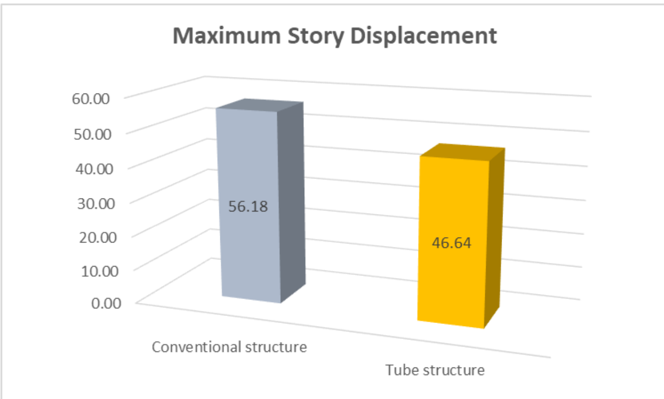

Chart -4: Maximum Story Displacement – Dynamic Time History

Peak Displacement Values (mm)			
Sr. No.	Permissible limit	Conventional structure	Tube structure
1	99.08	56.18	46.64

Table -5: Maximum Story Displacement Values – Dynamic Time History

4.5 Weight Comparison in Tons

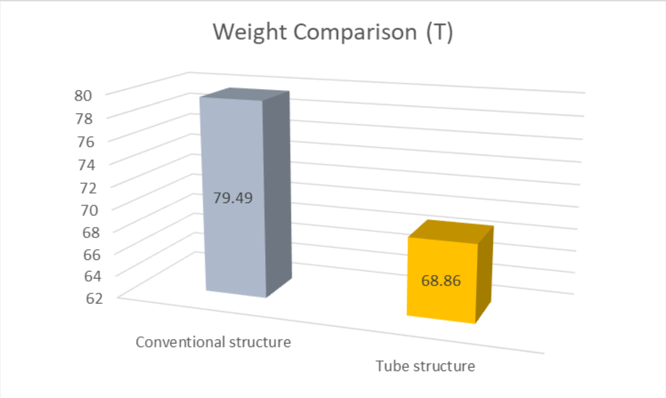

Chart -5: Weight Comparison

Weight Comparison (T)		
Sr. No.	Conventional structure	Tube structure
1	79.49	68.86

Table -6: Weight Comparison Values

5. CONCLUSIONS

From the above-mentioned analysis of conventional and tubular structure. It is understandable that the tubular system is highly effective than conventional system that are subjected to lateral loadings. The following discussion has been made from the present study.

From the modular investigation it can be inferred that, steel tube structures are more adaptable than regular conventional steel structure.

The tubular system is effective to resist the overall displacement than conventional system.

Above study reveals that tubular sections prove to be economical. Total saving of almost 12 – 15 % in cost is achieved. Tubular phase performance can be verified in different parts of the system. Members of a larger structure that are unsupported can be assigned to tubular sections that will benefit the entire economy.

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