Comparative Analysis between Tube in Tube Structure and Conventional Moment Resisting Frame

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Abstract - *Lately, Framed tube and framed tube in tube structures have been broadly utilized as framework for tall structures. Framed tube structure with various internal tube or tubes in tube structure, are generally utilized in view of their high solidness in opposing horizontal load and the accessibility of inside tubes in supporting the vertical tubes. At the point when subjected to parallel load, for example, wind load, the corner sections encounter considerably higher axial load because of the notable amount of shear lag. The investigation is completed in ETABS V15. Here behavior of Tubular. The impact conduct of tall tubular structures with truss around the peripherals, and the investigation the impact of column spacing on arrangement of truss individuals for tubular structure is completed.*

Key Words: Framed Tube, Framed Tube in tube, axial load, Seismic load, wind load, ETABS, Steel Tube Truss.

1. INTRODUCTION

Due to limited area and increasing expansion of urbanisation it is feasible to expand in vertical direction than in horizontal direction. And due to increasing vertical urbanisation it is important to adopt to more stable structure. Here, tubular structure is one such structure, where the columns are placed at the periphery of the structure. Also here Tube in Tube structure is used. Compared to conventional structure the tube in tube structure is more stable lateral loads, allows more interior space and helps save around 30% steel. Here five models are done having tube in tube structure with different column spacing and also providing X bracing to them.

1.1 TUBULAR STRUCTURE

Tubular structure is a type of structure where, the columns are placed on the periphery of the building. There are different types of tubular structure- Framed tube structure, Tube in Tube structure, Bundled Tube structure, Braced tube Structure. These structure are basically designed to act like a hollow tube which are perpendicular to the ground. These building are basically made of Steel, concrete or composite of both.

In these structure external frame takes the lateral loads like seismic, wind. The interior frame takes care of the connectivity and gravity loads. Both the frames are connected by beams or truss. It is to be noted that in tubular structure help in resistance of the structure due to lateral load.

1.2 TUBE IN TUBE STRCUTURE

Tube in Tube is most common used type of tubular structure. Here the structure consist of internal tube, thus the name. The internal tube can be used for movement between the floors i.e. can be used to provide stair case, lift room. Even though Tube in Tube Structure help in resisting lateral loads acting the structure, the lateral loads are mostly resisted by the external tubes of the structure.

1.3 OBJECTIVES

1. Comparative analysis between tube in tube structure and moment resisting structure. With static and dynamic loads in high seismic zones.
2. To study the behavior of the tubular structure in variation of the column spacing.
3. To study the behavior of the tubular structure with X bracing on the structure.
4. Results are compared between the models with respect to Base shear, Displacement, Drift, Time period, Stiffness.

1.4 METHODOLOGY

1. In the present examination a 50 storied Steel building is considered, having general arrangement measurement of 48 m x 48 m along X and Y course.
2. Steel structure is with floating columns are displayed.
3. To examination the impact of general execution of the structure, steel X bracings are given.
4. X bracings at various area at various statures are considered.
5. Total five models are viewed as one customary steel structure, two Tube in Tube structure with floating columns and two models with bracing.

6. Equivalent static and dynamic time history analysis is completed using ETAB Ver. 2015.

7. Important outcomes like displacements, story drifts, peak displacements, base force and acceleration are shown.

2. MODELLING AND ANALYSIS

Five models are considered for analysis.

Model 1 – Conventional Moment resisting frame.

Model 2 – Tube in Tube Model.

Model 3 – Tube in Tube Model with reduced spacing.

Model 4 – Model 2 with X bracing.

Model 5 – Model 3 with X bracing.

2.1 MATERIAL PROPERTIES

- M 30 grade concrete and Fe 500 grade reinforcement is considered.
- Young's Modulus steel, Es = 210000 Mpa
- Young's Modulus Concrete, Ec = 27386 Mpa
- Characteristic strength of concrete, fck = 30 Mpa
- Yield stress for steel, fy = 500 Mpa
- Ultimate strain in bending, ε_{cu} = 0.0035

2.2 MODEL GEOMETRY

- The structure considered is a 50 story moment resisting frame and tube in tube structure.
- The height of story is 3m.
- Total height of the building is 150m.
- Number of bays in each direction of X and Y is 9.
- Bay width is 6m in both X and Y direction.
- Spacing between each column, for model 1 and 2 is 6m, for model 3 is 3m.
- Bracing are provided to model 2 and 3 at spacing of 10 floors.

2.3 PLAN VIEW OF THE BUIDING

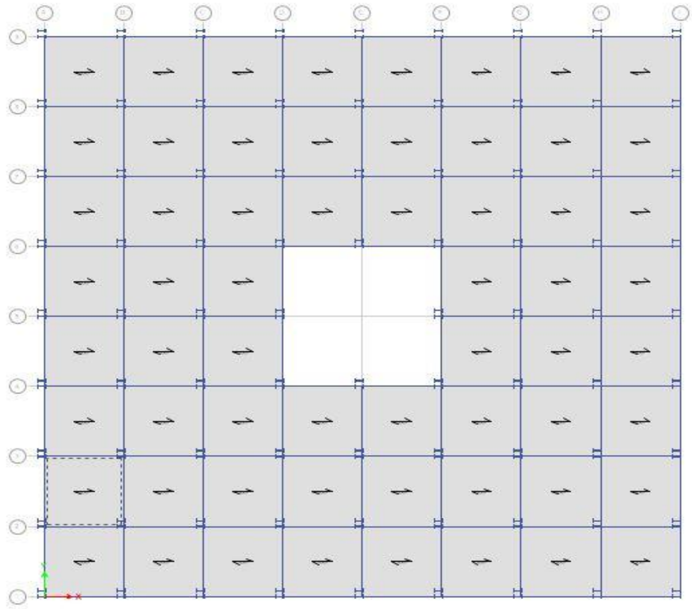

Fig 1: Plan view of the model 1

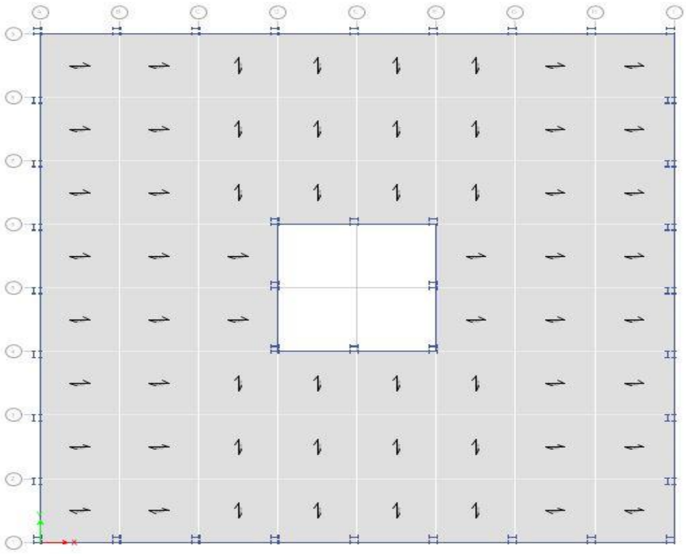

Fig 2: Plan view of the model 2

2.4 ELEVATION OF THE BUILDING

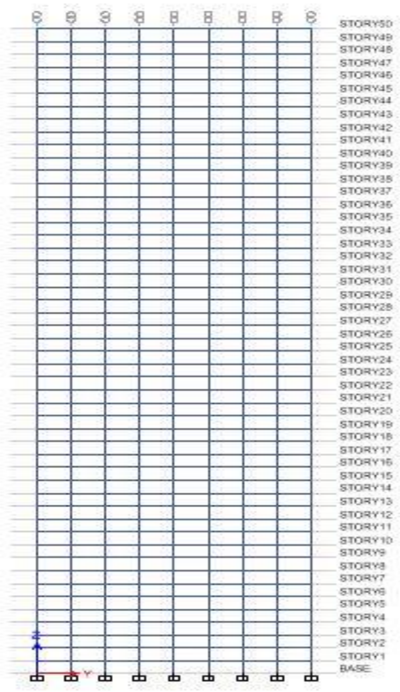

Fig -3: Elevation of Building

2.5 3D MODEL

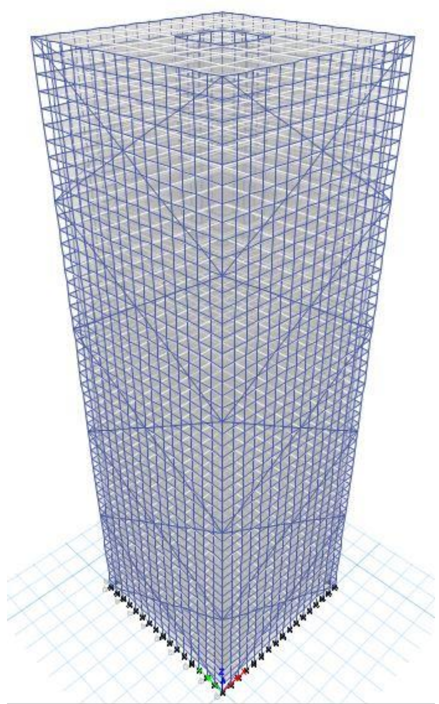

Fig -4: 3D Model of Structure Model 5

3. RESULTS

3.1 TIME PEROID RESULTS

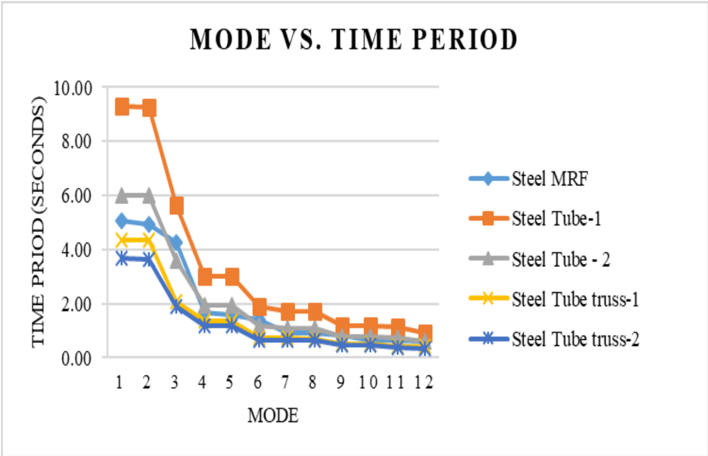

Chart -1: Time Period

3.2 BASE SHEAR RESUILTS

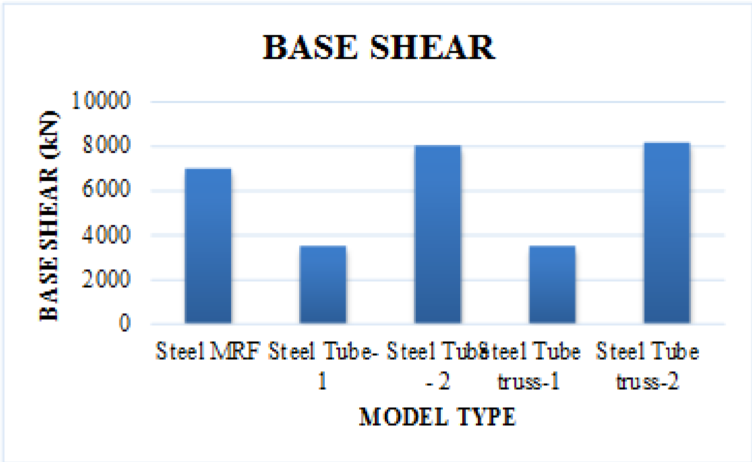

Chart -2: Maximum Base Shear

Base Shear (KN)				
Steel MRF	Steel Tube-1	Steel Tube - 2	Steel Tube truss-1	Steel Tube truss-2
6986	3470	8031	3523	8127

Table -1: Maximum Base Shear Values

3.3 MAXIMUM STORY DISPLACEMENT

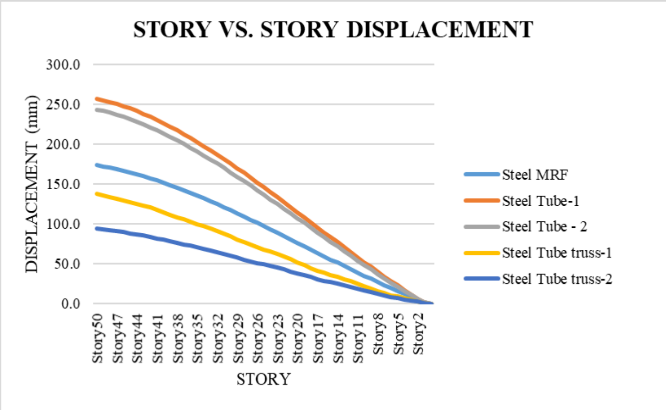

Chart -3: Maximum Story Displacement

Peak Displacement Values (mm)					
Story	Steel MRF	Steel Tube-1	Steel Tube - 2	Steel Tube truss-1	Steel Tube truss-2
Story50	173.9	257.5	243.8	138.2	94.6

Table -2: Maximum Story Displacement

3.4 MAXIMUM STORY DISPLACEMENT – DYNAMIC TIME HISTORY

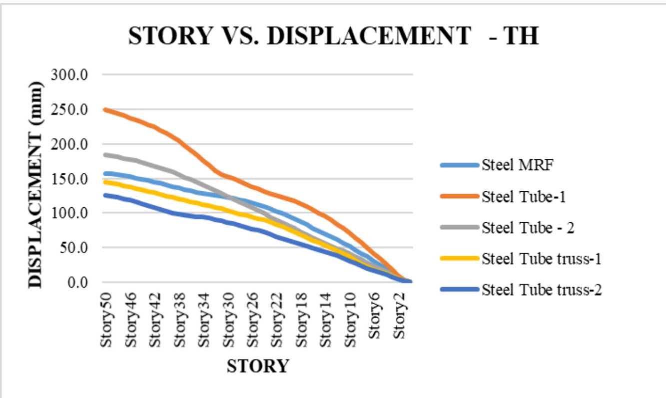

Chart -4: Story Displacement – Dynamic Time History

Peak Displacement Values (mm)				
Steel MRF	Steel Tube-1	Steel Tube - 2	Steel Tube truss-1	Steel Tube truss-2
157	248	183	145	125

Table -3: Maximum Story Displacement – Dynamic Time History

3.5 BASE SHEAR RESULTS – DYNAMIC TIME HISTORY

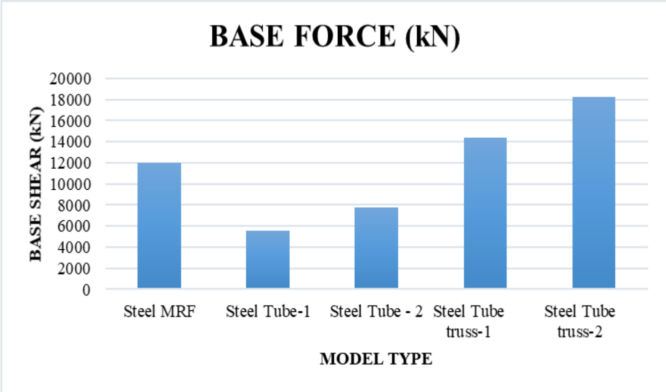

Chart-5: Base Shear – Dynamic Time History

Base Force (kN)				
Steel MRF	Steel Tube-1	Steel Tube - 2	Steel Tube truss-1	Steel Tube truss-2
12000	5550	7764	14348	18287

Table -4: Base Shear – Dynamic Time History

3.6 TIME PERIOD RESULTS – WIND LOAD

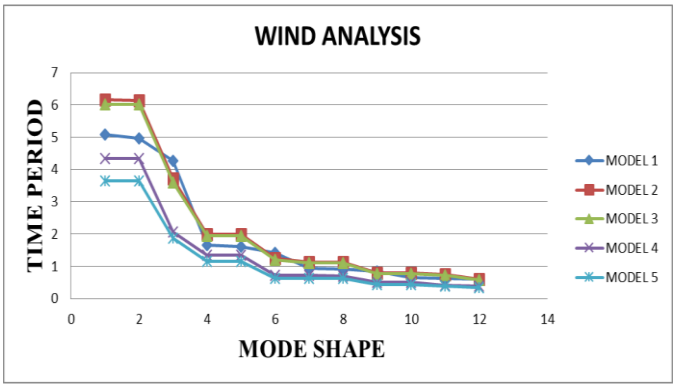

Chart -6: Wind Load Results

3.7 BASE SHEAR - WIND LOAD

Base Shear Values				
Steel MRF	Steel Tube - 1	Steel Tube – 2	Steel Tube Truss – 1	Steel Tube Truss - 2
8940	8940	8940	8940	8940

Table -5: Maximum Base Shear Values

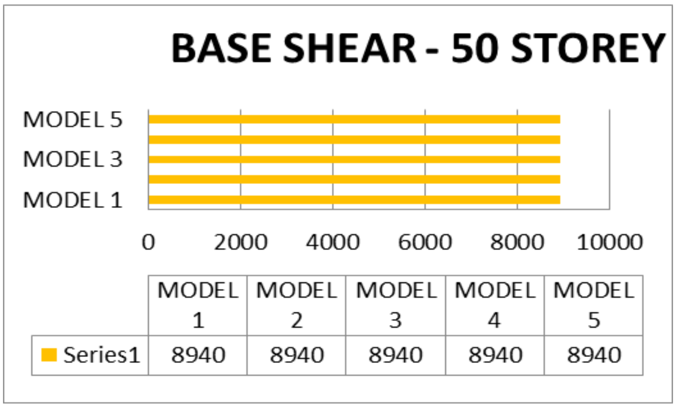

Chart -7: Base Shear Values

3.8 MAXIMUM DISPLACEMENT – WIND LOAD

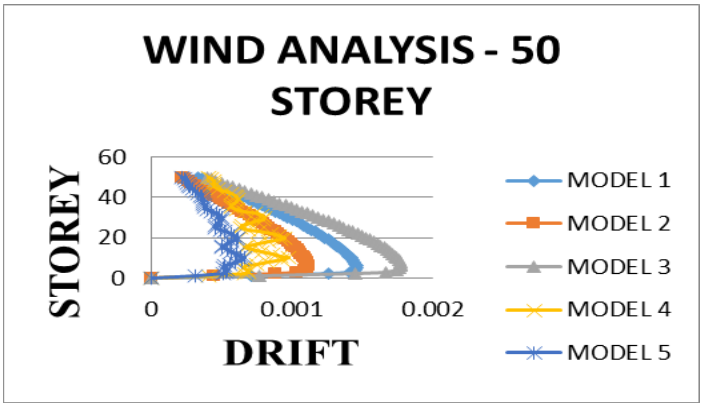

Chart -8: Maximum Displacement – wind load

Maximum Displacement (mm)				
Steel MRF	Steel Tube – 1	Steel Tube – 2	Steel Tube Truss – 1	Steel Tube Truss – 2
152	185	115	103	69

Table -6: Maximum Displacement Values

3. CONCLUSIONS

Following conclusions are produced using the equivalent static and dynamic time history investigation of steel moment resisting frame and tube structure.

- From the modular investigation it can be inferred that, steel tube structures are more adaptable than regular steel moment resisting frame, since they have additional time period and less frequency. Because of the expansion of external bracing time period will decrease. Additionally time period relies upon column distance where despite everything it decreased with the nearer separating of column in steel tube – 2.

- Column separating and external truss system affects base shear, since base shear has expanded with the diminishing in column dispersing, which is found in steel tube 2 and steel tube truss – 2.

- Due to diminishment in stiffness in steel tube structures, extensive displacements and drifts are watched contrasted with customary steel moment resisting frame.

  Increase in stiffness is found in firmly dispersed column steel tube structure and further with the expansion of steel truss individuals on the outskirts of the structure stiffness has been expanded.

- Truss part powers are more in steel tube truss – 2, subsequently steel tube truss – 2 with firmly divided columns has more noteworthy protection towards static and dynamic loads.

- Hence lessening in column dispersing and execution external truss individuals has demonstrated better execution in constraining the displacements and drifts, with increment in base shear and acceleration.

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