

Study of Tube Structural System for High Rise Building

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Abstract—A tube – in tube structure comprises of a peripheral framed tube and a core tube interconnected by floor slabs. The entire building act as a huge tube with a smaller tube in middle of it. Lateral loads are shared between the inner and outer tubes. The concept of tubular structure is that the building can be designed to resist lateral loads by designing it like a hollow cantilever perpendicular to the ground. The present work aims at an objective demonstrating the effect of the vulnerability arising due to different predominant directions of vibration in each rectangular arm of irregularities structures as L,T, and Plus with tube in tube structure with varying positions . The building studied in this section is 30 and 50-storey Designed for Gravity and Seismic Loads Using non -Linear Dynamic Analysis. The structure is evaluated in accordance with seismic code IS-1893:2016 using Non- linear time history analysis with the help of the ETABS version 20 software (CSI Ltd) analysis engine

Keywords-irregularities, tube in tube structure, non - Linear Dynamic Analysis.

I. INTRODUCTION

There are two types of framed tubes: an outer tube and an inner tube with an elevator and service core. Braced frames may be used to construct the inner tube. An outer and inner tube work together to resist gravity and lateral loads in steel-framed buildings. Since the outer tube has a greater structural depth, it usually plays a dominant role. The outer tube of such a structure is known as the hull, while the inner tube is known as the core.

In framed-tube systems, tube-tube interaction and shear-lag in tubes complicate the estimation of structural performance and accurate analysis of tubes. The existing approximate models ignore both the contribution of the internal tubes to the overall lateral stiffness as well as the negative shear-lag effects in the tubes. As a result, these models only consider the structural analysis of the external tube, but fail to consider the shear-lag phenomena

associated with the internal tubes. Therefore, they are not able to capture the true behavior of such structures. As we see that there is much development in the science and technology in the world and all the people are very competitive and also there is a change in lifestyles of the people resulting in the urbanization. But the urban areas are lagging because there is a lack of spaces in the areas, so there should be some alternate solutions to have proper lifestyles

- The present work aims at the study of following objectives:
- Investigate the behavior of buildings, i.e. irregular structures as L, T, and Plus with tube in tube. To study various responses such as Base shear, base moment, Displacement, inter story drift, story stiffness, time period of buildings.
- To check the reliability of structure with tube in tube structure with varying positions (centre and peripheral).

II. LITERATURE REVIEW

Charles Binck, Alex Sixie Cao & Andrea Frangi (2022): The aim of this paper is to develop and test a lateral stiffening system for tall timber buildings between 50 and 147 m in height. A tube-in-tube concept is utilized in the design of the system. The internal tube is comprised of a braced timber core, whereas the external tube is made up of a frame structure with semi-rigid beam-column joints in the façade. The lateral stiffening system's performance under wind loading is evaluated using more than 500 000 simulations based on a finite element framework. In order to determine the feasibility of the tube-in-tube system and the stiffness requirements for the joint between the beam column and the beam, the resulting data is used.

Mohammad Babaei, Yaghoub Mohammad (2021) (2): In this study, we explore the free vibration and frequency analysis of stepped tube-in-tube structures for tall buildings with stepped cross- sections. A

stepped structural system for free vibration was presented with dynamic equations, which were solved in accordance with boundary conditions, flexural and shear stiffness, and stepped cross-sections of different steps. By using the determinants of the matrix and mathematical calculations of frequency, the answer was converted into an 8 by 8 matrix. The outer tube height was increased by 15 meters in nine mathematical computational models for stepped tube-in-tube structures for a 50-story tube-in-tube building. As a final step, the inner and outer tubes' heights were equalized by raising the outer tube, and then the results of free vibration were compared with articles with tube-in-tube structural systems of equal height and characteristics. Based on the results of finite element analysis, this method was successful in calculating the frequency of structures accurately.

Mohammed sarcheshmehpour (2020): Tall buildings are complicated to design due to the wide variety of structural elements and the requirements of various design codes. When the objective is to achieve a seismic code-compliant optimal design with minimum weight, this process is exacerbated. The objective of the present paper is to provide a practical methodology for optimizing steel tall building structures in accordance with the constraints imposed by typical building codes. By determining the optimal seismic design for 20-, 40-, and 60-story buildings, both tube-in-tube and framed tube-in-tube, the applicability of the proposed approach is demonstrated. It is possible to compare the behavior of the framed tube and the tube-in-tube system under

applied loads with such a structure. Tube-in-tube buildings are found to be slightly less energy efficient than conventional framed-tube buildings

1. Module And Building Configuration

In this work, ETABS 2020 is used to evaluate the seismic response of a structure subjected to earthquake loading. This plan has an asymmetrical layout in both X and Y directions with bay lengths of 4 m in X and 4 m in Y. Reinforced concrete ordinary moment resisting frames of 30 and 50 stories with the same loads and properties, columns, and tube in tube at the center and peripheral locations of the frame are contemplated. We have analyzed all of these buildings using a non-linear dynamic analysis [time history analysis]. For all models, the typical storey height is 3 meters. To perform non-linear time history analyses, "Bhuj" earthquake data is used as ground motion data. The Plan configuration consists of Total 18 models were studied in seismic zone III.

- Model 1 – G+30 Normal Building (L,T & PLUS SHAPE)
- Model 2 – G+30 Building with tube in tube at centre(L,T & PLUS SHAPE)
- Model 3 – G+30 Building with tube in tube at peripheral (L,T & PLUS SHAPE)
- Model 1 – G+50 Normal Building (L,T & PLUS SHAPE)
- Model 2 – G+50 Building with tube in tube at centre(L,T & PLUS SHAPE)
- Model 3 – G+50 Building with tube in tube at peripheral (L,T & PLUS SHAPE)

The plan and 3D view of the building used for the modelling is as below:

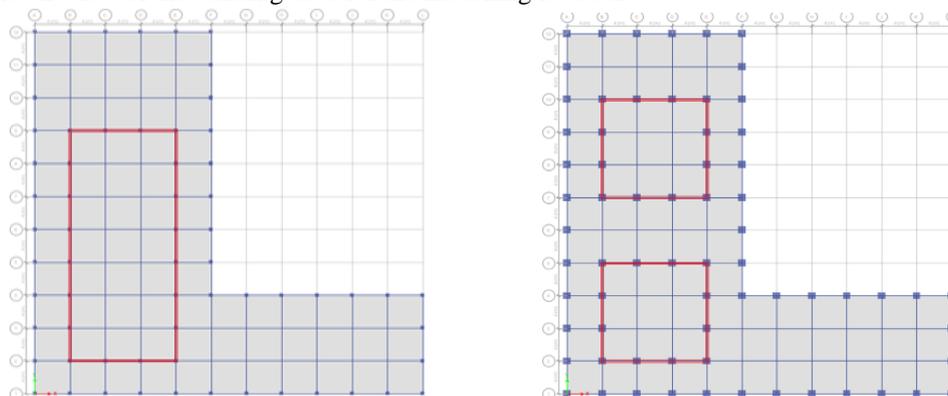


Figure 1: Plan view of 30 & 50 STORIES L-type building with Central & peripheral tube in tube

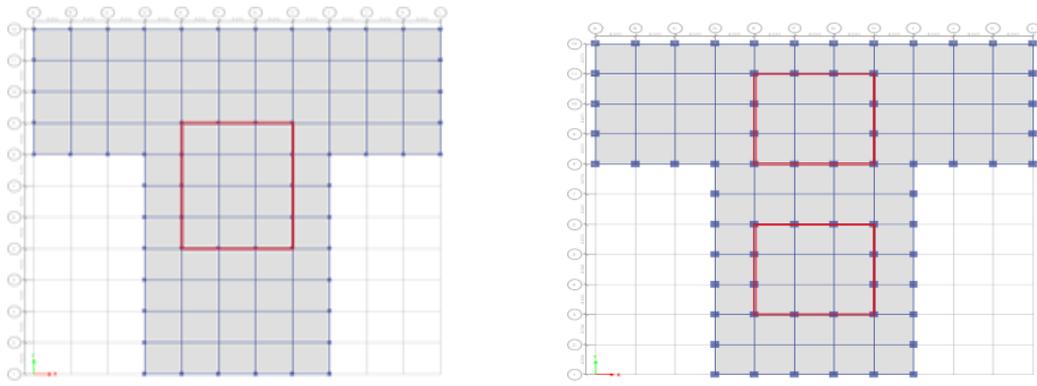


Figure 2: Plan view of 30 & 50 STORIES T-type building with Central & peripheral tube in tube

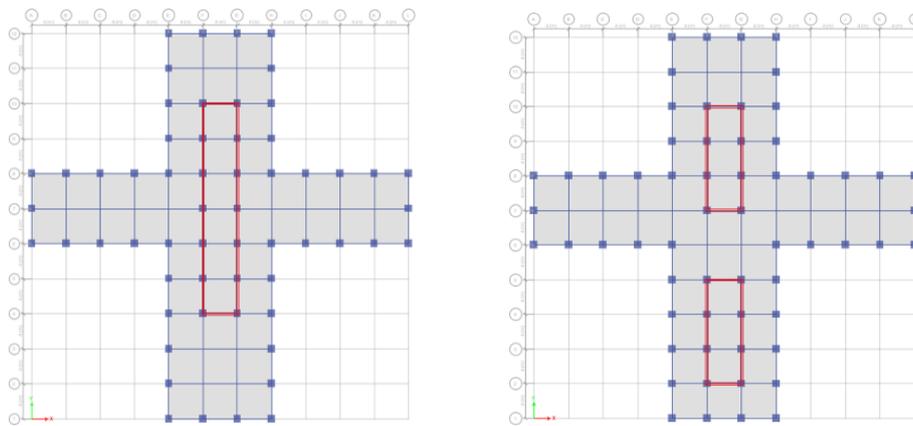


Figure 3: Plan view of 30 & 50 STORIES PUSL-type building with Central & peripheral tube in tube

2. RESULTS FOR G+30 & 50 L-TYPE BUILDING MODELS

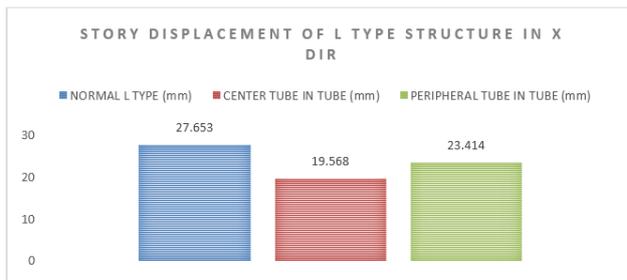


Figure 4: story displacement G+30 in the X direction

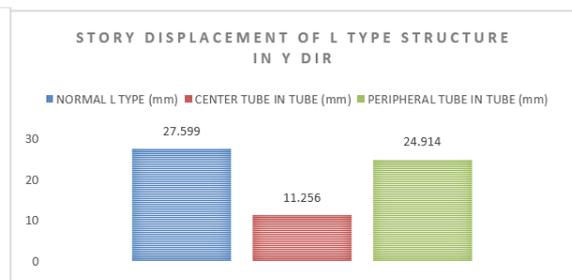


Figure 5: story displacement G+30 in Y direction

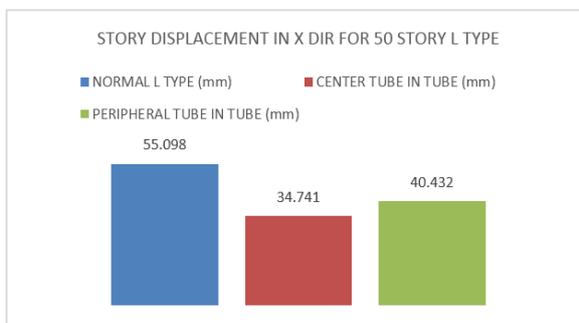


Figure 6: story displacement G+50 in the X direction

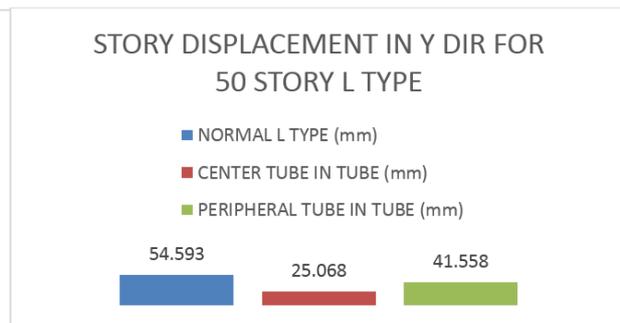


Figure 7: story displacement G+50 in Y direction

3. RESULTS FOR G+30 & 50 T-TYPE BUILDING MODELS

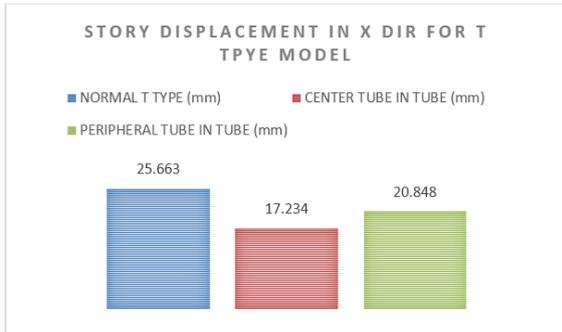


Figure 8: story displacement G+30 in the X direction

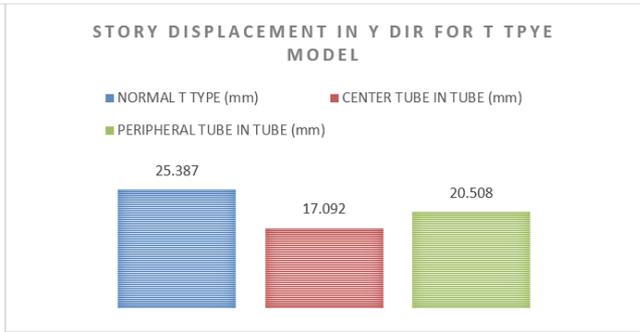


Figure 9: story displacement G+30 in Y direction

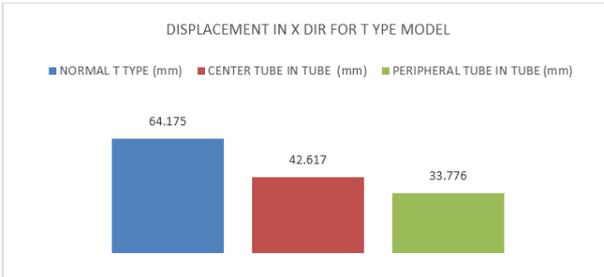


Figure 10: story displacement G+50 in the X direction

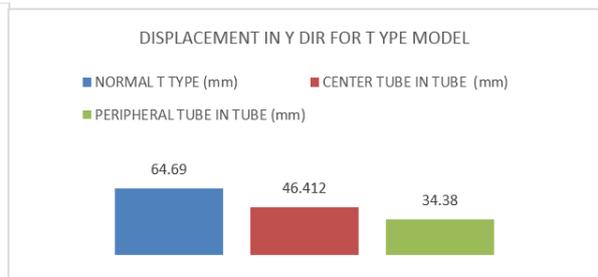


Figure 11: story displacement G+50 in Y direction

4. RESULTS FOR G+30 & 50 PLUS-TYPE BUILDING MODELS

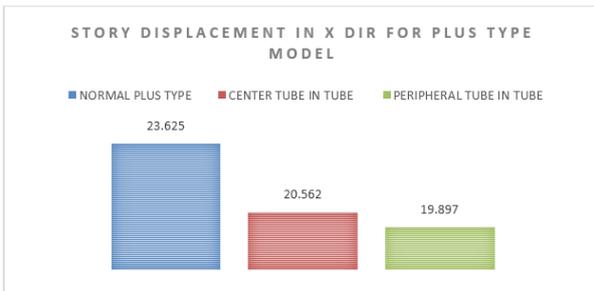


Figure 12: story displacement G+30 in the X direction

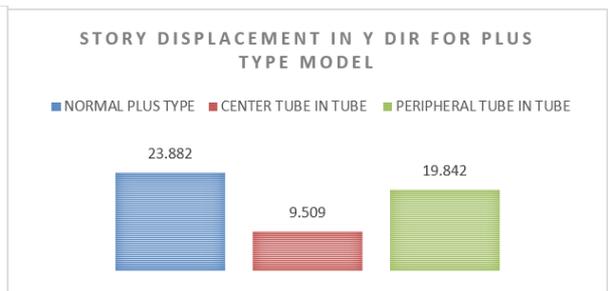


Figure 13: story displacement G+30 in Y direction

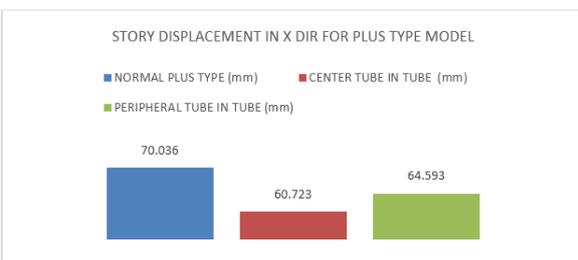


Figure 14: story displacement G+50 in the X direction

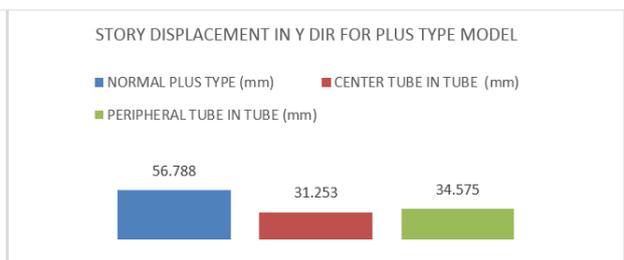


Figure 15: story displacement G+50 in Y direction

III. CONCLUSION

This dissertation investigates the comparison of the high rise buildings with considering 30 and 50 Storey buildings with tube in tube systems at two different location i.e. centre and peripheral, the floor size 44mX56m and typical Storey height as 3m, the first structural system i.e. L- Type RCC moment resisting frame. In the second structural system i.e. the T-Type system, and in third structural systems i.e. PLUS -

Type. Thus by investing response of the structure like base shear, Lateral displacement, Storey drift, Storey stiffness, Time period. The seismic performance is studied using nonlinear dynamic analysis

- This chapter presents a summary of the study, for the four identical structures with different system i.e. Normal structure, L-Type, T-Type and PLUS -Type. The effect of lateral forces has been studied. Based on the observations and the

results obtained during the course of this study, the following conclusions can be arrived:

- Base shear of the buildings were compared, it was found the normal building has less compared to center tube in tube and peripheral model base shear. The base shear for normal model is reduced by 24% and 39 % when compared to other models. The base shear is more for tube in tube models as the seismic weight is more compared to normal model.
- It can be observed that Base moment is less for peripheral tube in tube structure which shows that its ability to absorb the horizontal forces and to transmit the resulting moment into the foundation.
- As the lateral loads are resisted using inner core of tube in tube, the top storey displacement is very much less as compared to the normal building.
- As per the results for G+30 and G+50 models center tube in tube is more effective for reducing the displacement and drift for L and T Type model. For plus type model center tube in tube is effective in y dir.
- The values of story drift are within the permissible limit as per is 1893, which is 0.004 times the story height.

IV. SCOPE OF FURTHER STUDY

- Further research can be carried out by using combination of different structural systems as outrigger, bundled tube and space frame Double layer space structure to tackle Earthquake and Wind.
- Further research can be carried by using the same system to see Elastic Column shortening effect in tube in tube structure.

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