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"ANALYSIS OF TUBE IN TUBE STRUCTURES WITH DIFFERENT SIZE OF INNER TUBE"

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ABSTRACT- ***Over the past few years the utilization of tube structural systems as structural systems for high tall buildings or tall structures has become common. Various types of tubular structural systems which are currently present in practical are as framed tube, tube in tube and bundled tube structural systems, in which the tube in tube structural system is commonly adopted one. Formation of a tube in tube structure is by connecting outer framed tube to inner tube by floor slab. It acts like a large tube (Peripheral tube) with a smaller tube(inner core tube) at centre of it. These tube structural systems improves the structural stability of structure or buildings and as well increases the utilization of floor spacing. In this project, a comparative study of tube in tube structure with different size of inner tube is done to find most efficient size of inner tube in order to maximize the lateral resistance of the combined system. From the comparison of results we got tube in tube structure with larger inner tube shows better lateral resistance compared medium and small size inner tube.***

Keywords: Tube structural systems, Wind load, Displacement , Story Drift , Base Shear.

I. INTRODUCTION

In recent days high rise buildings and tall structures are becoming more slender which increases the possibility of extra sway compared to prior high-rise buildings. This is bringing more challenges for the engineering field to resist both lateral loads i.e., wind and earthquake loads as well as gravity loads. Earlier structures were being designed only for the gravity loads but in recent years because of increase in height and seismic zone, the engineers are taking care of lateral loads due to wind and seismic forces. In tall buildings the tallness is comparative term. There is no exact definition for tall structures which can be applied through worldwide. From the structural engineering point of view all tall structures must resist gravity as well as lateral loads. The competition in rising of tall structures have made it significant to design the building to resist against lateral loads. It has been identified that the geometry of the building is not only the fundamental criteria to design the tall and slender structures, yet the story drifts of the buildings are also responsible for stresses developed in the building.

Generally as the height of structures increases, their overall response to lateral loads (such as wind and earth- quake) increases. So when such response becomes satisfactorily great such that the impact of lateral loads should be clearly taken into consideration in design then a multi storey building is said to be tall building. Tall buildings are usually prone to more displacements, because of which introduction of special measures becomes neccessary to counteract these displacements. The effect of lateral loads on buildings can be resisted by Moment resisting Frame, Bracings and Shear Walls or configuration of tall structures. Lateral displacement/side sway and peak inter storey drift are two significant parameters used in assessing the stiffness and lateral stability of lateral force resisting systems for high rise buildings.

II. LITERATURE REVIEW

Mohan K , Rahul Y and Virendra Kumara K N(2017) published their paper with title ''Analysis of Different Forms of Tube in Tube Structures Subjected to Lateral Loads'', in which they studied the different tube in tube structures to get the most effective structure to resist the lateral loads of various shapes having rectangular, square, , triangle and

hexagonal geometric configuration. They varied the geometry of tubular structural system and developed different models in SAP 2000 in respect to study the seismic performance and behaviour of tube-in-tube buildings. The Response Spectrum analysis was performed on different type of tubular structures i.e., on various models created and the outcomes of the analysis were evaluated and documented to make a comparative study on seismic performance and behavior of them. From the analysis result they got square geometric plan of tube in- tube structural system was more efficient in resisting lateral loads compared with square geometric plan of frame tubed structure and the tube-in-tube models of rectangular, triangular and hexagonal geometry. From the comparison they found triangular tube in tube structure have more displacement, drift, time period and got less base shear for zone-II and zone-V, so we can consider the structure is severly vulnerable compare to other geometry of structures. Compared to all types of geometry in tube-in-tube structure with core square type of structure will perform better for lateral loads and triangular tube in tube structure is the most vulnerable for lateral loads.

Archana J, Reshmi P R (2016) studied and analyzed the tube in tube structures with different position of inner tube in their paper '' Comparative Study on Tube in Tube Structures and Tube Mega Frames''. For modeling they considered three types of models, the first type of model was bare frame model A, Second modal B which was the tube in tube building and the third type of model, model C was the tube mega frame. To develope model B, the different positioning of the inner tube was considered in tube in tube structure as model B1 with central tube, model B2 with tube in edge, model B3 with inner tube. Model C is the tube mega frame. After modeling three sets of models, they were analyzed. From analysis outputs the tube in tube structure with centre tube shows better result than that of bare frame and tube mega frame structures. After the comparison it can be suggested that tube in tube structure with centre tube acts as an efficient structural system for tall buildings. When compared the bare frame structure with other two systems, they found that tube mega frames shows better floor space utilization.

Hamid Mirzahosseini's(2015) primary objectives of study in ''Optimal Design Of Tube In Tube Systems'' were to examine effects of varying design parameters on the tube action as well as shear lag behavior of a typical rcc tube in tube building, and to propose a optimal design approach of similar tube in tube buildings. They performed a parametric study on the performance of a 40 story building by varying selected key design variables which includes the beam depth, column depth and interior walls of the moment frames. For assessing the performance of every individual model overall and critical (maximum) story drifts, and shear lag behavior were considered. They concluded in their study that story drifts or overall building drifts of a structure as in that of case study building can be efficiently reduced by increasing the stiffness properties of web and flange frame members, as well increase in column depth had many effects on story and overall building drift. With increase in column depth corner columns axial force decreases and increases axial force in middle columns and subsequently sharing of axial forces become nearer to the ideal state. By increasing columns depth and decreasing clear beam bay subsequently increases stiffness of beam to high degree.

III. OBJECTIVES OF STUDY

- To obtain the most effective tube in tube structure to resist the lateral loads with different sizes of inner tube by equivalent static analysis in Etabs software.
- Preparation of 3D models and Analysis of the following configuration of structural systems for a 60 STOREY FRAMED BUILDING under lateral loads.
  - Model 1-Framed tube
  - Model 2-Tube in tube with larger inner tube
  - Model 3-Tube in tube with medium inner tube
  - Model 4-Tube in tube smaller inner tube.
- Determination of base shear, lateral displacements and storey drifts for framed tube structure i.e., Model 1.
- Determination of base shear, lateral displacements and storey drifts for tube in tube structure with larger inner tube i.e., Model 2.
- Determination of base shear, lateral displacements and storey drifts for tube in tube structure with medium inner tube i.e., Model 3.
- Determination of base shear, lateral displacements and storey drifts for tube in tube structure with smaller inner tube i.e., Model 4.
- Comparing base shear, lateral displacements and drift values of above mentioned systems to determine the most effective configuration system for resisting lateral loads.

IV. DESCRIPTION OF MODEL

- No of stories = 60(G+59)
- Dimensions of plan area = 54m x 54m
- Height of each story = 3.2m
- Bay spacing in both direction = 6m
- Spacing of outer core columns = 2m
- Spacing of inner core columns = 2m
- Spacing of remaining columns in both direction = 6m
- Slab section - Deck (composite) slab
- Type of column-Steel tube
- Column size – 850x850x50mm
- Beam - ISMB 600
- Secondary beams - ISMB 225

Applied Loads

Only external loads are applied on structure neglecting the self weights of members which is calculated automatically by ETABS 2015 software itself. The Shell loads (on Slabs) acting in the Gravity direction are superdead load i.e., floor finish =1.2kN/m2 and Live=3kN/m2. The Frame/wall loads applied uniformly on the beams as Dead=3kN/m.

The Earthquake loads EQ-x and EQ-y are defined in Load patterns directly using Code on earthquakes IS1893:2002. Also the Wind loads in transverse and longitudinal direction wind-x and wind-y are given using Code IS875:1987 part III.

Material Properties

PROPERTIES	VALUES
Young's modulus of concrete	$25X10^6$ kN/m^2
Density of reinforced concrete	25 kN/m^3
Density of steel	76.59 kN/m^3
Poisson's ratio of steel	0.3
Assumed floor finishes	1.2 kN/m^2

Seismic Data

- Zone factor =0.36(Zone V)
- Importance factor = 1.5
- Response reduction factor =5
- Soil type = Type 2 (medium)

Wind Data

- Code IS 875:1987 (part3)
- Terrain category =3
- Structure class =C
- Risk coefficient =1.07
- Windward coefficient = 0.8
- Leeward coefficient = 0.5
- Topography factor =1
- Wind speed = 33m/s (Bengaluru)

Different types of models considered for present study :

MODEL 1: The building is modeled as a framed tube with an outer core formed by placing columns at every 2m spacing.

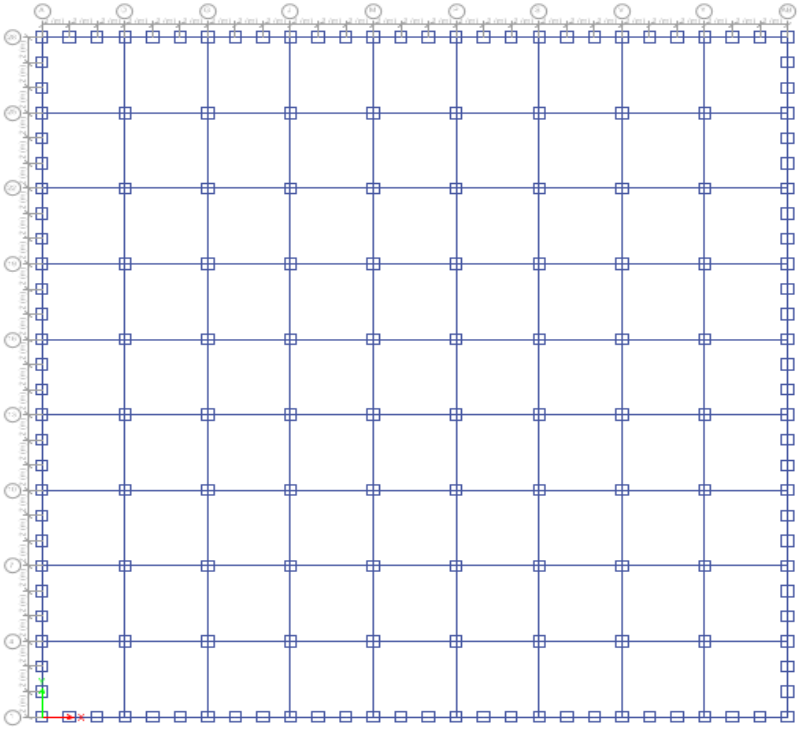

Fig. 1 Plan of model 1

MODEL 2: The building is modeled as tube in tube, having a larger inner core of 30m x 30m dimension along with outer core, both cores formed by placing columns at every 2m spacing.

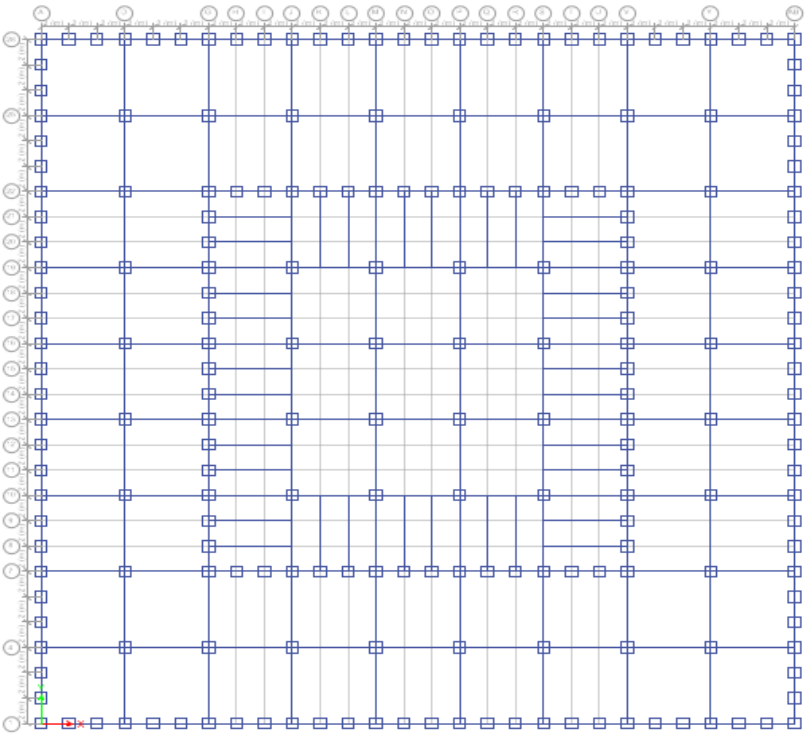

Fig. 2 Plan of model 2

MODEL 3: The building is modeled as tube in tube, having a medium inner core of 18m x 18m dimension along with outer core, both cores formed by placing columns at every 2m spacing.

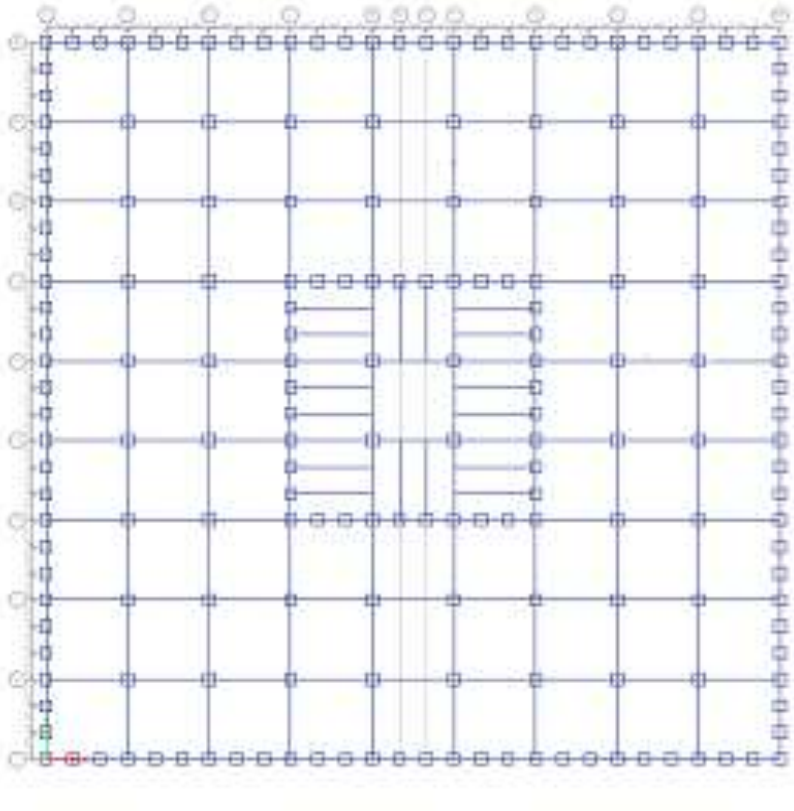

Fig. 3 Plan of model 3

MODEL 4: The building is modeled as tube in tube, having a larger inner core of 6m x 6m dimension along with outer core, both cores formed by placing columns at every 2m spacing.

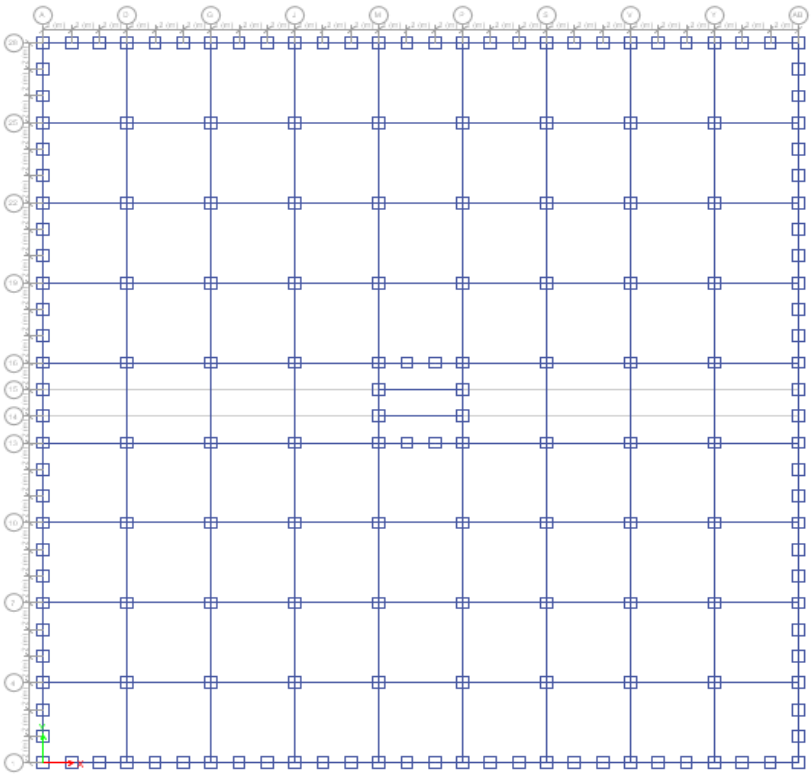

Fig. 4 Plan of model 4

V. RESULTS AND DISCUSSION

For the analysis of all four building models both wind and earthquake loads are applied. The analysis of the all the different building models is done by using ETABs 2015 software. The analysis results such as displacements and story drifts of all building models are presented and compared.

Displacement

The performance of the models under the application of lateral loads is studied to understand the effect of wind and seismic loads. The displacements which are likely to happen due to lateral loads are calculated and tabulated.

As per the Indian standards the maximum allowable displacement in any multistory building is hs/500,

Where hs =height of building.

For the models used in the investigation the maximum allowable displacement

= 198.6/500 =0.397m.

As the building is symmetrical about both X and Y axis the displacements along longitudinal and transverse direction are same, therefore the displacement is tabulated only for X direction. The displacements in X directions due to wind and seismic loads for models 1, 2, 3 and 4 are presented in Table 4.1 to 4.4 respectively. The displacements for model 2, 3 and 4 are lesser than that of model 1.

Storey Drifts

As per IS 875 part 3 the maximum allowable drift for any building is =0.004H

H= height of one storey

For our models maximum allowable drift =0.004*3200= 12.8 mm.

The story drifts due to wind and earthquake loads for models 1, 2, 3 and 4 are presented in Table 4.5 to 4.8 respectively. It was observed that story drifts due to wind load were higher than that due to seismic load in all the 4 models. The drifts for model 2, 3 and 4 are lesser than that of model 1. The maximum percentage decrease of drift was observed in model 2 when compared with that of model 1. Hence tube in tube with larger inner tube of framing system is more efficient than other three in resisting lateral loads.

RESULTS OF ANALYSIS

DISPLACEMENT DUE TO WIND LOAD

MODEL	MAX DISPLACEMENT IN MM	PERCENTAGE REDUCTION(COMPARED TO MODEL 1)
MODEL 1	196.9	0
MODEL 2	157.3	20
MODEL 3	172.8	13
MODEL 4	190.9	5

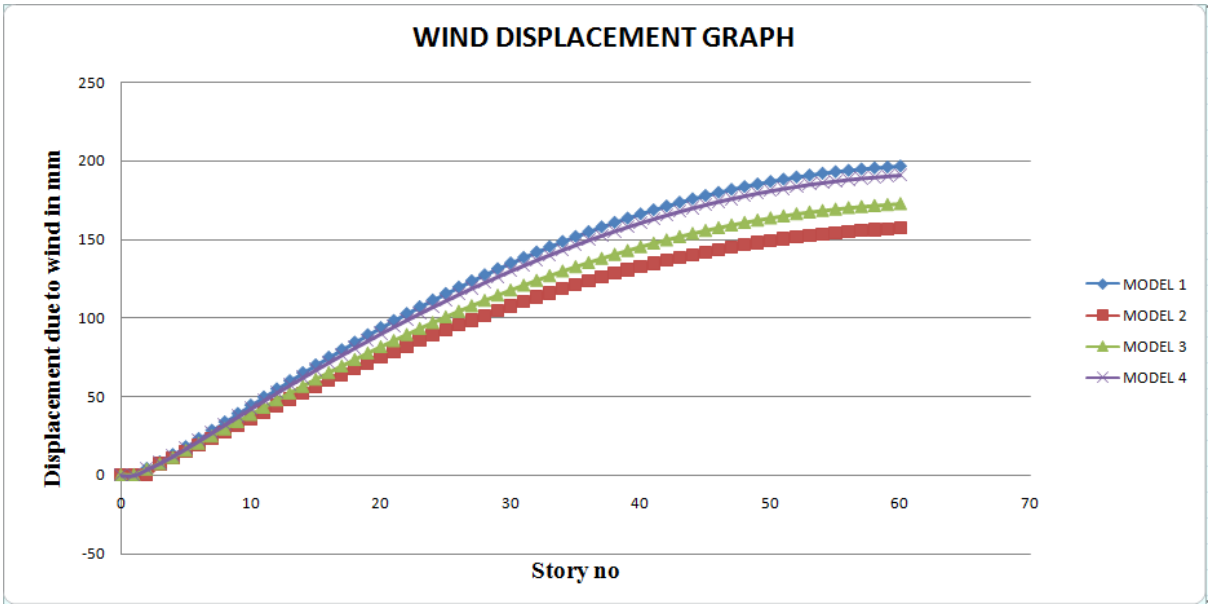

Fig. 5 Story displacements due to wind for all Models

DISPLACEMENT DUE TO SEISMIC LOAD

MODEL	MAX DISPLACEMENT IN MM	PERCENTAGE REDUCTION(COMPARED TO MODEL 1)
MODEL 1	199.4	0
MODEL 2	175	12
MODEL 3	186.4	7
MODEL 4	197.5	1

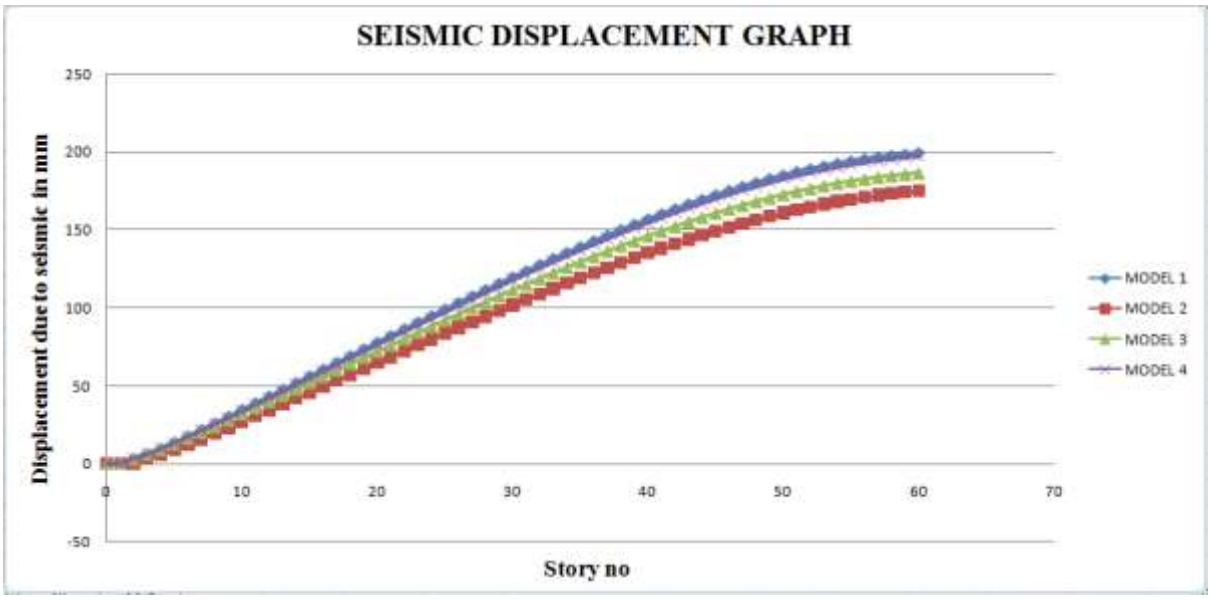

Fig. 6 Story displacements due to seismic for all Models

STORY DRIFTS DUE TO WIND LOAD

MODEL	MAX STORY DRIFT IN MM	PERCENTAGE REDUCTION(COMPARED TO MODEL 1)
MODEL 1	0.00168	0
MODEL 2	0.00131	22
MODEL 3	0.00144	15
MODEL 4	0.00160	5

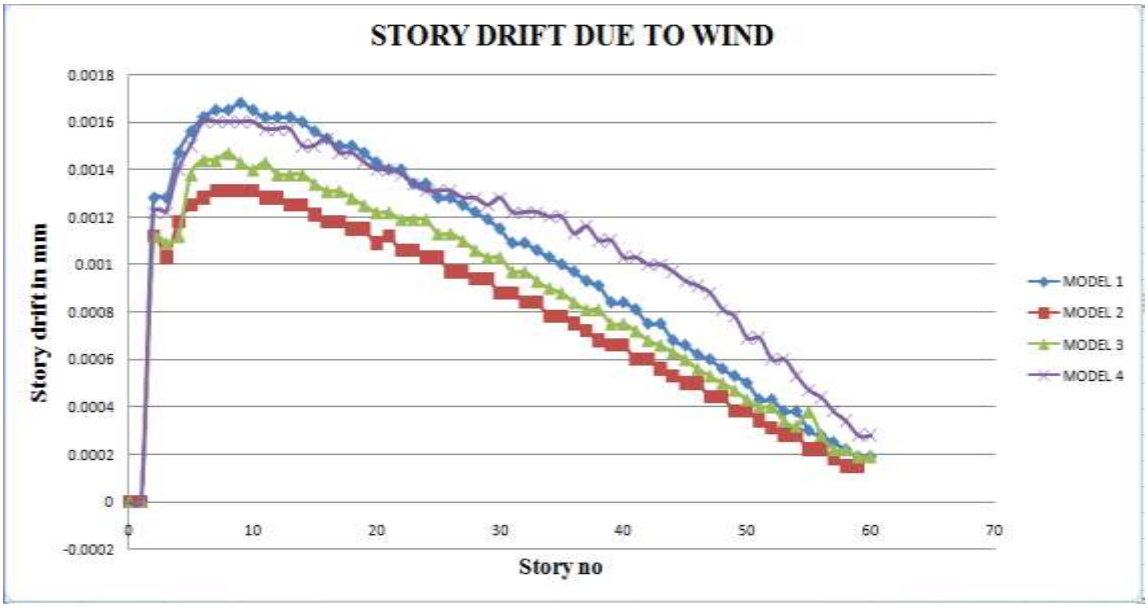

Fig. 7 Story drifts due to wind for all Models

STORY DRIFTS DUE TO SEISMIC LOAD

MODEL	MAX STORY DRIFT IN MM	PERCENTAGE REDUCTION(COMPARED TO MODEL 1)
MODEL 1	0.00134	0
MODEL 2	0.00119	12
MODEL 3	0.00128	5
MODEL 4	0.00130	0.5

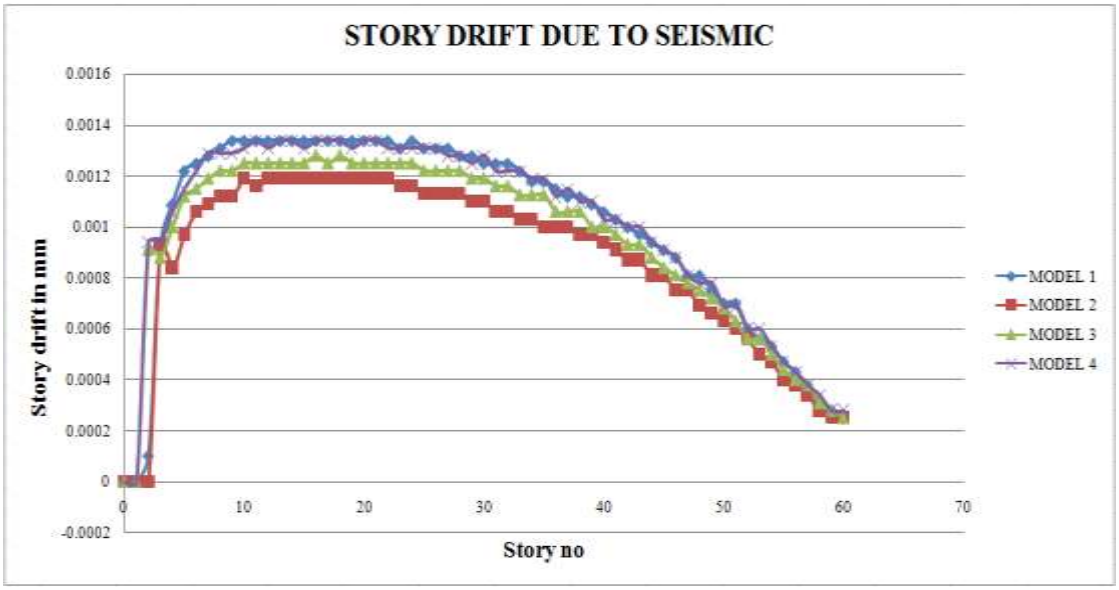

Fig. 8 Story drifts due to seismic for all Models

BASE SHEAR

MODEL	BASE SHEAR IN kN
MODEL 1	19143.19
MODEL 2	20976.15
MODEL 3	20231.73
MODEL 4	19490.71

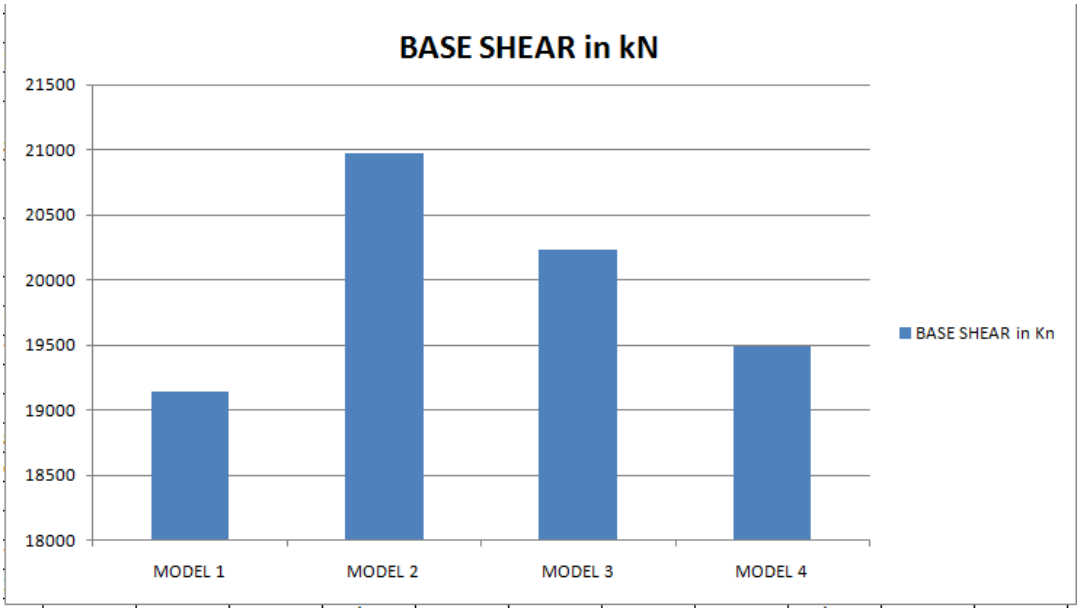

Fig. 9 Base shear for all models

VI. CONCLUSIONS

- The models 1, 2, 3 and 4 when compared with wind displacements, the wind displacements of model 2, model 3 and model 4 are reduced by 20%, 13% and 5% respectively when compared with model1.

- The models 1, 2, 3 and 4 when compared with seismic displacements, the seismic displacements of model 2, model 3 and model 4 are reduced by 12%, 7% and 1% respectively when compared with model1.

- The models 1, 2, 3 and 4 when compared with story drifts due to wind load, the story drifts of model 2, model 3 and model 4 are reduced by 22%, 14% and 5% respectively when compared with model1.

- The models 1, 2, 3 and 4 when compared with story drifts due to earthquake load, the story drifts of model 2, model 3 and model 4 are reduced by 12%, 5% and 0.5% respectively when compared with model1.

- When compared the base shear values of all models, the framed tube i.e., model 1 showed the lowest base shear value and tube in tube with larger inner tube i.e., model 2 showed the highest base shear value. These values clearly explains that the rigidity of model 2 is very high compared to others which makes it more efficient in resisting lateral loads.

- The tube in tube with larger inner tube is the most efficient structural system in resisting lateral loads among the all models considered in study.

- Study highlights one more point that Tube in Tube structures are much efficient in resisting wind loads than seismic loads.

REFERENCES

1. **Hamid Mirzahosseini ''Optimal Design Of Tube In Tube Systems'', IJFALS, ISSN: 2231– 6345 , Vol. 5, Issue 3 , pp. 119-138, APR 2015.**
2. **Nimmy Dileep1, Renjith R ''Analytical Investigation On The Performance Of Tube-in-tube Structures Subjected To Lateral Loads'', IJTRA, ISSN: 2320-8163, Vol 3, Issue4, PP. 284-288, JUL 2015.**
3. **Dhanapalagouda Patil, Nveena M P, '' Dynamic analysis of steel tube structure with bracing systems'', IJRET, ISSN: 2319-1163, Vol 4, Issue 8, Aug 2015**
4. **Jignesha Prel, Roshni J Jhon, ''Seismic analysis of framed tube structure'', IJSER, Vol 6, Issue 12, Dec 2015**
5. **Basavanagouda Patil, Kavitha s, '' Dynamic analysis of tall tubular steel structures for different geometric configurations'',IJOER, ISSN: 2321-7758 Vol 4, Issue 4, Jul 2016**
6. **Archana J, Reshmi P R, '' Comparative Study on Tube in Tube Structures and Tubed Mega Frames'', IJIRSER, ISSN(Online) : 2319-8753, Vol. 5, Issue 8, AUG2016.**
7. **Lavanya T, Sathyanarayana Sridhar R Dynamic analysis of tube in tube tall buildings'', IJET, ISSN: 2395-0056, Vol 4, Issue 4, Apr 2017**
8. **Mohan K 1, Rahul Y and Virendra Kumara K N, ''Analysis of Different Forms of Tube in Tube Structures Subjected to Lateral Loads'', IJIRT, ISSN: 2349-6002, Vol 4, Issue 2, July 2017.**
9. **Bipin H Naik, B S Suresh Chandra , ''Comparative Analysis between Tube in Tube Structure and Conventional Moment Resisting Frame'', IRJET, ISSN: 2395-0056, Vol 4, Issue 10, OCT 2017.**
10. **Ajay Shindhe '' Dynamic analysis of RC frame braced tube structure'', IRJET, ISSN: 2395 -0056, Vol 4, Issue 5, May 2017**