A COMPARATIVE STUDY OF FRAME TUBE, TUBE IN TUBE AND BUNDLED TUBE STRUCTURES SUBJECTED TO LATERAL LOAD UNDER DIFFERENT ZONES

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Abstract - *In this study, Tall Structure Systems (TSS) have been utilized extensively to be the framework for tall buildings, making use of Framed Tube, Tube in Tube, and Bundled Tube frameworks. Internal tubes and tube in tube construction are often used because of their great solidness in vertical and horizontal loading, as well as their accessibility. Under lateral stresses, due of the noticeable degree of shear lag, the corner portions are hit with much greater axial loads. In the case of a tube-in-tube construction, floor slabs are used to link the outer-framed tube to the inner tube. It works like a big pipe with a smaller pipe in the middle. These tube structural systems help to enhance structural stability of structures, and they make it possible to use floor space more efficiently.*

In this research, we investigate a frame tube and tube-in-tube structural comparison, bundle tube structure and bundle tube structures with shear wall under Zone III and Zone V is done to find most efficient structure to improve system's lateral stability We discovered that shear wall bundles had more lateral stability than other types of tube constructions.

Key Words: Framed Tube, Tube in tube, bundle tube structure and bundle tube structures with shear wall, Seismic load, ETABS, IS-875:1987-Part III.

1. INTRODUCTION

Nowadays, the presence of more sway in buildings taller than previous models, such as high-rise structures, makes buildings narrower relative to buildings built in the past. With problems like lateral stresses, that are the burden of seismic forces loads as well as gravity loads, the engineering profession is hard pressed to be stable. In past times structures designed to mainly resist gravity loads only, nowadays with increased height of the structures and with idea of seismic zones lateral loads due wind and Earth quake are also taken into consideration. Tall structure does not have particular definition which can be applied all over the world. As the competition is increasing the rising of Tall constructions have made it critical to design buildings to withstand lateral loads. One of key factors in designing tall, slim buildings has to take building geometry into account. This is because deviations in layout of stories in building may potentially be to blame for strains in structure.

Development of country can be accomplished through proper planning and economic development as they are the vital reasons that encourage technological progress by dogging the use of the latest materials and technological systems. Individually each of these factors succors in attracting sources of capital to the nation-state. By the ending of the 20th century lot of countries began to achieve advancement through the preparation of comprehensive plans to establish tall structure investment projects with the development of numerous standards and principles to make certain the success of these systems. Gulf consolidated countries such as Dubai and cities like Singapore, and Malaysia initiated the construction of skyscrapers in order to encourage their countries at various levels. The study of all aspects and elements which affects the venture and the success level of the investing organizations one can say the feasibility studies has a chief role. In advanced countries concerned authorities developed such studies to construct large skyscrapers. Overall success of such projects depends on good feasibility studies made an important impact in such countries. At the beginning of the 21st century only few investments in projects of tall construction were witnessed at Egypt such as The Nile City tower, First Tower, and Faisal Islamic Bank Tower. There had been several attempts to develop a broad plan of Cairo (Cairo 2050) in an attempt to encourage the instituting of investments in projects of high-rise buildings. Unfortunately, no improvement was succeeded in such stabs, and they could not obtain the enough support to approve them and to fund the construction of such projects.

It's been observed that constructions tend to grow in size with associated rise in their entire response to lateral stresses (like wind and earth- quake). Since multiple storey buildings often have bigger lateral loads, they must take these forces into consideration while designing structures. High rise structures are generally susceptible to extra disarticulations, and hence therefore the outline of distinct processes befits essential for countering such displacements. Bracings system, Moment resisting Frame and Shear walls systems can be effectively used for resisting the lateral loads. Two important characteristics are utilized to measure rigidity as well as lateral stability of high-rise structures' lateral force resisting systems: inter storey drift and lateral displacement/side sway.

2. LITERATURE REVIEW

The performance of the tall structural systems is studied by many research papers. The following researcher's investigation gives the clear view of the performance of tall structures.

Mohammad Tabrez Shadulla, al., (2018) **(5)** has done "Analysis of Tube in Tube Structures with Different Size of Inner Tube". They studied and researched differences in tube-in-tube designs to discover the most efficient structure to withstand lateral stresses with various inner tube diameters, doing so using the Etabs programme. Did 3D models and structural system analysis for a 60-storey building's design under lateral stresses. model one has a standard tube, while model two uses a large-diameter tube for the inside of the design. Model three has a medium-diameter tube, while model four uses a small-diameter tube. Findings were compared across several models, and many differences in displacement, drift, time, and base shear results were noted. Model 2, 3, and 4 have less displacement than model 1. When compared to model 1, model 2 had the greatest reduction in drift. It follows that a tube-in-tube construction, whereby the internal tube is bigger than the external tube, is more effective than a simple extrusion of the frame system in resisting lateral stresses.

Shilpa Balakrishnanal., (2019) **(4)** has done the

"Comparative Study on Tube in Tube and Tube Mega Frames On Different Building Geometry Using ETABS"

In this project, a comparative study of tube in tube structures and tube mega frame system with different building geometry has been done using ETABS software.

They have considered structure of Concrete moment resisting frame number of stories-G+39 height of each floor-3m height of building-120m.

Material properties: Grade of concrete-M30 Reinforcement bars-Fe 415

The objectives are following:

To determine the effect of lateral loads on buildings with tube-in-tube and tube mega framed structure. To study the lateral storey displacement, story drift and base shear in tube-in-tube and tube mega framed structure. To summarize the advantages of tube in tube and tube mega frames under different geometry using the obtained results. To identify the vulnerable building among the models considered for seismic action.

He had concluded that following:

Storey displacement, storey drift and storey shear are higher for tube mega frames when compared with tube in tube under different geometry. Tube in tube will act as a better structural system than tube mega frames for tall buildings The most vulnerable building is square tube mega frame since the storey displacement is large.

3. OBJECTIVES OF THE STUDY

1. To discover how lateral stresses affect frame tube, tube in tube, and bundle tube structures.

2. We will research time period of frames, such as Tube in Tube and Bundle Tube, in event of lateral storey displacement, tale drift, Base shear, and time period.

3. For purposes of research, the investigators are interested in exploring behavior of tubular structures, including structures with and without shear walls.

4. To investigate tubular structure's behavior in zones III and V.

5. finding most susceptible structure out of many models for seismic strain

4. METHODOLOGY

In this project there is an attempt to investigate the wind and seismic effect on G+39 multi storied steel framed buildings. The Modeling of 40 storied steel framed building is done in ETABS 2015 software. Framed tube model, tube in tube model and bundled tube without and including shear are modeled. Then the results are compared. Height of each floor is 3.5m. For wind analysis the code used is IS 875:1987 (part3). Referring to this code terrain category is taken as 3 and Structure class is selected as C while the risk coefficient and topography factor are taken as 1.07 and 1 respectively. Similarly, the windward coefficient and leeward coefficient for analysis are taken as 0.8 and 0.5 respectively. Wind speed is the major factor which is also provided by the code is taken as 44m/s in zone 3.

The seismic zones considered are Zone III and V while soil type taken is Hard. In these structures, loading such as dead, live loads and seismic or earthquake load is done conferring to IS 875 part I, IS 875 part II, IS1893-2002, respectively. Analysis is carried out by Equivalent Method and Response Spectrum Method. Results such as Displacement, story drift and base shears, time period are determined. After analysis, results are obtained in the form of graphs which are in turn observed to form conclusions.

The methodology of the project is as follows:

Plan of multi-story building (40 storied) Modeling different models in ETABS Software

The 4 models are examined.

1. Model 1 – Frame tube model.
2. Model 2 – Tube in Tube Model.
3. Model 3 – Bundled tube without shear wall Model
4. Model 4 – Bundled tube with shear wall.

Carrying out seismic, wind and response spectrum analysis One by one for all models in Zone III and Zone V Defining loads, Assigning the loads and its combinations on the structure Results and discussion

Conclusion

A. DESCRIPTION OF MODELS

Dimensions of plan area = 52.5m x 52.5m

No of stories = 40(G+39)

Height of each storey = 3.5m

Spacing of columns along X-direction = 7.5m

Spacing of columns along Y-direction = 7.5m

Loading includes just external loads that are applied to the structure, without considering weight of members. programme automatically calculates weight of members. Shell loads that bear weight of the floor are equivalent of weight of 1 kN/m2 while facing gravity (floor finish) and are able to handle up to 4 kN/m2 (live load). To evenly distribute the weight of 14.26kN/m, a frame or wall was built. EQ-X and EQ-Y load values are specified in IS1893:2002 for Load patterns that include Code to explicitly load EQ-X and EQ-Y. Additionally, wind-x and wind-y, which describes transverse and longitudinal stresses respectively, are listed in IS875:1987 (Part III).

Table I Models proposed for the present study:

S.no	Model no	Description
		Seismic ZONE-III
1	Model 1	Framed tube model
2	Model 2	Bundled tube model
3	Model 3	Bundled tube without shear wall
4	Model 4	Bundled tube with shear wall
		Seismic ZONE-V
6	Model 1	Framed tube model
7	Model 2	Bundled tube model
8	Model 3	Bundled tube without shear wall
9	Model 4	Bundled tube with shear wall

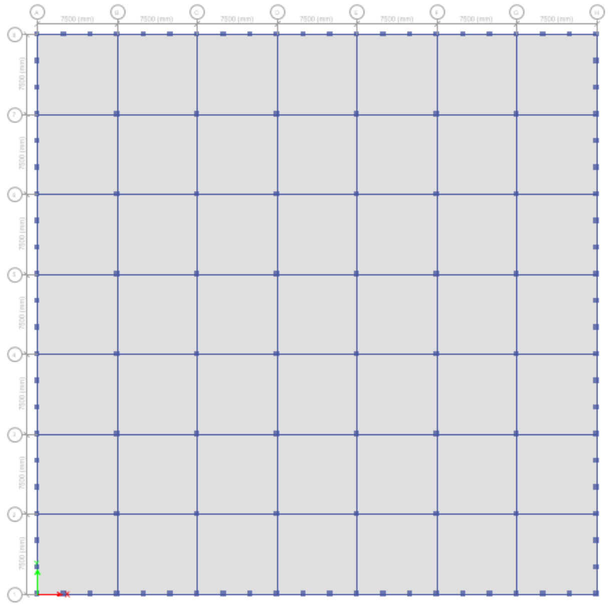


Fig 1: Plan of frame tube i.e. Model 1

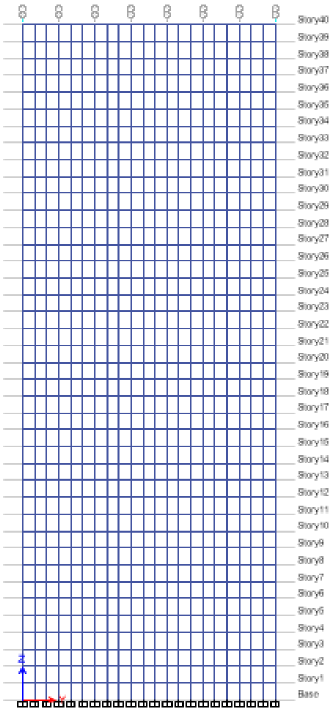


Fig 2: Elevation of frame tube i.e. Model 1

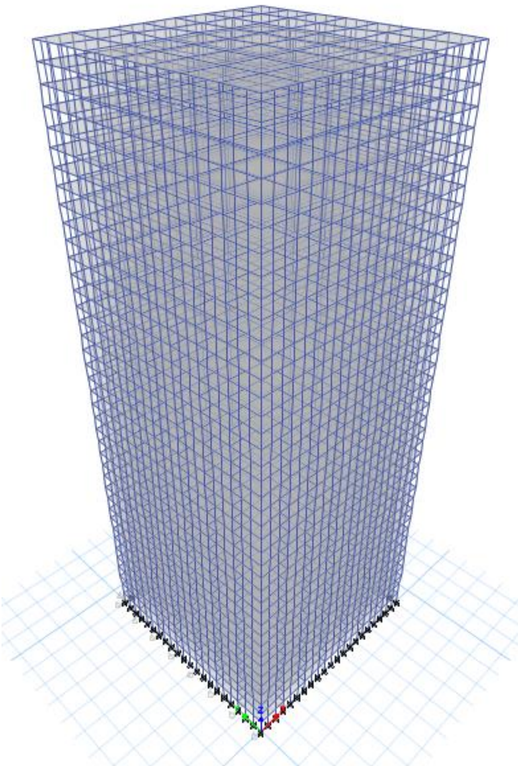


Fig 3: 3-D view of frame tube i.e. Model 1

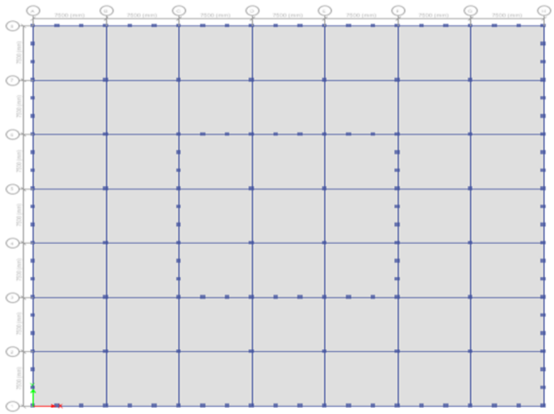


Fig 4: Plan of tube in tube i.e. Model 2

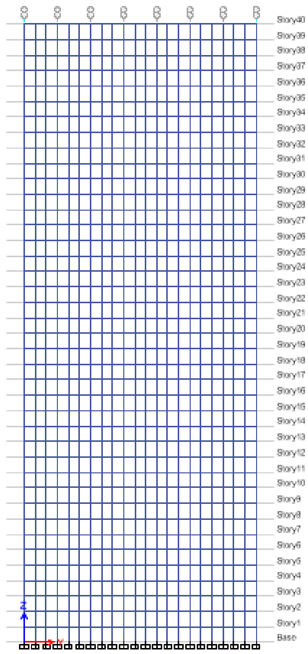


Fig 5: Elevation of tube in tube i.e. Model 2

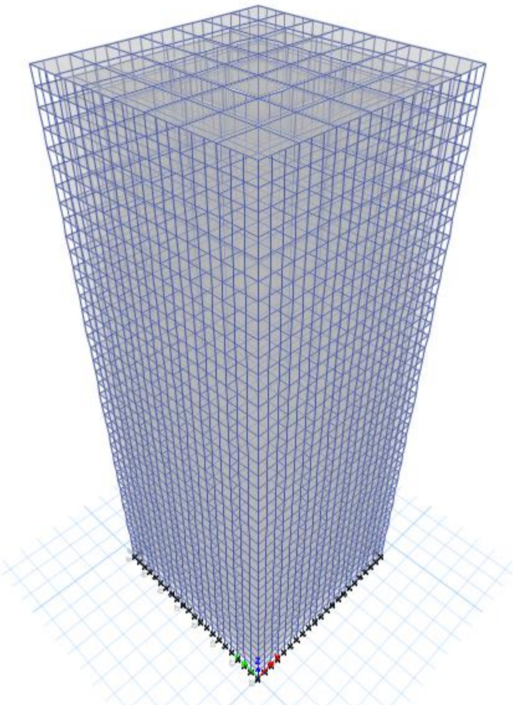


Fig 6: 3D view of tube in tube i.e. Model 2

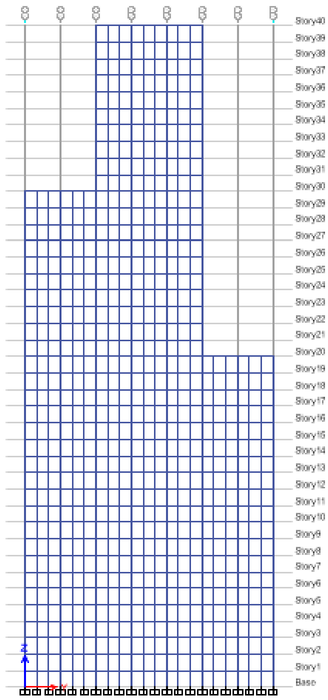


Fig 8: Elevation of bundled tube without shear model i.e. Model 3

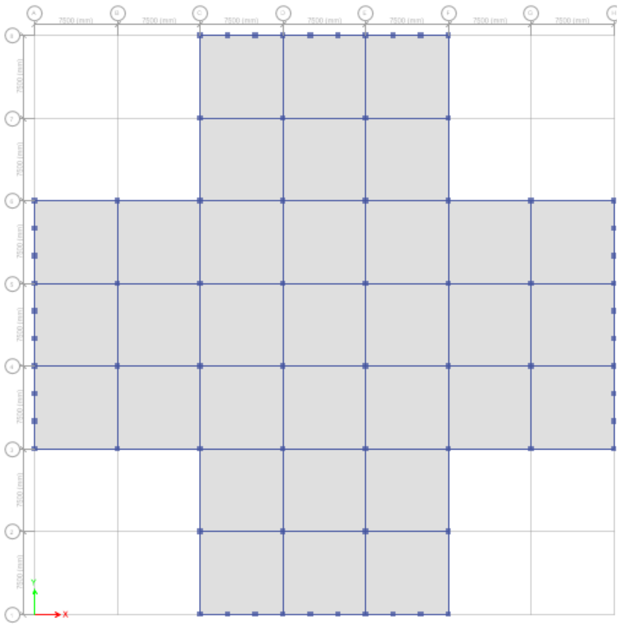


Fig 7: Plan of bundled tube without shear model. i.e., Model 3

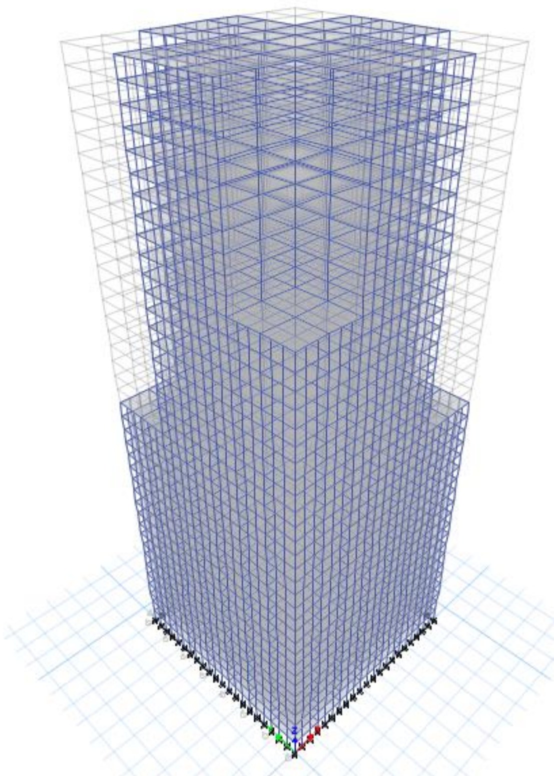


Fig. 9 3d view of bundled tube without shear model i.e. Model 3

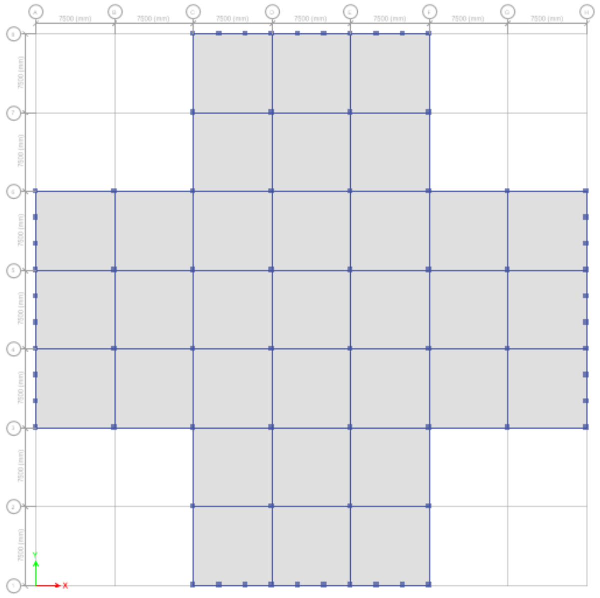


Fig 10: Plan of bundled tube with shear wall i.e. model 4

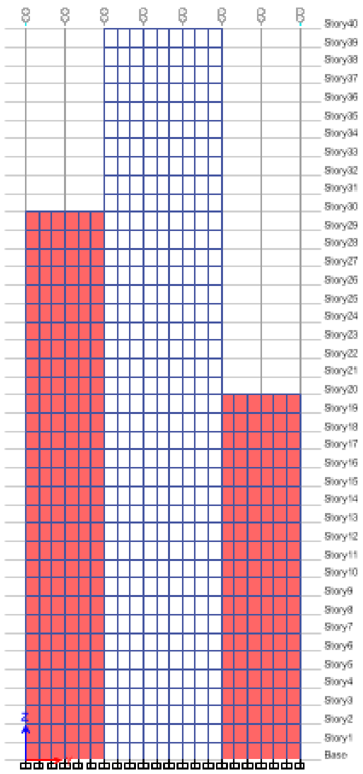


Fig 11: Elevation of bundled tube with shear wall i.e. model 4

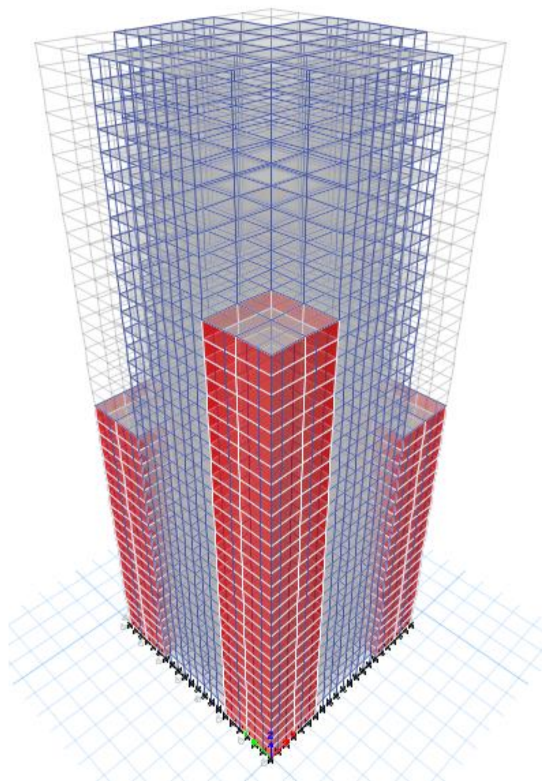


Fig 12: 3d view of bundled tube with shear wall i.e. model 4

B. Parameters used for analysis of different framing systems

The plan is kept same for the study of all the framing systems. Storey height is kept as 3.5m from bottom to top.

Properties of Material

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
Floor finishes Assumed	1 kN/m^2
Live load	4 kN/m

Material properties

C. Cross sections of the elements in structural frame

- Slab section - Deck slab(composite slab)
- **Column size**

- C1 –1000mm x 1000mm
- C2 – 800mm x 800mm
- C3 – 600mm x 600mm
- C4 – 500mm x 500mm
- **Beam size** – 300mm x 450mm

D. Seismic data

- Zone factor =0.16(Zone III) & 0.24(ZONE V)
- Importance factor = 1.5
- Response reduction factor =5
- Soil type = Type 1 (Hard)

E. 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 = 44m/s

RESULT AND DISCUSSION

Wind and seismic loads are applied to all 10 building models for examination. The ETABs 2015 software is used to analyze all of the different construction models. All building models' study outcomes, such as displacements, storey drifts, and time period, as well as base shear, are provided and compared.

A. Displacement

The models' performance under lateral loads is investigated to understand the effects of wind and seismic stresses. displacements to every model owing to different lateral loads are tabulated.

Where hs= building height

By Indian norms, maximum allowed displacement in a multistory structure is hs/500.

The maximum allowed displacement for the models utilised in the study

= 140/500 =0.280m.

Since the models are symmetrical therefore displacements along longitudinal and transverse direction will be similar, thus just X displacement is tabulated. The X and Y displacements owing to wind, seismic loads, and response spectrum technique for models 1, 2, 3, and 4 are shown in the tables below. Models 1, 2, and 4 have smaller displacements than model 3.

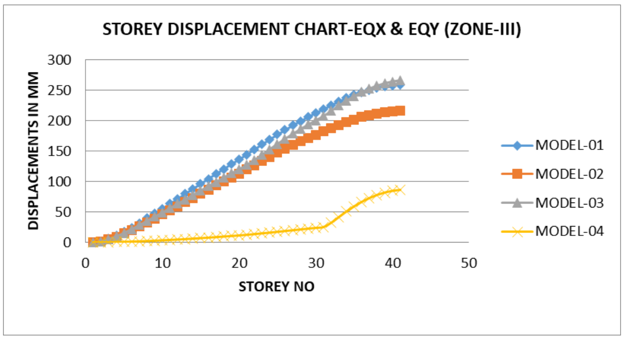
B. Storey Drifts

A building's maximum allowed drift is 0.004H per IS 875 part 3.

H= height of one storey

Maximum allowed drift for our models =0.004×3200=14 mm.

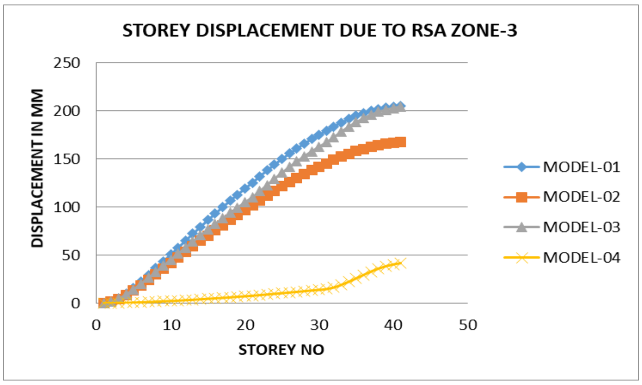
The table below shows storey drifts caused by wind and seismic loads for model 1, 2, 3 and 4. In all four models, seismic load caused greater storey drifts than wind load. Models 1, 2, and 4 have less drift than model 3. Model 2 showed the greatest reduction in drift compared to model 1. Thus, the tube in tube model system resists lateral loads better than any other.



1. STOREY DISPLACEMENT CHART-EQX & EQY (ZONE-III)

From the graph it is observed that,

1. The Storey displacements for model 1 i.e. framed tube are 259mm compared to other models.
2. Once we move from framed tube model to tube in tube model displacement values are reduced by 16.48% compared to framed tube model.
3. Again these values are slightly increased by 2.6% if we introduce tube in tube model with bundled tube model without shear wall.
4. Hence, the maximum storey displacement values are lowest for model 4 i.e. tube in tube model with shear wall the displacement is reduced by 66.83%.

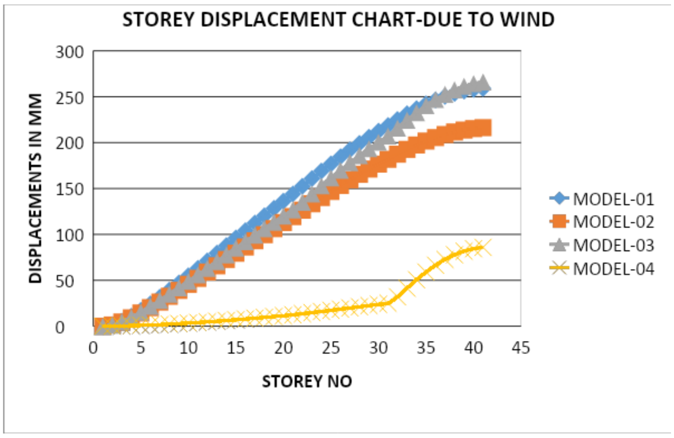


2. STOREY DISPLACEMENT DUE TO RSA

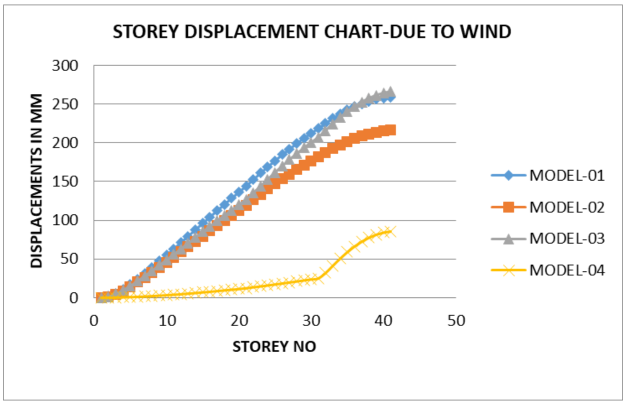
ZONE-3

From the graph it's seen as,

1. Storey wise displacement value being maximum for model 1 i.e. framed tube model compared to other models.
2. Once we move from framed tube model to tube in tube model displacement values are reduced by 18.47%.
3. Again these values are further reduced by 0.53% if we introduce bundled tube model without shear wall.
4. Hence, the maximum storey displacement values are minimum for model 4 i.e. bundled tubes with shear wall the displacement is reduced by 79.76% compared to framed tube model.

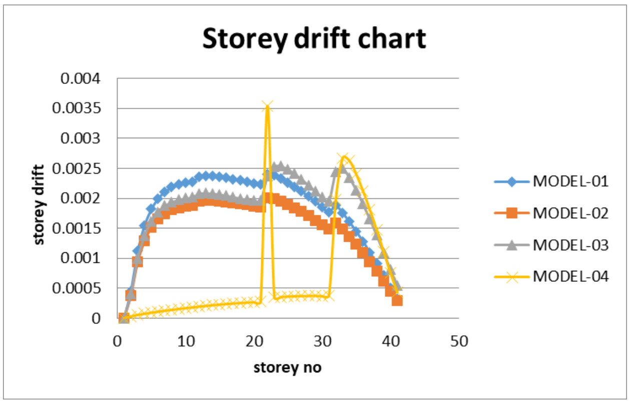


3. STOREY DISPLACEMENT CHART-DUE TO WIND



From the graph and it is observed that,

1. The Storey displacements for model 1 i.e. framed tube are 248.9mm compared to other models.
2. Once we move from framed tube model to tube in tube model displacement values are reduced by 19.52% compared to framed tube model.
3. Again these values are increased by 13.48% if we introduce tube in tube model with bundled tube model without shear wall.
4. Hence, the maximum storey displacement values are lowest for model 4 i.e. tube in tube model with shear wall the displacement is reduced by 75.65%.

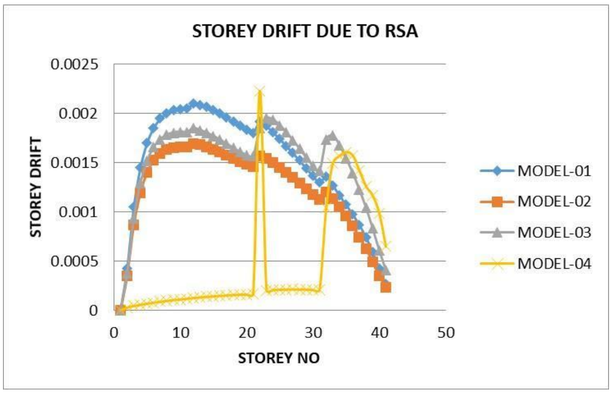


4. Storey drift chart

From the graph it's seen as

1. The Storey drift values for model are 0.000328 compared to all other models.
2. These storey wise drifts values are sufficiently decreased by 9.57% when tube in tube structure is introduced i.e. model 2.
3. The storey wise drift value is increased by 40.47% for model 3 when compared to model 1.

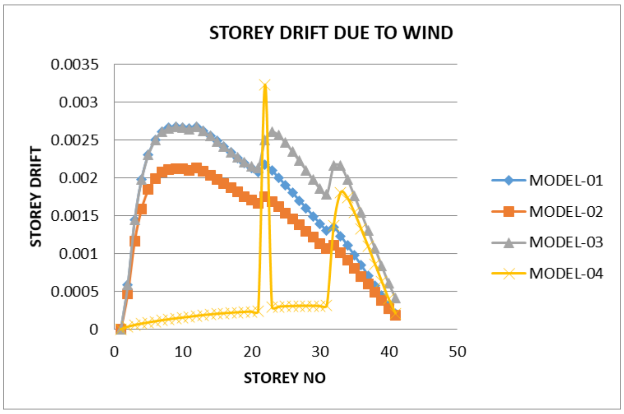
The storey wise drift value is increased by 23.89% for model 4 when compared to model 1.



5. STOREY DRIFT DUE TO RSA

From the graph it's seen as

1. The Storey drift values for model are 0.000265compared to all other models.
2. These storey wise drifts values are sufficiently decreased by 13.58% when tube in tube structure is introduced i.e. model 2.
3. The storey wise drift value is increased by 34.56% for model 3 when compared to model 1.
4. The storey wise drift value is increased by 58.97% for model 4 when compared to model 1.



6. STOREY DRIFT DUE TO WIND

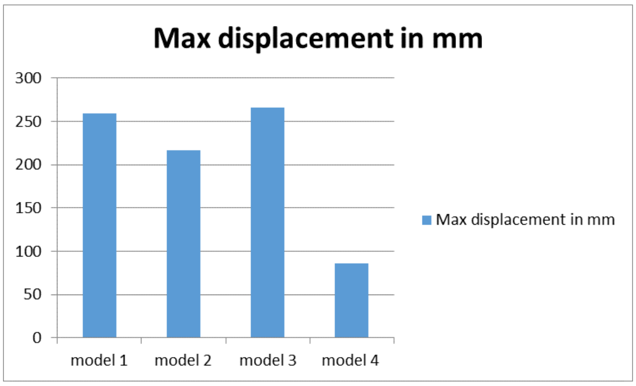
From the graph and table 7.6, it's observed

1. Storey drift values for model are 0.000214compared to all other models.
2. These storey wise drifts values are sufficiently decreased by 9.81% when tube in tube structure is introduced i.e. model 2.
3. The storey wise drift value is increased by 48.30% for model 3 when compared to model 1.
4. The storey wise drift value is increased by 0.92% for model 4 when compared to model 1.

A. Comparison of maximum displacements of all models due to seismic loads in ZONE-III (Equivalent Static Method)

MODEL	MAX DISPLACEMENT IN mm	PERCENTAGE (%) REDUCTION(COMPARED TO MODEL 1)
MODEL-1	259	0
MODEL-2	216.3	16.4
MODEL-3	266.1	2.6% increased
MODEL-4	85.9	66.83

Maximum displacements of all models due to seismic loads in Zone III



Maximum displacements of all models due to seismic loads in Zone III

From the graph and table 7.7, it is observed that

The maximum storey displacements for seismic analysis from equivalent static are hauling out and listed in the above table. By outcomes it's seen as the bundled tube model might have max roof displacements are

266.1mm along X-direction and Y-direction both, and the minimum roof displacements are obtained in model-4 i.e. is bundled tube with shear wall is 85.9 mm.

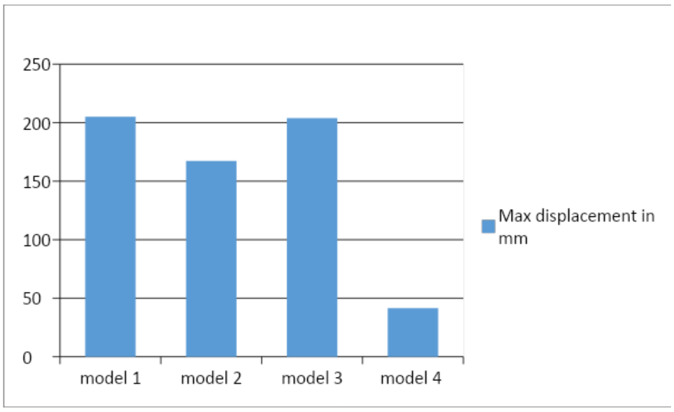
Comparison of maximum displacements of all models due to Response spectrum method in ZONE-II

B. Comparison of maximum displacements of all models due to Response spectrum method in ZONE-III

	MAX	PERCENTAGE (%)

MODEL	DISPLACEMENTIN mm	REDUCTION (COMPARED TO MODEL 1)
MODEL-1	205.1	0
MODEL-2	167.2	18.47%
MODEL-3	204	0.536%
MODEL-4	41.5	79.76%

Maximum Displacements Of All Models Due To Response In Zone III



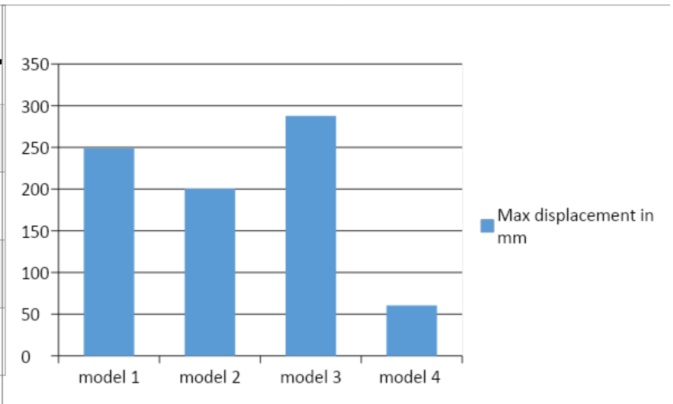
Maximum displacements of all models due to response in Zone III

Similarly, response storey displacements are obtained after seismic analysis and listed in above table. From the results it can be observed that framed tube model will have maximum roof displacements which are 205.1 mm.the minimum roof displacements are obtained in bundled tube with shear wall are 41.5mm.

C. Comparison of maximum storey displacement due to wind loads of all models in ZONE-III

MODEL	MAX DISPLACEMENT IN mm	PERCENTAGE (%) REDUCTION (COMPARED TO MODEL 1)
MODEL-1	248.9	0
MODEL-2	200.3	19.52%
MODEL-3	287.7	13.51% increased
MODEL-4	60.6	75.65%

Maximum displacements of all models due to wind loads in Zone III



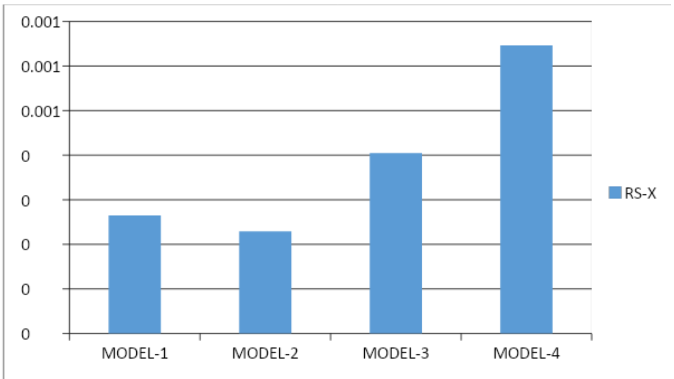
Maximum displacements of all models due to response in Zone III

Wind analysis results for storey displacement are obtained and tabulated in the table above. From the results it can be observed that bundled tube model will have maximum roof displacements which are 287.7 mm.the minimum roof displacements are obtained in bundled tube with shear wall are 60.6mm.

. D. Comparison of maximum storey drift due to seismic loads of all models in seismic ZONE-III

S.NO	MODEL	EQ-X
1	FRAMED TUBE	0.000328
2	TUBE IN TUBE	0.000296
3	BUNLED TUBE WITHOUT SHEAR WALL	0.000551
4	BUNLED TUBE WITH SHEAR WALL	0.000431

Maximum storey drift of all models due to seismic loads in Zone III



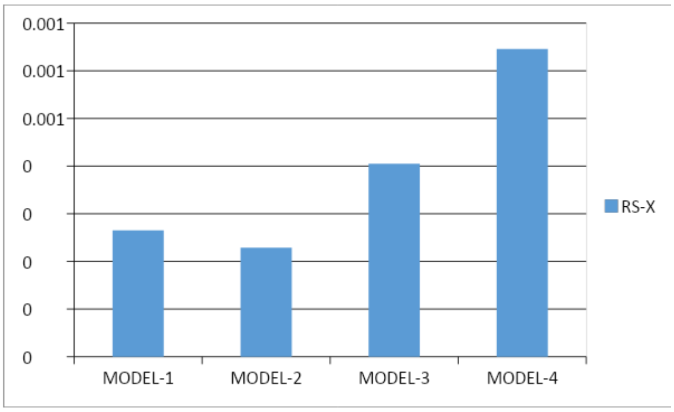
Maximum storey drift of all models due to seismic loads in Zone III

Maximum storey drifts for all models are hauling out and listed in above table. It is observed that bundled tube without shear wall model has maximum values of storey drift compared to all models i.e. 0.000551along EQ-X and EQ-Y directions respectively, the minimum storeydrift are obtained in tube in tube model is 0.000296.

E. Comparison of maximum storey drift due to wind loads of all models in ZONE-III

S.NO	MODEL	WIND-X
1	FRAMED TUBE	0.000214
2	TUBE IN TUBE	0.000193
3	BUNLED TUBE WITHOUT SHEAR WALL	0.000414
4	BUNLED TUBE WITH SHEAR WALL	0.000216

Maximum storey drift due to wind loads for all models in ZONE-III



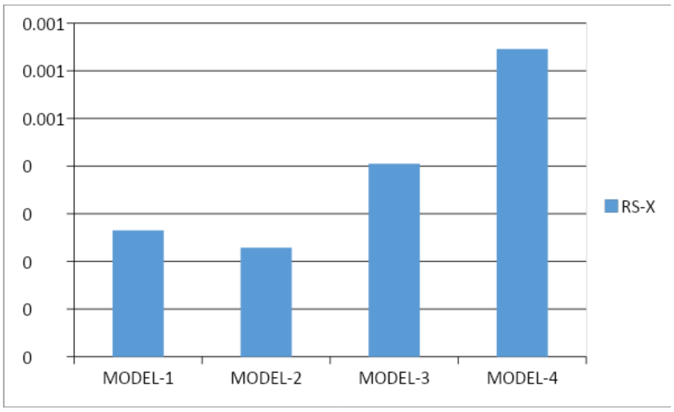
Maximum storey drift due to wind loads for all models in ZONE-III

Maximum storey drifts for all models are hauling out and listed in above table. It is observed that bundled tube without shear wall model has maximum values of storey drift compared to all models i.e. 0.000414along WIND-X and WIND-Y directions respectively, the minimum storey drift are obtained in tube in tube model is 0.000193.

F. Comparison of maximum storey drift due to response spectrum method of all models in ZONE-III

S.NO	MODEL	WIND-X
1	FRAMED TUBE	0.000265
2	TUBE IN TUBE	0.000229
3	BUNLED TUBE WITHOUT SHEAR WALL	0.000405
4	BUNLED TUBE WITH SHEAR WALL	0.000646

Maximum storey drift due to response for all models in ZONE-III



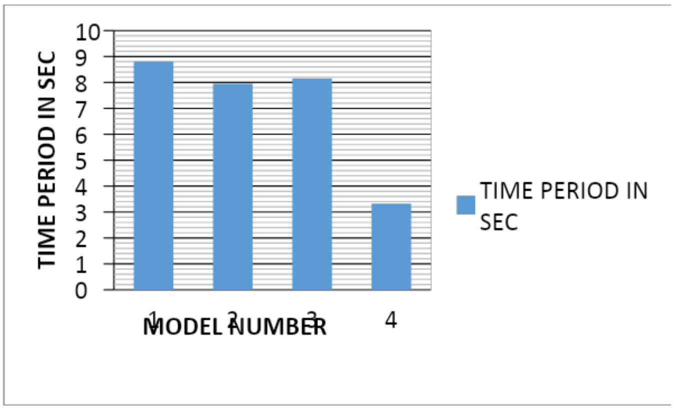
Maximum storey drift due to response for all models in ZONE-III

Maximum storey drifts for all models are hauling out and listed in above table. It is observed that bundled tube with shear wall model has maximum values of storey drift compared to all models i.e. 0.000646along RS-X and RS-Y directions respectively, the minimum storey drift are obtained in tube in tube model is 0.000193.

G. Time Period

	TIME PERIOD
MODEL-01	8.808
MODEL-02	7.957
MODEL-03	8.154
MODEL-04	3.329

Time Period in Seconds for ZONE-III



Time Period in Seconds for ZONE-III

From the graph and table 7.13, it is observed that

1. The Time Period values are maximum for framed tube model i.e. model 1 compared to other all models. These time period values are sufficiently decreased when tube in tube structure is introduced i.e. model2.

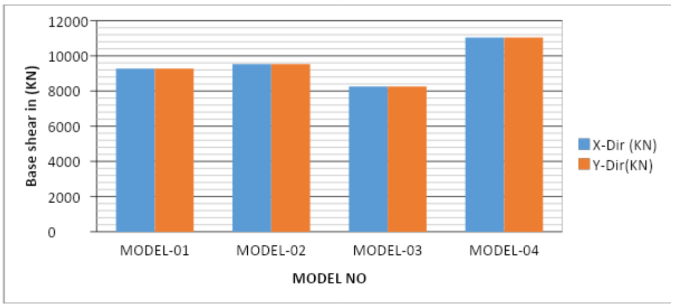
2. The percentage decrease in fundamental time period for model 2 is 9.66% when compared to model 1. These values are further reduced in bundled tube without shear wall.

3. Therefore it can be concluded from the graph that model 4 i.e. Tube-in-Tube model with shear wall has least Time Period value when compared to all other models.

H. Base shear

BASE SHEAR	X-Dir (KN)	Y-Dir(KN)
MODEL-01	9267.3753	9267.375
MODEL-02	9530.4036	9530.404
MODEL-03	8257.2094	8257.209
MODEL-04	11033.426	11033.43

Base shear in (KN) for ZONE-III



Base shear in (KN) for ZONE-III

From the graph and table 7.14, it is observed that

Maximum base shears developed at the ground floor for all the structures in zone 4 are presented in the above Table, Maximum base shear values are observed in model 4 i.e. tube in tube model with shear wall11033.426 kN and 11033.43 kN along X and Y direction respectively. When compared for base shear values of all models, the bundled tube without shear wall i.e. model 3 showed the lowest base shear values and bundled tube with shear wall model i.e., model 4 showed the maximum base shear values.

Again if compared with model 1 the base shear values are increased by 2.75%, and decreased by 10.90% again increased by 16.00% along X and Y directions respectively, model 4 i.e. bundled tube with shear wall is very high compared to others which makes it more efficient in resisting lateral loads.

6. OBSERVATIONS AND DISCUSSIONS

1. Wind analysis results showed that the maximum displacements due to wind loads for tube in tube model without shear wall are high, when compared to all other models. These maximum displacements are gradually reducing when move to framed tube model and then to bundle tube model and tube in tube model with shear wall. Therefore the wind displacements of model 1, model 2, and model 4 are reduced by 13.48%, 30.37%, and 78.93% along X-direction and Y-direction respectively, when compared with model 3 in wind zone 3.

2. The storey drift for model 2 shows least value compare to all other models. The storey drift for model 1, model 3 and model 4 increases by 9.8%, 53.38% and 10.64% compared to model 2 due to wind analysis in wind zone 3.

3. Similarly, seismic analysis results showed that the maximum displacement values due seismic loads are highest for model 3 i.e. tube in tube model without shear wall, when compared to all other models. These maximum displacement values are gradually reducing when we move from tube in tube without shear wall to frame tube, tube in tube and bundle tube with shear wall models. Therefore, the displacements of model 1, model 2, and model 4 are reduced by 2.66%, 18.71%, and 67.71% along X and Y-direction respectively, when compared with model 3 in zone 3.

4. The storey drift due to seismic load for model 2 is least compared to all other models when we move to model 1 the storey drift increases by 9.75%, for model 3 the storey drift increases by 46.27%, and for model 4 the storey drift increases by 31.32% for seismic zone 3.

5. When base shear values of all models are compared, the tube in tube model without shear wall i.e., model 3 showed the lowest base shear values, when compare to all other model. The base shear for model1, model 2 and model 4 is increases by 7.57%, 10.51% and 22.4% along X and Y direction in seismic zone 5.

6. Similarly base shear values of all models are compared, the tube in tube model without shear wall i.e. model 3 showed lowest base shear values, when compared to all other models. The base shear for model 1, model 2 and model 4 is increases by 10.9%, 13.35% and 25.16% along X and Y direction in seismic zone 3.

7. After performing both wind and seismic analysis it was also observed that the model 3 shows maximum displacement. But model 4 shows high lateral load resistance due to wind and seismic forces.

8. It is observed that resisting capacity of the wind loads and seismic loads by tube in tube structures with shear wall is very high when compared to without shear wall.

7. SCOPE OF STUDY

Within the limited scope of the current study, the broad conclusions have been drawn and reported in this study. However, further study can be taking on in the ensuing areas:

1. By considering different geometrical plan such as square, rectangular and circular plan analysis can be done.
2. Further study can also be done on unsymmetrical building with successive soft storey.
3. Additional study can also be done by introducing Shear wall with openings on the same building configuration.
4. Further investigation can also carry out by combing both tubular technology and outrigger belt system for same building models.
5. Further study can be carried out by applying pushover analysis and time history analysis.

8. CONCLUSIONS

1. Wind analysis results showed that the displacements due wind loads for tube in tube without shear wall model 3 were highest when compared to all other models. Least displacements are for model 4, similarly the storey drift for model 3 is highest and least storey drift is for model 2.
2. Similarly, seismic analysis results showed that the displacement values due seismic loads for tube in tube without shear wall are maximum when compared to all other model. The storey drift for model 3 is highest when compared to all other models.
3. When we use response spectrum method the storey displacement is maximum for model 3 and least displacement for model 4.
4. When base shear values of all models are compared, the tube in tube model without shear wall i.e., model 3 showed the lowest base shear value and tube in tube models with shear wall model 4 in zone 3 and zone 5 showed the highest base shear value. These values clearly explains that the rigidity of model 4 in zone 3 and zone 5 is very high compared to others which makes them more efficient in resisting lateral loads.
5. The tubes in tube structures with shear wall are comparatively more efficient in resisting wind loads than that of seismic loads compare to other models.
6. The time period for model 1 is highest and model 4 is lowest.
7. The storey displacement in seismic zone 5 for model 3 is highest and for model 4 is lowest.

REFERENCES

1. Shilpa Balakrishnan, Rona Maria James "Comparative Study On Tube In Tube And Tubed Mega Frames On Different Building Geometry Using ETABS". International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 12, 2019.
2. Mohammad Tabrez Shadulla, Kiran K M "Analysis of Tube in Tube Structures with Different Size of Inner Tube" International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES) e-ISSN: 2455-2585Volume 4, Issue 10, October-2018
3. 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.
4. M. R. Jahanshahi, R. Rahgozar, M. Malekinejad, "A SIMPLE APPROACH TO STATIC ANALYSIS OF TALL BUILDINGS WITH A COMBINED TUBE-IN TUBE AND OUTRIGGER-BELT TRUSS SYSTEM SUBJECTED TO LATERAL LOADING", Ije Transactions A: Basics Vol. 25, No. 3, July 2012.
5. Basavanagouda A Patil and Kavitha.S, "Dynamic Analysis of Tall Tubular Steel Structures for Different Geometric Configurations," International Journal of Engineering Research, ISSN: 2321-7758, Vol.4. Issue.4. 2016(July-August).
6. J. S. Arvind* and M. Helen Santhi, "Effect of column shortening on the Behavior of Tubular Structures" Indian Journal of Science and Technology, Vol 8(36), DOI: 10.17485/ijst/2015/v8i36/87533, December 2015.
7. Hamid Mirzahosseini, "OPTIMAL DESIGN OF TUBE IN TUBE SYSTEMS", IJFALS, ISSN: 2231– 6345, Vol. 5, Issue 3, pp. 119-138, APR 2015.
8. Khan FR, Amin NR. "Analysis and design of framed Tube Structure for all Tall Buildings", ACI Publications SP- 36: Response of multi-storey concrete structures to lateral forces. 1973; 51(3):39–60.

9. Dhanapalagouda Patil, Nveena M P, " DYNAMIC ANALYSIS OF STEEL TUBE STRUCTURE WITH BRACING SYSTEMS", IJRET, ISSN: 2319-1163, Vol 4, Issue 8, Aug 2015.

10. 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.

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