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Effect of Bundled Tubular System on Response of Building Subjected to Dynamic Wind Loads

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Abstract: As the number of Population increases, there is demand in high rise building also increases. Whenever the height of building increases, effect of lateral forces also increases. Hence, there is need to analyse the wind forces/lateral forces acting on the building. In tubular structure, Bundled tube structure is the most efficient structure against heavy lateral load. Bundled tube and Bundled tube in tube structures of varying space in column and varying column dimensions are considered. Wind analysis done by using ETABS 2019 for the models with response spectrum analysis.
Keywords: lateral load, Bundled tube, Bundled tube in tube structures, column, wind analysis.

I. INTRODUCTION

The increasing rate of population, rapid industrialization and consequent shortage of land especially in metro cities has turned designers for construction in vertical direction. In the past, available of conventional methods of construction, this restricted the buildings up to seven or eight stories. These low to medium- rise structures are normally designed for gravity loads, and then checked for their ability to resist lateral loads. In tall buildings, generally the gravity load system cannot resist horizontal forces efficiently. Therefore, there was a need of such a type of structural system that can fulfil the requirements of resisting all types of load cases with economic point of view, A recent development in the structural design is the concept of tubular behaviour introduced by Fazlur R. Khan. At present, tubular system are four of the world's five tallest buildings. They are the Scars Tower, the Hancock Building and the Standard Oil Building in Chicago, and were the World Trade Centre in New York. Tubular structural systems are so efficient that in most cases the amount of structural material used per square meter of floor is comparable to that used in conventionally framed buildings half the size.

1) *Bundled Tube Structure:* In Bundled Tube system, there is several numbers of tubes which are interconnected to each other to form a multi-cell tube. All together to build the tallness of the structure fundamentally bundled with tubes and helping its cantilever activity, inclining individuals could be included accordingly acquiring the auxiliary framework. For making a different look to the existing building, the bundled tube structure gives extra-ordinary flexibility in the architectural planning. A bundled tube structure is the structures which includes numerous particular tubes at its base and only one at its peak level.
2) *Bundled Tube-in-Tube Structure:* In Bundled Tube-in-Tube structural system consists of an outer-framed tube together with internal tubes which have an internal elevator and service core. The inner and outer tubes which are resisting both gravity and lateral loading in framed buildings. However, the outer tube usually plays a dominant role because of the greater structural depth. Hence, the structure is also called as Hull (outer tube) and core (inner tube) structure.
3) *Dynamic Wind Effect:* Wind load plays a predominant role on the tall structure. Generally larger structure will be affected more by gust of larger duration and thus subjected to smaller pressure compared to smaller structure. The difference between the structural designs as a result of wind of a high-rise building can be explained by using the wind spectrum and natural frequencies, since the wind fluctuates with the time. The intensity of the wind load depends on how fast it varies and also on the structure. Therefore, wind load need to be studied.

According to IS 875 part III, Dynamic effects of wind load is described as flexible slender structures and structural elements shall be investigated to the wind induced oscillations or excitations along and across the direction of wind.

II. REVIEW OF LITERATURE

A. *Jay P. Patel, Vishal B. Patel and Elizabeth George (2017)*

They Investigated about 48 storied building. Demand of construction of high-rise building is growing day by day in densely populated areas in India. In construction of tall building lateral load is main governing factor in design of tall structure. Tubular system is one of the common and popular systems. Framed tube and Bundled tube systems are commonly used systems in construction of high-rise building. For designing these systems, it requires accurate analysis. Here attempt has been made for 48 storey building structure using ETABS software in triangle tubes bundled system and square tubes bundled system.

B. Shaival J. Patel, Prof. Vishal B. Patel (2016)

Tall building developments have been rapidly increasing worldwide and also in India. Steel has a more advantages material in world today it gives innovative framing systems, easy to assembling, high strength to weight ratio availability of various strength and wider selection of sections and it is an environment friendly so steel is being used in worldwide tall building. In past designers are only considering a gravity loads for the design of building. But now improvisation in seismic and wind study, lateral forces is added in design of building. Tubular frames are one of the common structural systems in designing tall buildings. Framed Tube and Bundled Tube are famous structural system. Design of these systems requires precise analysis. Tubular system is considering in two parts, exterior and interior which uses to resist lateral load and gravity load respectively. In this study one steel building of each framed tube system and bundled tube system of optimum section with 64 stories with symmetric plan area and identical loading condition using ETABS. Various parameters like fundamental time period, maximum top story lateral displacement, maximum base shear, steel weight, and maximum story drift are considered in this study

C. Vikram J & Geethu Varghese (2017)

They analysed the multi storied building in Staad-Pro. Multi-storeyed buildings are used for office, complex, residential flats, public centres, etc. There is need for multi-storeyed building due to overcrowding of cities. These multi-storeyed buildings can be transformed into tall buildings in order to achieve more floor space but occupy less land space. In the design of tall buildings, lateral loads play predominant role.

The lateral loads are wind load and seismic load. There are various lateral load resisting systems such as braced frame system, moment resisting frame system, frame truss-interacting system, shear wall system, core and outrigger system and tubular system. The tubular system comprises various types such as framed tube, trussed tube, tube in tube and bundled tube. In this project, a plan has been created for the bundled tube comprising four tubes using Auto-cad. The various loads such as dead load, live load and wind load are assigned using software.

Analysis of the structure has been done using software. The components of the structure such as the slab beam and column has been designed by manual calculations. The slab is designed as continuous slab. The load calculations for slab and beam are done manually. The load for column design has been obtained from staad analysis report. The pile foundation for the bundled tube structure has been designed. The two main components of pile foundation are pile and pile cap. The design of pile and pile cap has been done by manual calculations. The pile has been designed as a square pile. The design detailing of all the designs such as beam, column, slab, pile and pile cap has been made in Auto-cad.

D. Karthik A L, Geetha K (2016)

They studied Competition towards ascent of tall steel structures made certain elements are necessary like serviceability and comfort of people with lateral forces brought on by quake. Seismic tremor is unsafe to the living creatures as far as its consequences for artificial structures. Structures like tall structures are worked to oppose gravity loads. However, many tall structures are not that safe in lateral forces because of seismic tremor so require an improvement in resisting lateral forces. So, there are numerous structural frameworks which oppose lateral forces by varying orientation, addition of various basic frameworks. Like steel bundled tube framework is considered and compared for their outcomes against lateral forces and also by providing super belt-truss and mega bracings. In this work, five structural frameworks are considered in which are 1) Regular steel structure, 2) Tube structure, 3) Bundled tube structure, 4) Bundled tube structure with belt-truss, 5) Bundled tube structure with belt-truss and mega bracings. For the reason 110 story steel structure with rectangular arrangement of measurement 60mx60m is considered and analysed for gravity and lateral forces utilizing ETABS programming. Functioning characteristics like displacement, story shear, time period, story drift are extracted from ETABS. Results shows that the steel bundled tube structure with belt-truss and mega bracings framework is much stable than the other four structural frameworks.

E. Patil Kiran Kumar et. al. (2020)

They investigated Seismic performance of the 150m tall rectangular plan Bundle tube and framed tube structures have been performed with the CQC method in Response spectrum method in Seismic zone 4 and Zone 5 of IS 1893-2016 code provisions. With the high flexibility to terminate the tubes at required heights of the structure, the bundled tube structure can be selected in tall buildings.

This statement is established with the higher specific performance of peak characteristics is found in comparison with the framed tube structure for the similar seismic characteristics.

F. Jignesha Patel, Roshni J John (2015)

They analysed the Frame tube structure. The frame tube structure takes more of lateral load. The efficiency of this system is derived from the great number of rigid joints acting along the periphery, creating a large tube. Exterior tube carries all the lateral loading. Structurally, the framed-tube is superior to a rigid frame because it places material on the exterior of the building. The entire interior structural system is secondary - designed to carry only gravity loads to the ground level. The tube buildings leave the interior floor plan relatively free of core bracing and heavy columns, enhancing the net usable floor area. The reduction of material makes the buildings economically much more efficient. These new designs opened an economic door for contractors, engineers, architects. This study is focused on seismic behaviour of tube structure for varying zones in India for the parameters like displacement, story drift, and time period.

G. Prof. S .Vijaya Bhaskar Reddy (2018)

They studied Lateral load effects on high rise buildings are quite significant and increase rapidly with increase in height. In high rise structures, the building of the structure is greatly influenced by the type of lateral system provided and the selection of appropriate lateral structural system plays an important role in the response of the structure. The selection is dependent on many aspects such as structural building of the system, economic, feasibility and availability of materials. Few of the lateral structural systems are shear wall system, Framed tube system, Tube in tube system, Bundled tube system. The lateral structural systems give the structure the stiffness, which would considerably decrease the lateral displacements. In the present work a Plain frame system, a Shear wall system and framed tube system are considered for 30,40,50,60 storey structures. The analysis has been carried out using software STAAD Pro-2005. The roof displacements, internal forces (Support Reaction, Bending Moments and Shear Forces) of members and joint displacements are studied and compared. It is seen that the Shear wall system is very much effective in resisting lateral loads for the structures up to 30 stories and for structures beyond 30 stories the Framed tube system is very much effective than Shear wall system in resisting lateral loads.

III. STRUCTURAL MODELLING AND ANALYSIS

A G+39 Storey Bundled Tube and Bundled Tube-in-Tube Buildings are considered for computation and analysis work. For 3m column spacing, the structure is 120m tall, 81m wide and 81m in length square in plan. For 2m column spacing, the structure is 120m tall, 54m wide and 54m in length square in plan. The following are the properties of the Bundled Tube and Bundled Tube-in-Tube model for designing and modeling system shown in table. The plan and 3D view of optimized model as shown in fig. The model is designed as per IS 456-(part3).Modeling and analysis is done with the help of ETABS-2019.Location of the structure is Chennai considered for the wind analysis by response spectrum analysis.

Table 1: Parameters of structures

Sr. No.	Particulars	Data
I	Number of Storey	G+39
II	Storey Height	3m for all the storey
III	Beam Size	300 mmX600 mm
IV	Slab Thickness	200 mm
V	Grade of Materials and Concrete	• M30 for all Columns, Beams and Slab • Fe 415 and Mild 250 Steel for Rebar

Table 2: Seismic Parameters

Seismic Zone	III
Soil Type	II
Importance Factor	1.5
Response Reduction Factor	5

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Table 3: Model Description

Sr. No.	Model No.	Model Name	Column Spacing	Column Size
I	M1	Bundled Tube Model	2m	800mmX800mm
II	M2	Bundled Tube in Tube Model	2m	800mmX800mm
III	M3	Bundled Tube Model	2m	600mmX600mm
IV	M4	Bundled Tube in Tube Model	2m	600mmX600mm
V	M5	Bundled Tube Model	3m	800mmX800mm
VI	M6	Bundled Tube in Tube Model	3m	800mmX800mm
VII	M7	Bundled Tube Model	3m	600mmX600mm
VIII	M8	Bundled Tube in Tube Model	3m	600mmX600mm

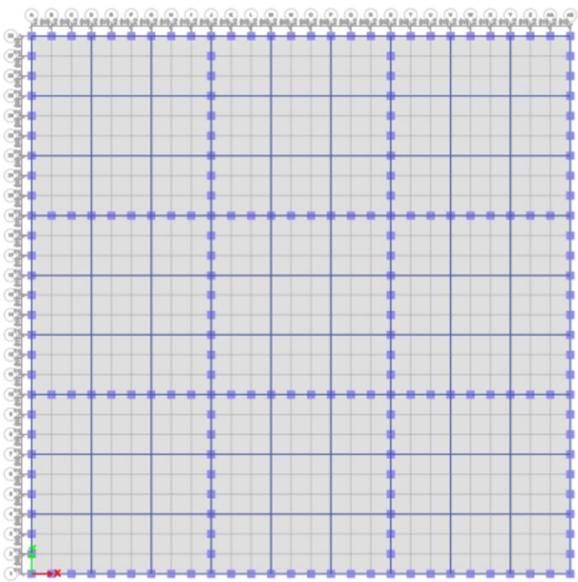

Fig1. Plan of 1st to 10th storey of Bundled tube structure

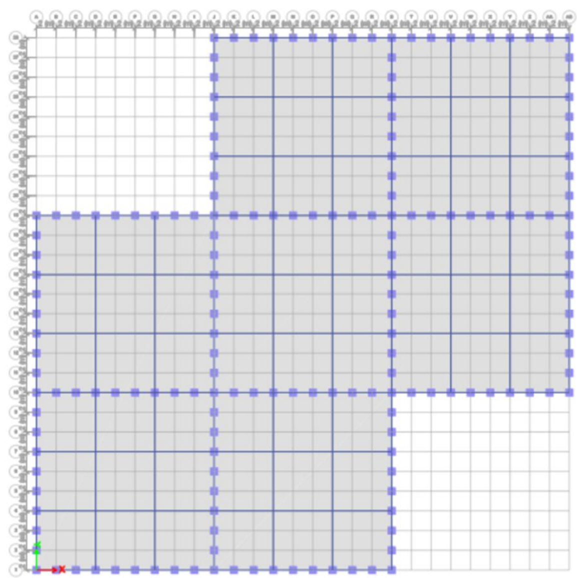

Fig 2. Plan of 11th to 20th storey of Bundled tube structure

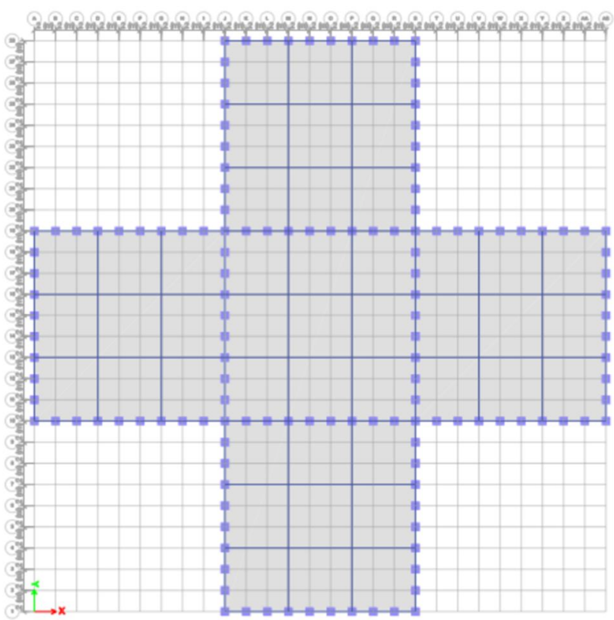

Fig 3. Plan of 21th to 30th storey of Bundled tube structure

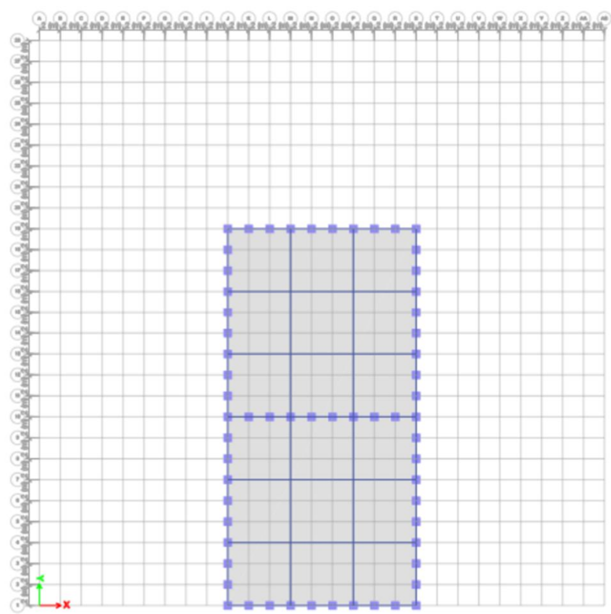

Fig 4. Plan of 31th to 40th storey of Bundled tube structure

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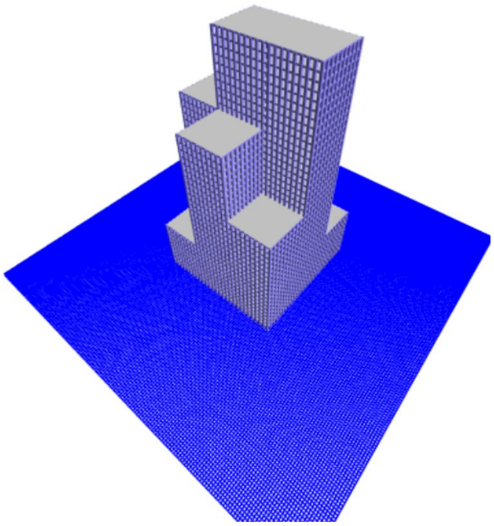

Fig 5.3D Rendered view of Bundled tube structure

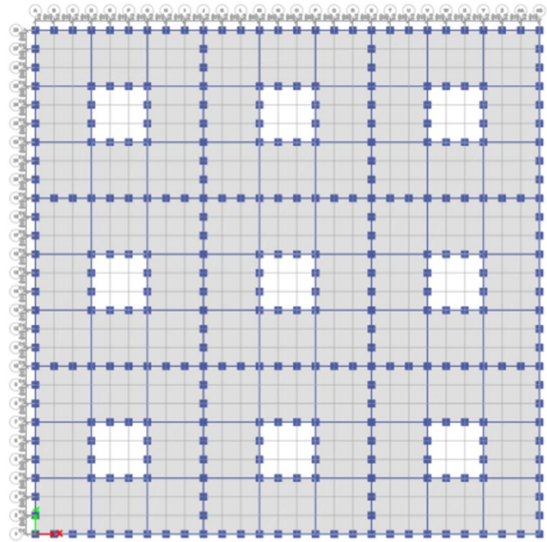

Fig 6. Plan of 1st to 10th storey of Bundled tube in tube structure

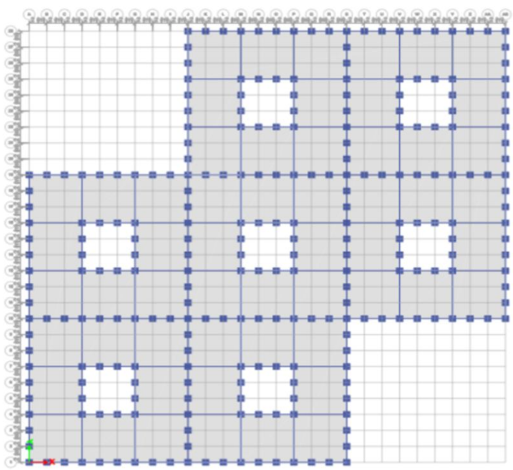

Fig 7. Plan of 11th to 20th storey of Bundled tube in tube structure

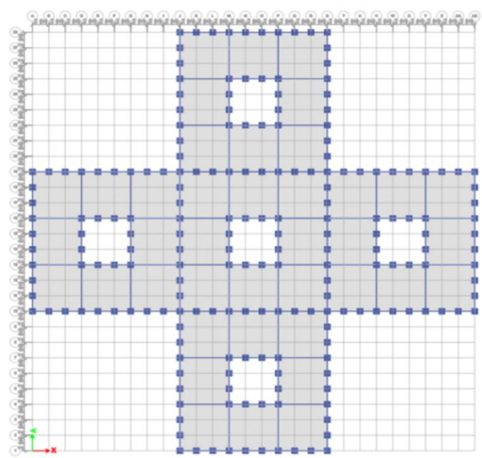

Fig 8. Plan of 21st to 30th storey of Bundled tube in tube structure

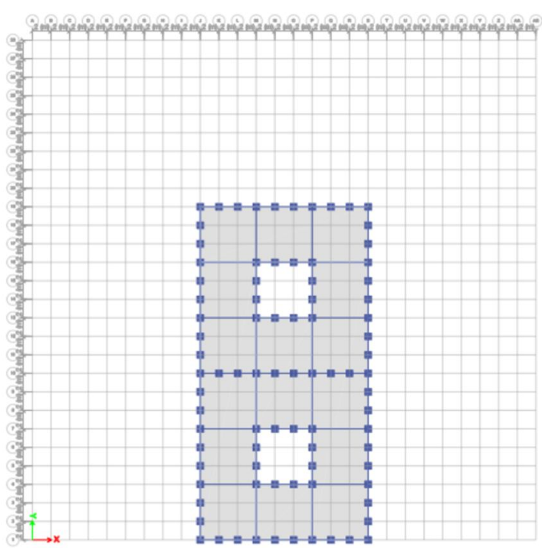

Fig 9. Plan of 31st to 40th storey of Bundled tube in tube structure

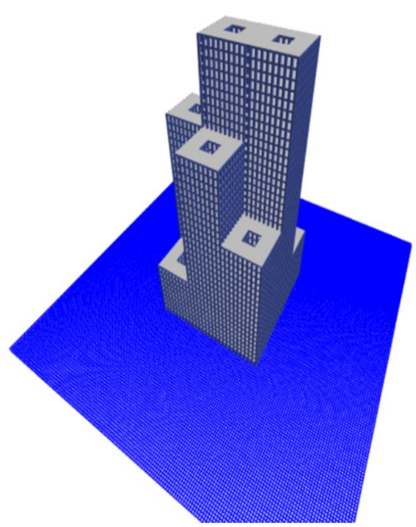

Fig 10.3D Rendered view of Bundled tube in tube structure

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IV. RESULTS

Fig 11. Comparision of Maximum storey displacement with 2m column spacing

From the above comparision Model M3 has the maximum storey displacement and Model M2 has minimum storey displacement.Because Model M2 has column size (800X800) mm and Model M3 has column size (600X600) mm. M2 is Bundled tube in tube model M3 is Bundled tube model.

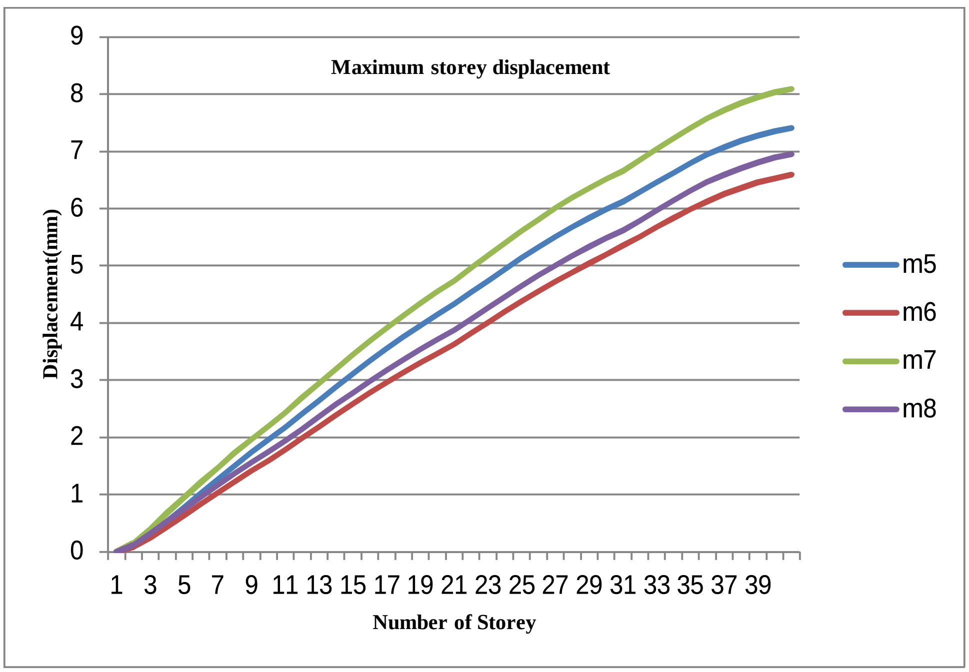

Fig 12. Comparision of Maximum storey displacement with 3m column spacing

From the above comparision Model M7 has the maximum storey displacement and Model M6 has minimum storey displacement.Because Model M6 has column size (800X800) mm and Model M7 has column size (600X600) mm. M6 is Bundled tube in tube model M7 is Bundled tube model.

Fig 13. Comparision of Top Floor Displacement

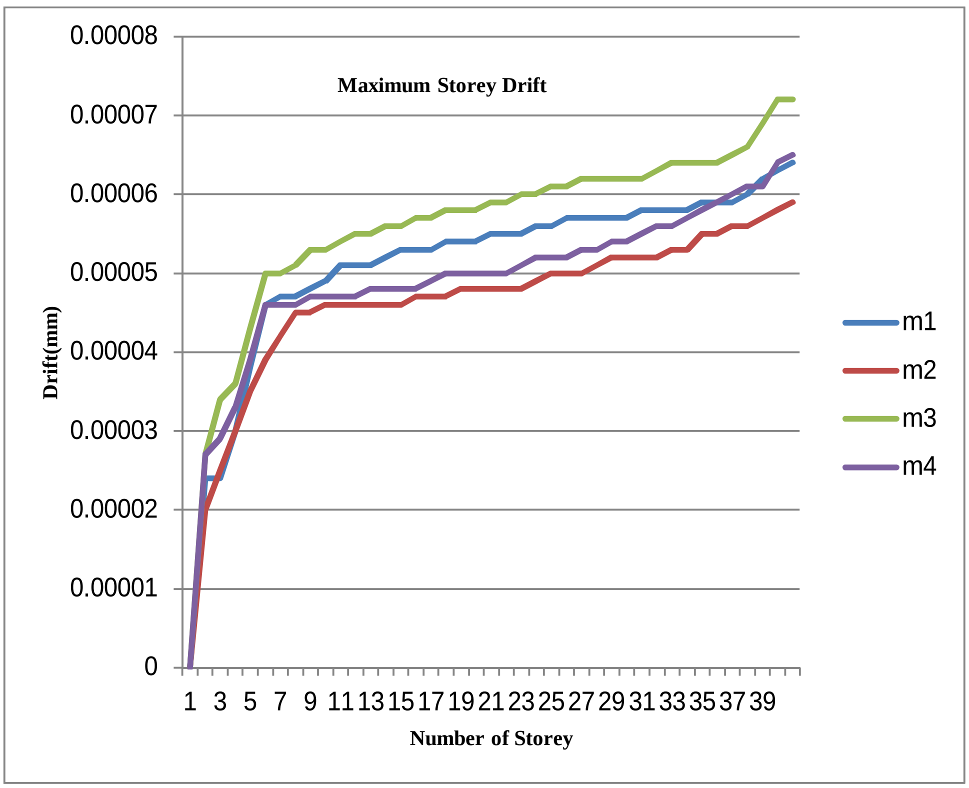

Fig 14. Comparision of Maximum storey drift with 2m column spacing

From the above comparision Model M3 has the maximum storey drift and Model M2 has minimum storey drift.Because Model M2 has column size (800X800) mm and Model M3 has column size (600X600) mm. M2 is Bundled tube in tube model M3 is Bundled tube model.

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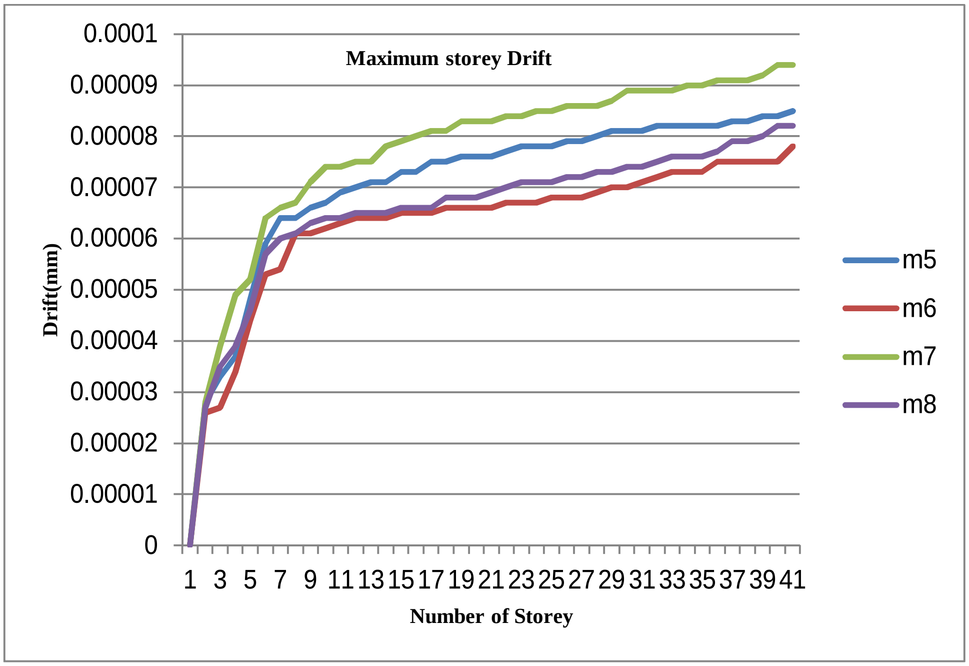

Fig 15. Comparision of Maximum storey drift with 3m column spacing

From the above comparision Model M7 has the maximum storey drift and Model M6 has minimum storey drift.Because Model M6 has column size (800X800) mm and Model M7 has column size (600X600) mm. M6 is Bundled tube in tube model M7 is Bundled tube model.

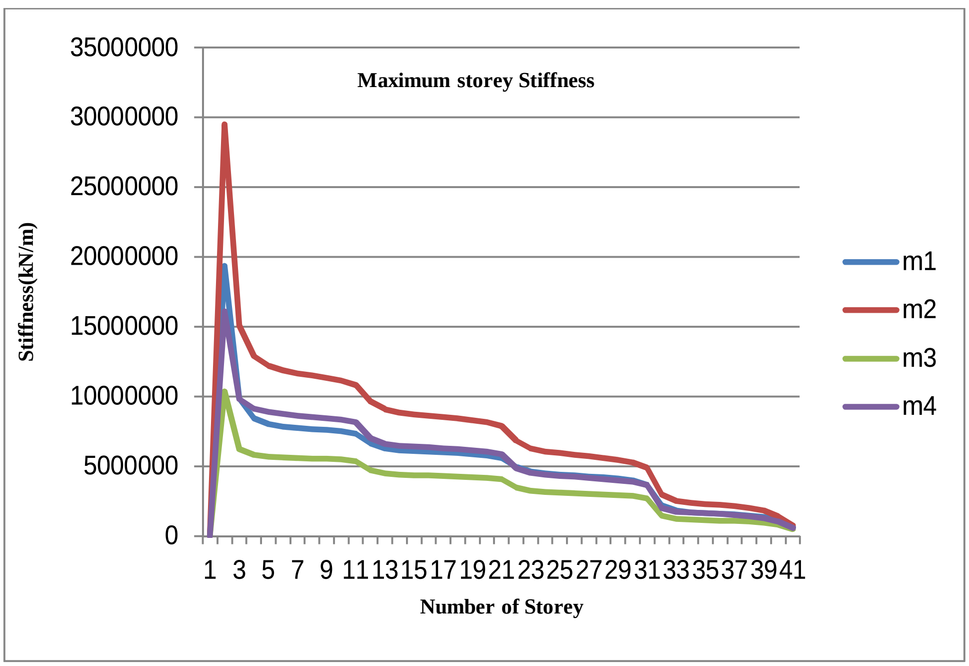

Fig 16. Comparision of Maximum storey stiffness with 2m column spacing

From the above comparision Model M2 has the maximum storey stiffness and Model M3 has minimum storey stiffness.Because Model M2 has column size (800X800) mm and Model M3 has column size (600X600) mm. M2 is Bundled tube in tube model M3 is Bundled tube model.

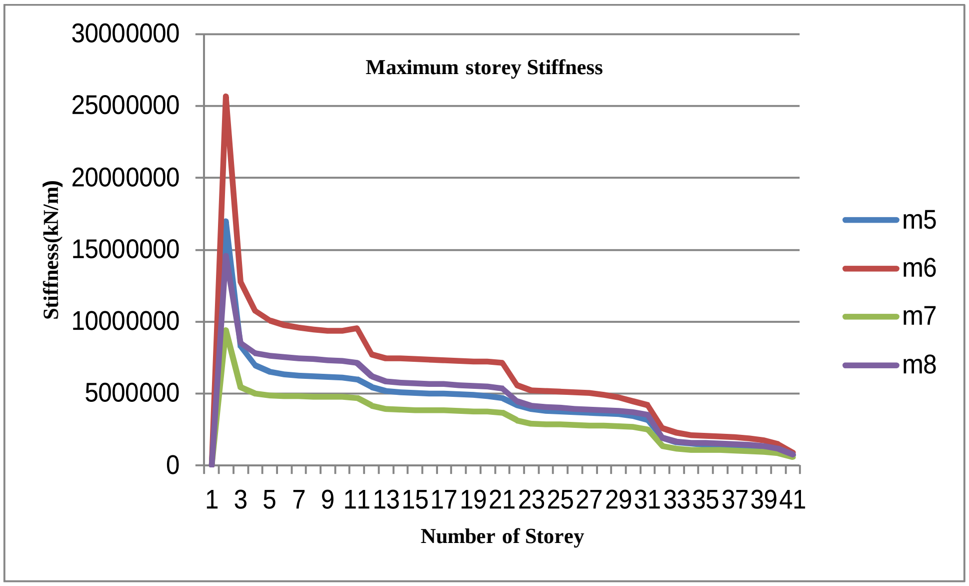

Fig 17. Comparision of Maximum storey stiffness with 3m column spacing

From the above comparision Model M6 has the maximum storey stiffness and Model M7 has minimum storey stiffness.Because Model M6 has column size (800X800) mm and Model M7 has column size (600X600) mm. M6 is Bundled tube in tube model M7 is Bundled tube model.

V. CONCLUSION

The conclusions from the above study are as follows:

A. From the above study, it is concluded that Model 'M7' has the maximum storey displacement and maximum top floor displacement out of the other model. Model 'M2' has the minimum top floor displacement.
B. Model 'M2' has the maximum storey stiffness and Model 'M7' has the minimum storey stiffness.
C. Model 'M7' has the maximum storey drift and Model 'M2' has the minimum storey drift.
D. From the above study it is observed that, Model 'M2' and Model 'M7' has the column spacing 2m and 3m and Column size (800X800)mm and (600X600) mm. Out of the 8 Models, 'M2' is
E. Hence, Bundled tube in tube structure with 2m column spacing and Column size (800X800) mm response better against heavy lateral loading.
F. By comparing Bundled tube and Bundled tube in tube structure, it is observed that Bundled tube in tube structure plays effective role than the Bundled tube structure.

REFERENCES

[1] Hojat Allah Ghasemi 'Optimal design of high-rise building bundled tube systems', Advances in Science and Technology Research Journal, Volume 10, No. 30, June 2016, pages 96–102
[2] 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)
[3] Hamid Mirza Hosseini, "Optimal Design of Tube in Tube systems", Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 2015 Vol. 5 (S3), pp. 119- 138/Mirza Hosseini.
[4] Bungule S Taranath, "Structural Analysis and Design of Tall Buildings", McGraw Hill Book Company, Singapore, p l 30 311 - 340 1988
[5] Peter C. Chang, "Analytical modeling of tube-in-tube structure " ASCE Journal of Structural Engineering, Vol. I l l , No. 6, June
[6] Karthik A L, Geetha K "Dynamic Analysis of Bundled Tube Steel Structure With Belt-Truss And Mega Bracings" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 07 | July-2016
[7] Vijaya Kumari Gowda M R, Manohar B C "A Study on Dynamic Analysis of Tall Structure with Belt Truss Systems for Different Seismic Zones" International Journal of Engineering Research and Technology (IJERT)
[8] 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) Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585 Volume 4, Issue 10, October-2018
[9] Ashitha V Kalam, Reshma C. "Dynamic wind analysis of rc bundled tube in tube structure using etabs" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 06 Issue: 05 | May 2019

[10] Patil. Kiran Kumar , Chandan Kumar. Patnaikuni , Balaji .K.V.G.D , B. Santhosh Kumar "seismic performance of bundled tube structures in seismic zone iv & zone v of India" International Journal of Advanced Research in Engineering and Technology (IJARET) Volume 11, Issue 6, June 2020, pp. 328-337, Article ID: IJARET_11_06_029
[11] Simranjit Singh, Aamir Riyaz Dar "Dynamic analysis of the base isolated tubular tall building system (leadrubber bearing) in etabs" International Journal of Civil Engineering and Technology (IJCIET) Volume 10, Issue 04, April 2019, pp. 1203–1210, Article ID: IJCIET_10_04_126
[12] Karthik A L, Geetha K ,"Dynamic anaysis of bundled tube steel structure with belt-truss and mega bracings" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 07 | July-2016
[13] Adil G. Khatri, Rupali Goud, Gaurav Awasthi "Performance of Tube in Tube Structures: A Review" Proceedings of the International Conference on Sustainable Materials and Structures for Civil Infrastructures (SMSCI2019) AIP Conf. Proc. 2158, 020011-1–020011-4
[14] R.Ramasubramani, G.Pennarasi, S.Sivakamasundari "Differential Settlement in Various Tubular Structural Systems" International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-4, November 2019
[15] Vijaya Kumari Gowda M R , Manohar B C "A Study on Dynamic Analysis of Tall Structure with Belt Truss Systems for Different Seismic Zones" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV4IS080254 ,Vol. 4 Issue 08, August-2015
[16] Jayant Shaligram , Dr. K.B Parikh "Comparative Analysis of Different Lateral Load Resisting Systems in High Rise Building for Seismic Load & Wind load: A Review" International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
[17] Archana J, Reshmi P R "Comparative Study on Tube in Tube Structures and Tubed Mega Frames" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 8, August 2016
[18] Jayant Shaligram, Dr. K.B Parikh"Comparative Analysis of Different Lateral Load Resisting Systems in High Rise Building for Seismic Load & Wind load: A Review" International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
[19] Shaival J. Patel, Prof. Vishal B. Patel "Comparison of Different Types of Tubular Systems" International Journal of Advance Research in Engineering, Science & Technology e-ISSN: 2393-9877, p-ISSN: 2394-2444 Volume 3, Issue 4, April-2016
[20] Abdul Halim Etemad , Aditya Kumar Tiwary "Comparison of tubular, outrigger and bracing system for stabilization of high-rise buildings" (IJCIET) Volume 10, Issue 04, April 2019, pp. 811–820, Article ID: IJCIET_10_04_086
[21] Arafa Elhelloty "Effect of Lateral Loads Resisting Systems on Response of Buildings Subjected to Dynamic Loads" International Journal of Engineering Inventions e-ISSN: 2278-7461, p-ISSN: 2319-6491 Volume 6, Issue 10 [October. 2017] PP: 62-76
[22] Prof. S .Vijaya Bhaskar Reddy , M.Eadukondalu "Study of Lateral Structural Systems in Tall Buildings" International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 15 (2018) pp. 11738-11754
[23] JIGNESHA PATEL , Roshni J John "Seismic analysis of frame tube structure" International Journal of Scientific & Engineering Research, Volume 6, Issue 12, December-2015 ISSN 2229-5518