IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Comparative Study of Tube in Tube System and Bundled Tube System For High Rise Building

Ajit Kurey[#1], Sanket Hanjage[#2], Muzhir Chause[#3], Saurabh Gawande[#4]

Ashish R. Kondekar [#5],

[#1]UG Students, Civil Engineering Department, Savitribai Phule Pune University, Pune
[#5]Assistant Professor, Civil Engineering Department, Savitribai Phule Pune University, Pune

Abstract—**Reinforced Concrete Frames are the most commonly adopted type of buildings in India. As the urbanization is at its peak there is unavailability of horizontal space resulting in increased cost of land and need for agricultural land, high-rise structures have become highly preferable in India. High-rise structures not only have to take up gravity loads but also lateral forces. Many important Indian cities fall under high risk seismic zones; hence strengthening of buildings for lateral forces is a very important. In this study the aim is to investigate the safe, effective and economical structural system between Tube in Tube system and Bundled tube system. The ETABS models of Tube in Tube and Bundled tube system which is G+20+Terrace storey, are considered for analysis. The modeling and analysis of the building has been done by using structure analysis tool ETABS2018.both the building models are subjected to gravity as well as seismic loading, and analyze by using Equivalent static and Response spectrum analysis method. The results are compare and summarize on the basis of different parameters like lateral story displacement, base shear, storey drift, time period and shear lag.The aim of present study is to compare performance of high-rise structures with Tube in Tube system and Bundled tube system against lateral loading. Both system are designed by using Indian standard codes and Special Publication of Handbooks by Bureau of Indian Standards**.

***Keywords*— RCC Buildings, Earthquake, Response Spectrum Method, ETABS, Story Displacement, Shear lag**

I. INTRODUCTION

General Introduction

With the endless growth in population all around the world there has been a lot of increment in the land usage. This scenario is known as urban extension. It will have adverse effect on the environment such as air pollution and more energy consumption. Therefore to counteract these problems of extensive population without any drawbacks the construction of high rise or tall buildings becomes absolute necessary. Different types of structural systems are to be used to resist the effect of lateral loads on the buildings. They are rigid frame structures, braced frame structures, shear wall frame structures, outrigger systems, and tubular structures. Out of these the tubular systems are extensively used and which is considered as a better lateral structural systems for high rise buildings. The tubular structures are further classified as frame tube, braced tube, bundled tube, tube in tube, and tube mega frame structures. The tube in tube structures and tube mega frame structures are the innovative and fresh concept in the tubular structures. The tube in tube structures are to be widely used in tall buildings.

To make the structure earthquake resistant, the provision of lateral force resisting system is essential. During the earthquake, substantial horizontal forces are acting on the structures and cause severe damages to the structural elements leads to failure of structure. To avoid the damages from horizontal forces like seismic forces and wind forces, the provision of lateral force. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral loads. In this study, the emphasis is given on analysis of the structures having lateral force resisting systems like Tube–in–tube system and Bundled tube system which is sub-types of Tubular structural systems.

II.RESEARCH METHODOLOGY

2.1 Tall building

There is no established definition of what constitutes a 'Tall building', instead there are several different criteria that typically determine whether a buildings can be considered to be tall. Firstly, it is important to consider the urban context of the building. If a 10- storey building is in a central business district (CBD) surrounded by high rise buildings of 20- storeys, then it may not be considered particularly tall. However, if a 10- storey building is in a sub urban area that is predominantly low rise, it would be considered to be a "Tall" building. The Council on Tall Buildings and Urban Habitat (CTBUH) defines a "Super tall" building as on that is more than 300 m (984 ft) in height. This classification is exceeded by "Megatall" buildings which are those exceeding 600 m (1,968 ft) in height.

IS 16700;2017 says when the building height is greater than 50 m but less than or equal to 250 m then the building considered as "Tall" building , and building of height greater than 250 m as " Super tall" building

2.1.1 Exterior lateral load resisting system

a. Tubular system
b. Diagrid system
c. Buttressed core system
d. Exo-skeleton system
e. Super frame system
f. Hybrid system

2.1.2 Types of tubular system

a) Framed tube
b) Braced tube
c) Tube in tube
d) Bundled tube

a) Tube in tube

It is also known as "Hull and Core", these structure have core tube inside the structure, holding the elevator and other services and another tube around exterior of structure, both the tubes together resist lateral and gravity loads. The majority of the gravity and lateral load are normally taken by the outer tube because of its greater strength. 780 third avenue, a 50 storey concrete frame building in Manhattan, uses shear wall for bracing and off-center core to allow column free interior.

b) Bundled tube

In this system, instead of one tube building consist several tubes tied together to resist lateral loads. Such buildings have interior columns in perimeter of tube. Such building have interior column along the perimeter of the tube when they fall within the building envelop. The notable examples include willies tower and on magnificent mile.

2.2 Code Provisions:-

a) Code of practice for plain and reinforced concrete IS456:2000

b) Dead loads:- IS 875:1987 (Part-I)

c) Imposed loads:- IS 875:1987 (Part-II)

d) Seismic loads:- IS 1893:2016

e) Ductile detailing:- IS 13920:1993

2.3 Types Of Analysis

a) Static Equivalent Analysis (Linear Static Analysis)

b) Push Over Analysis (Non-linear Static Analysis)

c) Response Spectrum (Linear Dynamic Analysis)

d) Time History Analysis (Non-dynamic Analysis)

2.4 Preliminary Data

Sr.No	Parameters	Values
1	Grade Of Concrete	M 30
2	Grade Of Steel	Fe 500
3	Modulus of Elasticity of Steel	210 GPA
4	Modulus of Elasticity of Concrete	27000 MPA {as per IS 456:200, Cl.No.6.2.31}
5	Size Of Beam	300*300 mm
6	Size Of Column	400*400 mm
7	Thickness Of Slab	150 mm
8	Number Of Storey	G+20
9	Height Of Storey	3 m
10	Density Of Concrete	25kN/m^3
11	Location	Bhuj
12	Seismic Zone	V
13	Importance Factor	1
14	Response Reduction Factor	5 {SMRF}
15	Damping	5%
16	Site Condition	II
17	Seismic Zone Factor	0.36 (IS 1893:2016 ,Cl.No6.4.2)
18	Diaphragm	Rigid
19	Maximum Storey Displacement	H/500
20	Storey Drift Limitation	0.004h

Table No. I:- Data

2.5 Floor plan view of Tube in Tube and Bundled Tube System

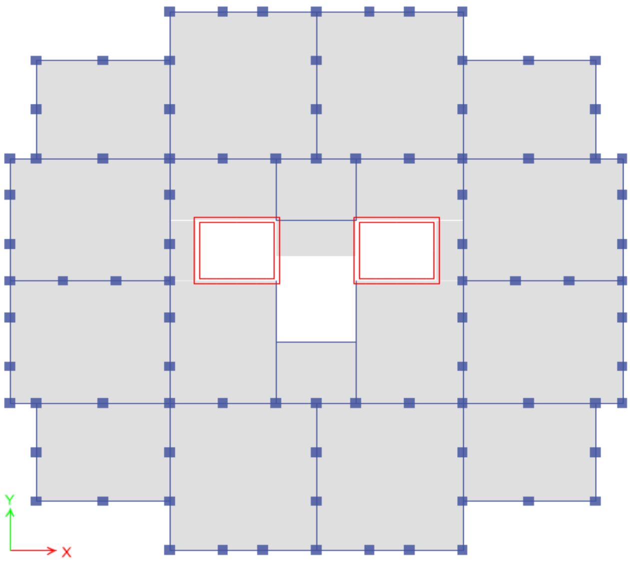


Fig No I. Floor plan of Bundled Tube structure

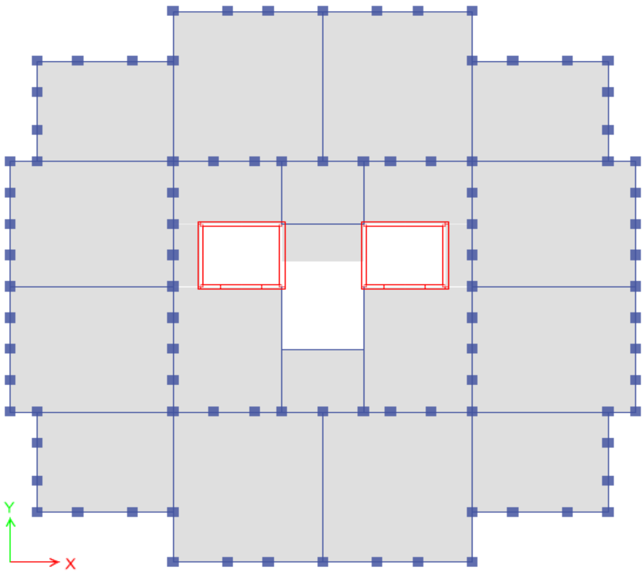
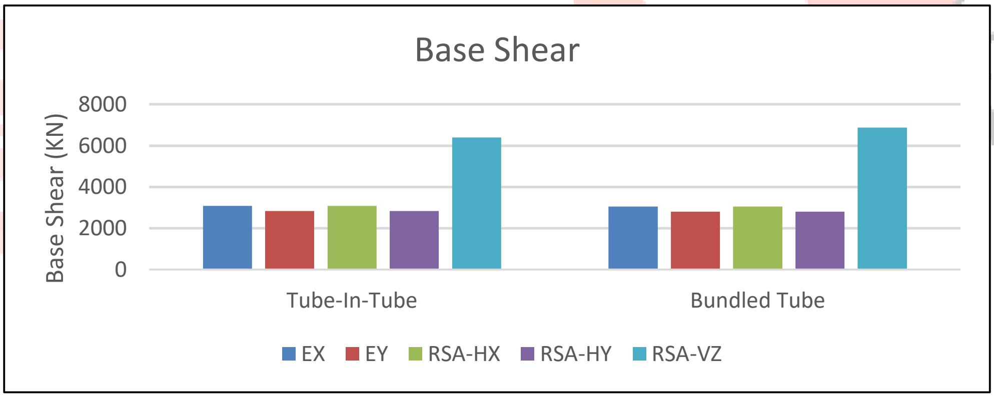


Fig No II. Floor plan of Tube in Tube structure

III. RESULTS & DISCUSSION

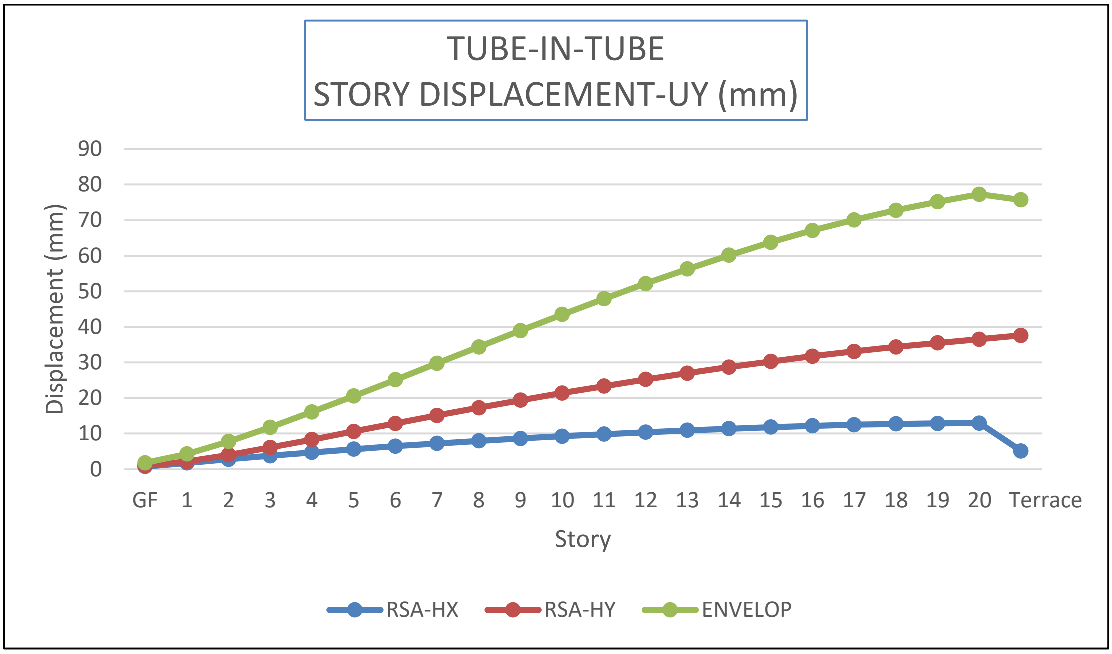


Graph No. I:- Load Combinations vs. Base Shear

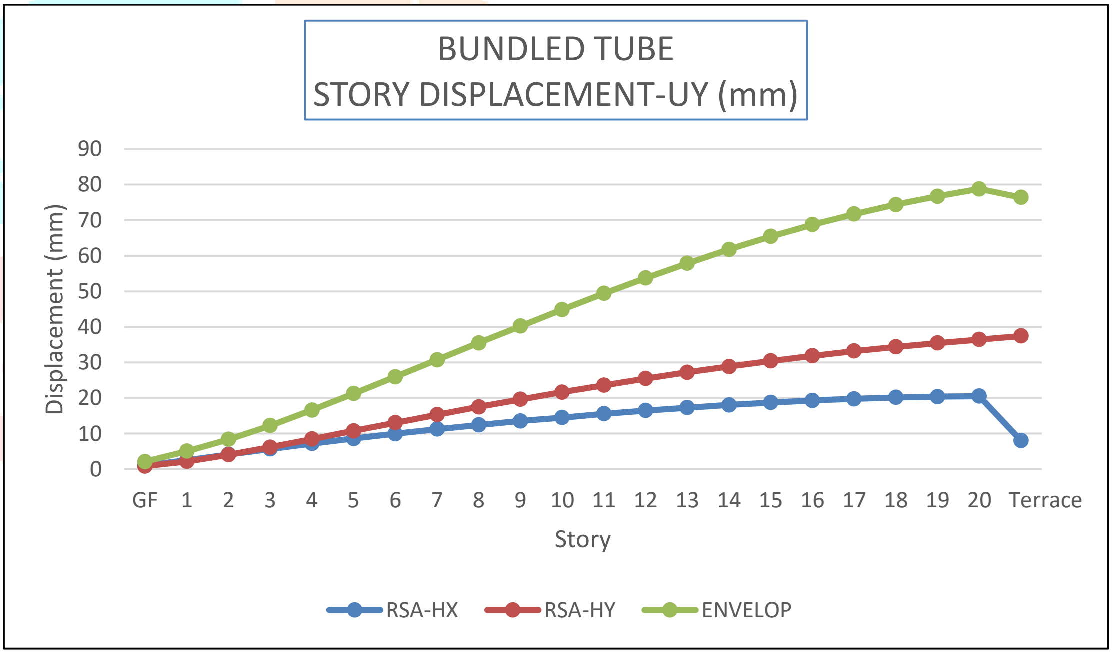
3.1 Discussion

3.1.2 Base shear respective to both the structural system are negligibly similar for all the load cases except RSA – VZ.

3.1.3 Base shear is 7% higher for Bundled Tube system compare to Tube in Tube System.



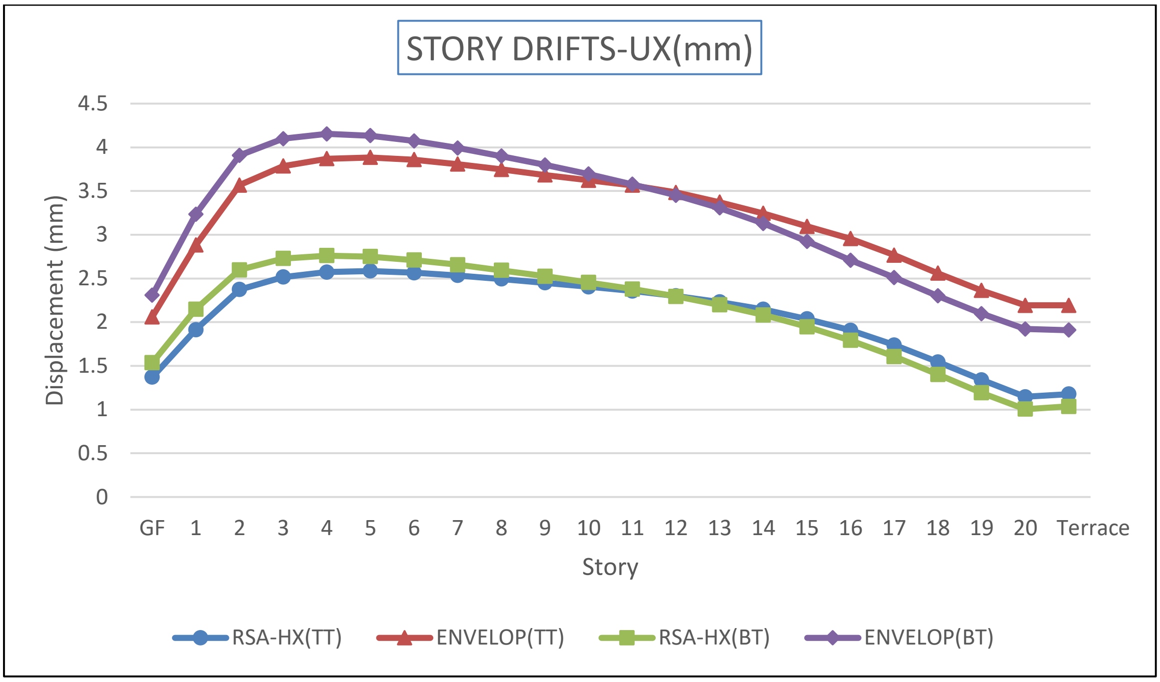
Graph No. II:-Story vs. Story displacement for Tube-in-Tube system (UY)



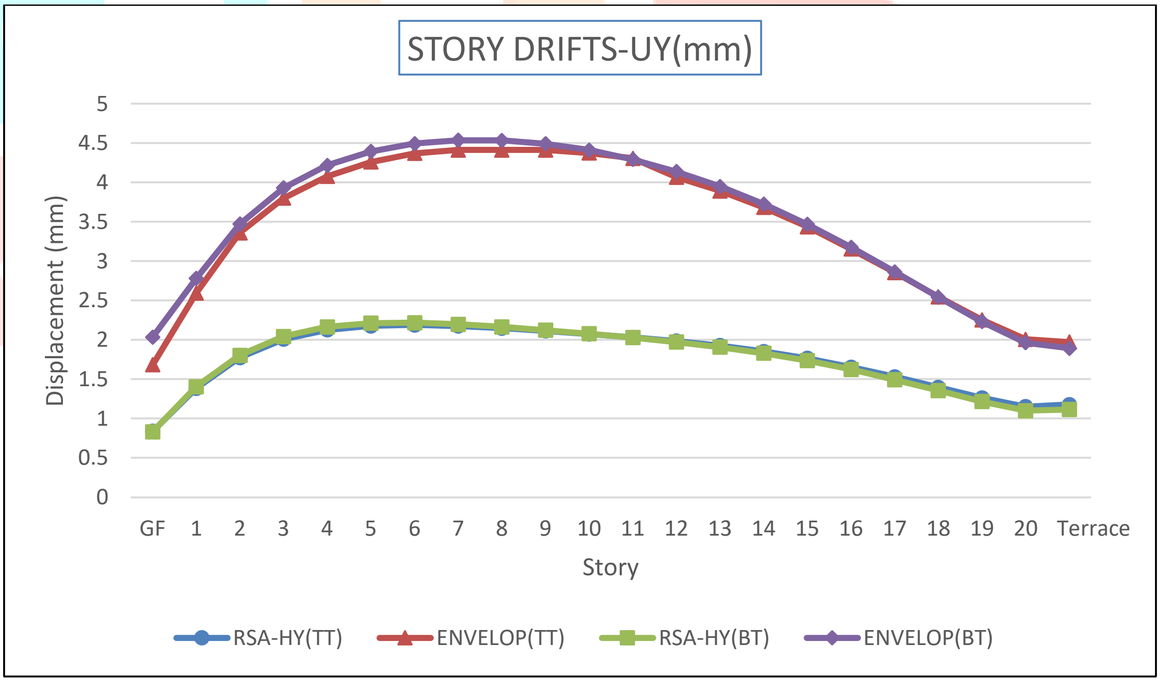
Graph No. III:-Story vs. Story displacement for Bundled Tube system (UY)

3.2 Discussion

3.2.1 Story displacement for both structural system along UY direction are similar for RSA-HY and ENVELOP and for RSA-HX displacement is higher for Bundled Tube System.



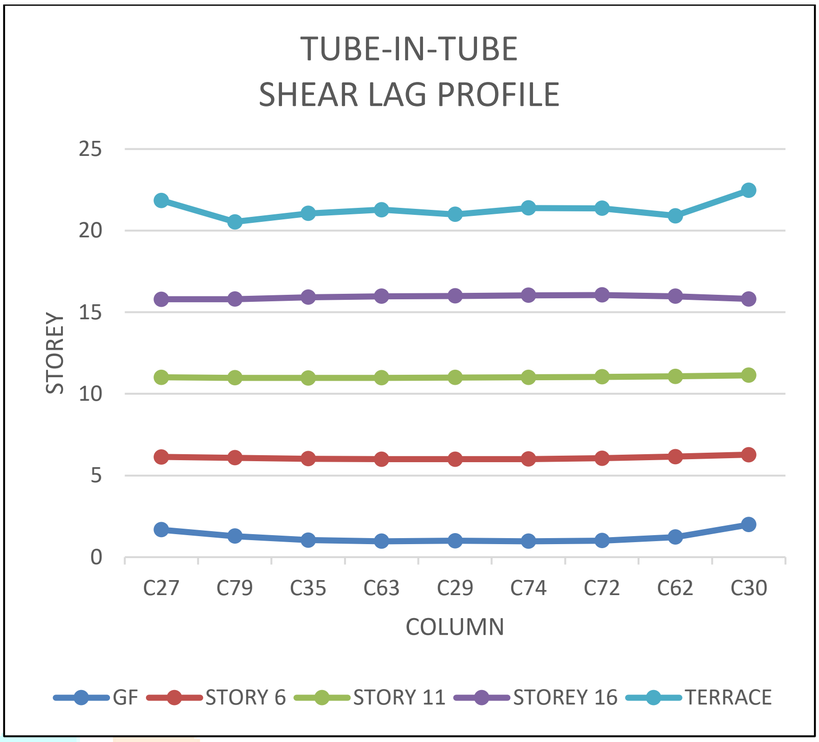
Graph No. IV:-Story vs. Story drift (UX)



Graph No. V:-Story vs. Story drift (UY)

3.3 Discussion

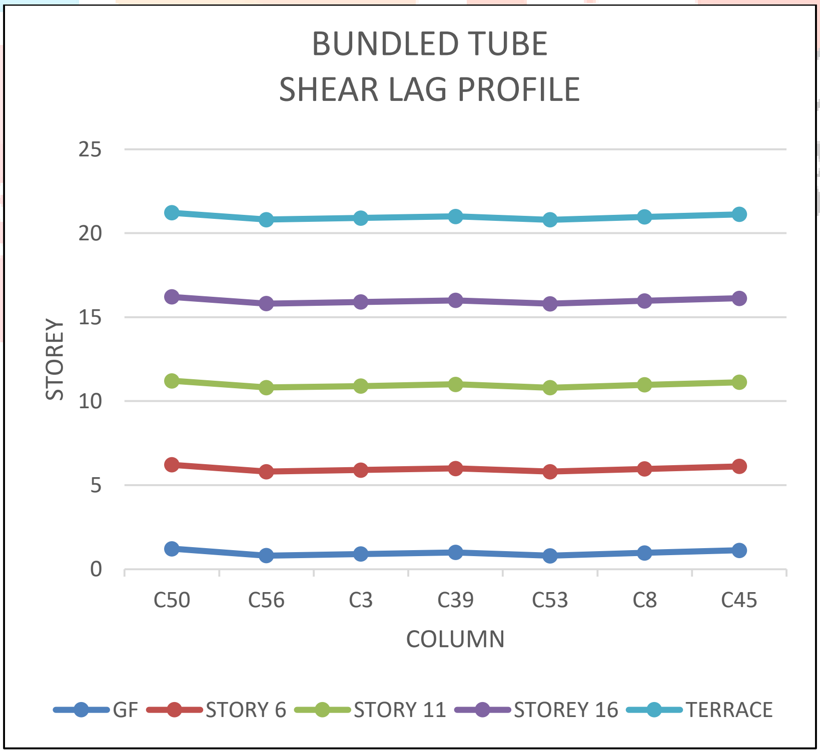
3.3.1 Story drift for both structural system along UX and UY direction are similar for all load cases and within allowable drift limit (12mm).



Graph No. VI:-Columns vs. Shear lag (Tune-in-Tube)

3.4 Discussion

3.4.1 Positive shear lag is present in lower half of tube in tube structure and get converted into negative shear lag because of that corner column suffering more than middle column due to earthquake.



Graph No VII:-Column vs. Shear lag (Bundled Tube)

3.5 Discussion

3.4.1 Column in bundled tube structure are not suffering due to shear lag and axial stress distributed uniformly as compared to tube in tube structure.

3.4.2 Bundled tube performed well for shear lag and no negative shear lag.

IV. CONCLUSION

In the present study, comparative evaluation of ‘Tube-in-tube’ and ‘Bundled tube’ structural system has been carried out for high-rise structure ofG+20+Terrace.The structure is located in Bhuj (zone V) and analyzed for static and dynamic earthquake load by using response spectrum method. Comparison has been made on different structural parameters viz. base shear, lateral story displacement, story drift, time period and shear lag etc.

Based on the analysis results following conclusions have been drawn

1. Base shear is slightly higher in Tube-in-tube system as compare to Bundled tube system for all load cases except RSA-VZ. Base shear is 7% higher in Tube-in-Tube as compare to Bundled tube system for RSA-VZ.
2. Maximum story displacement for both the structure are within limit and negligibly higher in Bundled tube in compare with Tube-in-Tube structure in both UX and UY directions.
3. Story drift is within allowable limit for both the structure, and which is higher in Bundled tube as compare to Tube-in-Tube upto 11th story and vice versa in storey 11th to Terrace in UX direction. Story drift is same and following same pattern in UY direction in both structures.
4. Shear lag effect can be observed in Tube-in-tube system. Positive shear lag is present in lower stories of building and then convert in negative shear lag in upper stories of Tube-in-tube structure.
5. Shear lag effect not dominate in Bundled tube structure. Result shows proper uniform distribution of axial force in columns of Bundled tube structure as compare to Tube-in-tube structure and no presence of negative shear lag effects.
6. Time periods of both Tube-in-tube and Bundled tube system are almost same for first three modes of buildings.

V. ACKNOWLEDGEMENT

We take this opportunity with great pleasure to express our deep sense of gratitude towards our guide**A. R. Kondekar** for his valuable guidance ,encouragement and cooperation extended to us during this projectwork.
We are so thankful to **Mr. I. M. Jain** Head ,Department of Civil Engineering for providing departmental facilities for this work.
We would also like to thank. **Dr.S.D. Markande** Principal ,Sinhgad Institute of Technology and Science for their unflinching help, support and cooperation during this project work.
We would also like to thank the Sinhgad Technical Educational Societyfor providing access to the institutional facilities for our projectwork.

REFFERENCES

1. **Nandeshwar lata, Swetha singh**, “Comparative analysis of rcc structure and Tube-in-tube structure system. **International Research Journal of Engineering and Technology (IRJET)Volume 6, Issue 7, July 2019**
2. **Suraj R Wadagule, Vishwanath.R. Charantimath**,“Comparative study of Tube-in-tube structure and Framed tube structure”, **International Research Journal of Engineering and Technology, Volume 6, July 2019**
3. **Shilpa Balakrishnan, Rona M James**, Vimal jyoti Engineering, Kannur, Kerla."“Comparative study on Tube-in-tube and Mega tubed Framed structure on different building geometry using ETABS”, **International Research Journal of Engineering and Technology, Volume: 4, Oct -2017.**
4. **Abdul Etemad, Aditya Tiwary**, “Comparison of Tubular, Outrigger and braced system for stabilization of high rise Building”, **International Journal of Civil Engineering and Technology (IJCET), March2019**.
5. **Abhishek Dept. Civil Engineering , Smitha.S.K**, “Comparative study of Tube-in-tube structure and Framed tube structure”, **International Research Journal of Engineering and Technology Volume 6, July 2019**
6. **Jun Teng, Pengyuan Liu, Ying Wang, Zuohua Li**, “Seismic performance and failure mechanism of Mega braced frame - core tube structure with different brace patterns”, **Advances in Civil Engineering, 2018.**
7. **Lavanya T, Satayanarayana Sridhar**, “Dynamic analysis of Tube-in-tube Tall Building”, **International Research Journal**

of Engineering and Technology (IRJET), July 2019.

8. **Vimlesh Agrawal, Vishal Arekar ,Shishav Modi**, "Parametric study of various tube in tube structure", **International Journal of Advance Research in Engineering, Science and Technology, IJAREST, May 2017**
9. **Bipin H Naik, B.S. Suresh Chand**, "Comparative Analysis between Tube in Tube Structure and Conventional Moment Resisting Frame", **International Research Journal of .**
10. **Engineering and Technology Volume: 04,| Oct -2017.**
11. **Hamid Mirzahosseini**, "Optimal design of Tube in Tube system", **Indian Journal of Fundamental and Applied Life Science (IJFALS), Volume 5, 2015.**
12. **Rakesh Banne, S.N.Tande**, "Analysis of framed tube structure with multiple internal tubes", **Journal of Civil Engineering and Environmental Technology (JCEET), Volume-2, Number-12, Sep 2015.**

IS CODE

A. **IS 875 (part 1): 1987**, Dead loads, "Code of practice for Design loads (other than earthquake) for buildings and structures", Bureau of Indian Standards, New Delhi.
B. **IS 875 (part 2): 1987**, Live loads, "Code of practice for Design loads (other than earthquake) for buildings and structures", Bureau of Indian Standards, New Delhi.
C. **IS 1893 (part 1): 2016**, "Criteria for earthquake resistant design of structures", Bureau of Indian Standards, New Delhi.
D. **IS 456:2000**, "Code of practice for plain and reinforced concrete", Bureau of Indian Standards, New Delhi.
E. **IS 13920:2016**, "Ductile detailing of reinforced concrete structure subjected to seismic forces",Bureau of Indian Standards, New Delhi.