

e-ISSN: 2319-8753 | p-ISSN: 2347-6710

EDIA

International Journal of Innovative Research in SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 9, September 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.118

9940 572 462

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Volume 11, Issue 9, September 2022

| DOI:10.15680/IJIRSET.2022.1109070 |

Parametric Comparison of Different Structural Systems for Lateral Loads

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ABSTRACT: The construction of high-rise structures has increased in recent years, resulting in global advancement. The desire for an ever-increasing population and enterprises to be as close as possible has led to the construction of high-rise buildings. This study intends to compare the performance of a G+30 building with Framed Structure, Bundled Tube Structure and Tube in Tube Structure. The results of these models are examined for a comparative study of their seismic and wind performance using linear static analysis and Response spectrum analysis. The following outputs were analyzed: Maximum Story Displacement, Maximum Story drift, and Maximum Story shear. It is seen that Tube in Tube structure is very effective in resisting lateral loads.

KEYWORDS: Bundled Tube Structure, Tube in Tube Structure, Response Spectrum, ETABs, Story Displacement, Story Drift, Story Shear.

I. INTRODUCTION

The recent trend of population development and land scarcity has given rise to a modern urbanization era, which has resulted in the vertical growth of buildings and given us the new trend-setting structures known as High Rise or Multi-Storeyed Structures. Due to land scarcity, increased demand for office and residential space, economic growth, technological improvements, innovations in structural systems, and metropolitan areas' need for aesthetics, these structures are now necessary.

Innovations in Structural Systems for High-Rise Buildings

Few buildings in the initial days reached a height of 10 to 15 stories, but later on, it became crucial to promote a building's ability to rise vertically.



The early typical structural systems types used in tall structures, including the moment resisting frame, braced frame and shear wall system. Later evolved the new structural systems for high rise structures developed and invented by Dr. Fazlur R Khan the "Father of Tubular systems". He introduced us new structural systems namely Braced tube system, Bundled tube system, Framed tube system and Tube in Tube system.

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Volume 11, Issue 9, September 2022

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II. LITERATURE SURVEY

1. "Evolution of Seismic Behavior of Irregular Tube Building in Tube Systems" ^[1], Published by Advances In Science and Technology Research Journal, 2016

Worked on evaluating irregular tube building's seismic behavior in tube systems. This study aimed to examine the seismic response of tube-in-tube building structures with irregular plans. To this end, the seismic response of 40 and 60 story reinforced concrete frame structures with irregular plans were assessed. Story drifts, overall building drifts, and shear lag behavior variables are used to evaluate the seismic behavior of irregular buildings. Story drift and shear lag are more significant for a 60-story building than for a 40-story one.

 "A Comparative Study Between The Use Of Framed Shear Wall System And Framed Tube System In Tall Buildings", Published by International Journal & Magazine Of Engineering Technology, Management And Research, 2015

Determined which system is the most effective at resisting lateral loads for structures up to 30 stories and beyond 30 stories, the effect of using framed shear walls and framed tube systems are examined for tall buildings with rectangular shapes. The Framed Shear Wall System and the Framed Tube System are considered for structures with 20, 30, 40, 50, and 60 stories. Results of the analysis are compared for the provided problem's roof displacements, base shear, support reactions, and joint displacements. The choice made that the Framed Shear Wall System is best. For constructions with a Framed Tube System, the maximum Base Shear was observed for structures with 30, 40, 50, and 60 stories.

3. "Comparative Seismic Analysis Of An Irregular Building With A Shear Wall And Frame Tube System Of Various Sizes", Published by International Journal Of Engineering And Computer Science, 2015

Worked on a comparative seismic analysis of an irregular building with a shear wall and a frame tube system of different sizes. For 30, 40, 50, and 60-story, analyses of the planar frame, shear wall and framed tube systems were considered. Compared with roof displacements, joint displacements, support reactions, bending moments and shear force members. It observed that for structures up to 30 stories, the shear wall system successfully resists lateral stresses. For constructions higher than 30 stories, the framed tube system is more effective than the shear wall system.

4. "A Comparative Study Of Frame Tube, Tube In Tube And Bundled Tube Structures Subjected To Lateral Load Under Different Zones", Published by International Research Journal Of Engineering And Technology, 2021

To discover the most effective structure to increase the lateral stability of the system, we explore a frame tube, tube-in-tube structural, bundle tube structure, and bundle tube structures with shear wall comparison under Zone III and Zone V. We found that compared to other kinds of tube designs, bundled tube with shear wall exhibited greater lateral stability.

III. METHODOLOGY

The methodology includes preliminary studies that fix the structure dimensions and perform linear static and response spectrum analysis. For the current project, a seismic and wind analysis has been conducted for the G+30 RCC structure, which is Framed structure, Bundled Tube Structure and Tube-in-Tube Structure for the Bengaluru region. To perform the analysis, Etabs V.18 is used.

Model 1



Fig 3.1: Plan and 3D Model of Framed Structure

e-ISSN: 2319-8753, p-ISSN: 2320-6710 www.ijirset.com | Impact Factor: 8.118



Volume 11, Issue 9, September 2022

| DOI:10.15680/IJIRSET.2022.1109070 |

Model 2

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G.F to 9th Floor plan

10th to 17th Floor plan



18th to 24th Floor plan

25th to 30th Floor plan



Model 3

Fig 3.2: Plan and 3D Model of Bundled Tube Structure



Fig 3.3: Plan and 3D Model of Tube in Tube Structure

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|



||Volume 11, Issue 9, September 2022||

| DOI:10.15680/IJIRSET.2022.1109070 |

Detailed Description of Models

Table 1.1: Detailed Description of Models						
	Structural Elements	Dimension				
Sl. No.						
1	Plan Dimension	45 m X 36 m				
2	Spacing in X direction	5 m				
3	Spacing in Y direction	4 m				
4	Grade of concrete	M40, M35, M30, M25				
5	Grade of steel	HYSD 550				
6	Typical story height	3 m				
7	Bottom story height	3 m				
8	Thickness of slab	120 mm				
9	Thickness of wall	300 mm				
10	Size of Column : G.F to 9 th story 10 th to 17 th story 18 th to 24 th story 25 th to 30 th story	1.2m X 1.2 m 1 m X 1m 0.9 m X 0.9 m 0.8 m X 0.8 m				
11	Size of Beam : G.F to 9 th story 10 th to 17 th story 18 th to 24 th story 25 th to 30 th story	1.2m X 0.8 m 1 m X 0.7 m 0.9 m X 0.6 m 0.8 m X 0.5 m				
12	City	Bengaluru				
13	Zone	П				
14	Importance factor, I	1.5				
15	Reduction factor, R	5				
16	Soil type	Π				
17	Damping ratio	5%				
18	Basic wind speed, V_b	33 m/s				
19	Limiting story displacement	H/500				
20	Limiting story drift	0.004h				

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|



Volume 11, Issue 9, September 2022

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IV. EXPERIMENTAL RESULTS

1. Story Displacement



Graph No. 4.1(a): Max Story Displacement due to Seismic



. Graph No. 4.1(b): Max Story Displacement due to Response Spectrum Analysis



. Graph No. 4.1(c): Max Story Displacement due to Wind



| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

Volume 11, Issue 9, September 2022

| DOI:10.15680/IJIRSET.2022.1109070 |

Observations

- 1. Graph 4.1(a) shows that story displacement for seismic analysis is 30.97 mm for the framed system. For Tube in Tube system, values are reduced by 31.16% and Bundled tube structure is reduced by 18.02% compared to a framed structure. Hence maximum story displacement values are minimum for Tube in Tube system.
- 2. Graph 4.1(b) shows that story displacement due to response spectrum analysis is 18.50 mm for the framed system. For Tube in Tube system, values are reduced by 29.67% and Bundled tube structure is reduced by 8.7% compared to a framed structure. Hence maximum story displacement values are minimum for Tube in Tube system.
- 3. Graph 4.1(c) shows that the story displacement due to wind is 3.02 mm for the framed system. For Tube in Tube system, values are reduced by 35.76% and Bundled tube structure is increased by 9.04% compared to a framed structure. Hence maximum story displacement values are minimum for Tube in Tube system.



2. Story Drift

Graph No. 4.2(a): 1	Max Story Drift	due to Seismic
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Graph No. 4.2(b): Max Story Drift due to Response Spectrum Analysis

e-ISSN: 2319-8753, p-ISSN: 2320-6710 www.ijirset.com | Impact Factor: 8.118



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0.00008 0.00007 0.00006 0.00005 0.00004 0.00003 0.00002 0.00001 0 Story30 Story15 Story10 Story5 Story25 Story20 Base Framed Structure 0.000014 3.8E-05 4.5E-05 3.7E-05 3.5E-05 2.6E-05 0 Bundled Tube Structure 3.1E-05 7.3E-05 5.8E-05 3.3E-05 2.9E-05 1.8E-05 0 Tube in Tube Structure 8E-06 2.4E-05 2.9E-05 2.4E-05 2.3E-05 1.7E-05 0

DOI:10.15680/IJIRSET.2022.1109070

Graph No. 4.2(c): Max Story Drift due to wind

Observations

- 1. It is interesting to see from Graph 4.2(a) that the story drifts for seismic analysis from linear static is 0.00020 for the framed system. For Tube in Tube system, values are reduced by 35% and Bundled tube structure is increased by 33% compared to a framed structure. Hence maximum story drift values are minimum for Tube in Tube system.
- 2. From Graph 4.2(b), story drift resulting from response spectrum analysis is 0.00016 for the framed system. For Tube in Tube system, values are reduced by 37.5% and Bundled tube structure is increased by 52.94% compared to a framed structure. Hence maximum story drift values are minimum for Tube in Tube system.
- 3. It can be observed from Graph 4.2(c) the wind-related story drift for framed tube systems is 0.00014 for the framed system. For Tube in Tube system, values are reduced by 42.85% and Bundled tube structure is increased by 54.83% compared to a framed structure. Hence maximum story drift values are minimum for Tube in Tube system.

3. Story Shear



Graph No. 4.3(a): Max Story Shear due to Seismic

e-ISSN: 2319-8753, p-ISSN: 2320-6710 www.ijirset.com | Impact Factor: 8.118



Volume 11, Issue 9, September 2022

DOI:10.15680/IJIRSET.2022.1109070



Graph No. 4.3(b): Max Story Shear due to Response Spectrum Analysis



Graph No. 4.3(b): Max Story Shear due to wind

Observations

- 1. From Graph 4.3(a), it can be observed that the maximum story shear for seismic analysis is 18118.78 kN for tube in tube system. For framed system, values are reduced by 7.68%, and Bundled tube structure also decreases by 27.22% compared to the tube in tube structure.
- 2. Graph 4.3(b) shows that story shear due to response spectrum analysis is 15400.96 kN for tube in tube system. For framed system, values are reduced by 7.68%, and Bundled tube structure decreases by 27.22% compared to the tube in tube structure.
- 3. Graph 4.3(c) shows that story shear due to wind is 2324.48 kN for tube in tube and framed systems. Bundled tube structure decreased by 9.19% compared to the tube in tube and framed structure.

4.

V. CONCLUSION

The study results for all situations considered lead to the following notable conclusions.

- 1) According to the seismic analysis results and using response spectrum method, the framed system has the highest displacement compared to the bundled tube and tube-in-tube model. Drift values are maximum for bundled tube and least for framed and tube-in-tube structures.
- 2) Similarly, wind analysis results showed that the displacement and drift due to wind loads were highest for bundled tube compared to framed and tube-in-tube model..



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Volume 11, Issue 9, September 2022

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- 3) When story shear values for all models are compared, the framed model showed the highest base shear value for the response spectrum method and the tube-in-tube model has the maximum base shear value for the linear static method.
- 4) The bundled tube structural system has become a more advantageous option for lateral load resisting systems in terms of lateral displacement for linear static analysis compared to a framed structure.
- 5) Overall, story displacement, story drift, and story shear for response spectrum, linear static analysis and wind analysis, the tube-in-tube structural system has proven to be more effective in resisting lateral load system.

REFERENCES

- [1] Hojat Allah Ghasemi, "Evolution of Seismic Behavior of Irregular Tube Building in Tube Systems", *Advances In Science and Technology Research Journal*, Vol 10, No 29, March 2016.
- [2] Abbas Ali Ibrahim, Dr. N. V. Ramana Rao "A Comparative Study Between The Use Of Framed Shear Wall System And Framed Tube System In Tall Buildings", *International Journal & Magazine Of Engineering Technology, Management And Research*, ISSNNo:2348-4845, Volume No: 2 (2015), Issue No: 8 (August).
- [3] B.N.Sarath, "Comparative Seismic Analysis Of An Irregular Building With A ShearWall And Frame Tube System Of Various Sizes" *International Journal Of Engineering And ComputerScience*, ISSN:2319-7242,Volume4Issue 4, April 2015.Eftychios A. Pnevmatikakis, Petros Maragos "An Inpainting System For Automatic Image Structure-Texture Restoration With Text Removal", IEEE trans. 978-1-4244-1764, 2008
- [4] Syed Musthafa Khadri, B.K.Kolhapure, "A Comparative Study Of Frame Tube, Tube In Tube And Bundled Tube Structures Subjected To Lateral Load Under Different Zones", *International Research Journal Of Engineering* And Technology, Volume: 08 Issue: 10 | Oct 2021
- [5] S. Nazari, J. Keyvani∟, A. Meshkat-Dini, M. Azhdarifar "Study On The Seismic Response Of Mid-Rise Bundled Tube Resistant Systems Under Simulated Closed-Form Near-Field Records", Asian Journal Of Civil Engineering (BHRC), VOL. 18, NO. 6, April 2017Xiaoqing Liu and Jagath Samarabandu, "Multiscale Edge-Based Text Extraction From Complex Images", IEEE Trans., 1424403677, 2006
- [6] 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.Mr. Rajesh H. Davda1, Mr. Noor Mohammed, "Text Detection, Removal and Region Filling Using Image Inpainting", International Journal of Futuristic Science Engineering and Technology, vol. 1 Issue 2, ISSN 2320 – 4486, 2013
- [7] Akshay C. Umare, Sandesh Kante, "Analysis Of G+45 Bundled Tube Structure Using Different Bracing System Under The Effect Of Seismic Forces", *International Research Journal Of Engineering And Technology*, Volume: 06 Issue: 06 | June 2019.
- [8] S. R. Kangle, D. S. Yerudkar, "Response Spectrum Analysis For Regular Multistory Structure In Seismic Zone Iii", *International Journal Of Engineering Research & Technology (IJERT)*, Vol. 9 Issue 09, September-2020.
- [9] Mohammed Jawad Uddin, MsGollapali Sandhya Rani, "Structural Modelling For Tall Framed Buildings", *International Research Journal Of Modernization In Engineering Technology And Science*, Volume:04/Issue:03/March-2022
- [10] Parasharam Sawant, AkshayUmre, Mr. Nitesh R. Motekar, "A Performance Study Of (G+20) RCC Structure Using Framed Bundled Braced Tube System Under The Effect Of Seismic Loads", *International Research Journal Of Engineering And Technology*, Volume: 06 Issue: 06 | June 2019.
- [11] Dr. Kiran T, Pooja Annarao Patil, "Comparative Analysis Of Rc Stucture And Tube In Tube Structure With And Without Shear Walls", *International Research Journal Of Modernization In Engineering Technology And Science*, Volume: 03/Issue:04/April-2021.
- [12] AjitKurey, SanketHanjage, MuzhirChause, Saurabh Gawande, Ashish R. Kondekar "Comparative Study Of Tube In Tube System And Bundled Tube System For High Rise Building", *International Journal Of Creative Research Thoughts (IJCRT)*, Volume: 05/Issue: 06/June-2021.
- [13] Nimmy Dileep, Renjith R, "Analytical Investigation On The Performance Of Tube-In-Tube Structures Subjected To Lateral Loads", *International Journal Of Technical Research And Applications*, Volume 3, Issue4 (July-August 2015).
- [14] Divyadarshini M, Khalid Nayaz Khan, Dr. N S Kumar, "Static And Dynamic Analysis Of RC Buildings Considering The Effect Of Dual System", *International Research Journal Of Engineering And Technology*, Volume: 08 Issue: 08 | Aug 2019.



| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

Volume 11, Issue 9, September 2022

| DOI:10.15680/IJIRSET.2022.1109070 |

- [15] Jay P. Patel, Vishal B. Patel, Elizabeth George, "Comparative Study Of Triangle Tubes Bundled System And Square Tubes Bundled System", *International Conference On "Research And Innovations In Science, Engineering &Technology*" ICRISET-2017.
- [16] Shaishav.A. Modi, Vimlesh.V.Agrawal, Vishal .A.Arekar"Parametric Study Of Various Tube In Tube Structures", International Journal Of Advance Research In Engineering, Science & Technology, Volume 4, Issue 5, May-2017.
- [17] 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.
- [18] 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.
- [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] Mohammad Tabrez Shadull, 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: 2455-2585 Volume 4, Issue 10, October-2018.
- [21] Lavanya.T, SathyanarayanaSridhar.R, "Dynamic Analysis Of Tube-In-Tube Tall Buildings", *International Research Journal Of Engineering And Technology*, Volume: 04 Issue: 04 | April 2017.
- [22] Bryan Stafford Smith And Alex Coull, Tall Building Structure: Analysis And Design.
- [23] Council OnTall Building And Urban Habitat.
- [24] Taranath B.S. "Steel, Concrete And Composite Design Of Tall Buildings". Mcgraw Hill Publication, Second Edition, Pg 397-701.
- [25] Taranath B.S., Wind And Earthquake Resistance Building Structural Analysis And Design.
- [26] Subramanian, N. Design Of Reinforced Concrete Structures.
- [27] IS 875 (Part 1): 1987 Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures, Part 1 Dead Loads.
- [28] IS 875 (Part2): 1987 Code Of Practice For Design Loads (Other Than Earthquake)For Buildings And Structures, Part 2 Imposed Loads.
- [29] IS 875 (Part3): 2015 Code Of Practice For Design Loads (Other Than Earthquake)For Buildings And Structures, Part 3 Wind Loads.
- [30] IS 1893: 2016Criteria For Earthquake Resistant Design Of Structures.
- [31] IS 13920: 2016 Code of Practice For Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.
- [32] IS 456: 2000 Code of Practice For Plain and Reinforced Concrete.





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