iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VII **Month of publication:** July 2017

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VII, July 2017- Available at www.ijraset.com

Research Paper on Earthquake and Wind Analysis of Braced Tube Structure with Different Plans in Configuration

Shubhangi V. Pawar[1], M. S. Kakamare[2], M.B.Pendhari[3]
[1]PG Student, [2]Professor, [3]Assistant Professor Civil Department PVPIT Budhgaon -416410, India

Abstract* : *This research paper consists of effects of earthquake and wind force on Steel Braced Tube Structure with different shapes in plan. The Indian standard code of practice IS- 1893 (Part I: 2002), IS- 875:1987(Part III), IS-800-2007 guidelines and methodology are used to analyze and design building. Etab2015 structural analysis software is used to analyze buildings under the effect of wind and earthquake forces in zone III. Equal area of 1296 m2 used for Circular, Square, Rectangular plans . Seismic and Wind analysis done by Linear Static method. The behaviour of building components was examined and compared on the basis of displacement, story drift, and base shear.
Keywords: Braced Tube Structure, Etab 2015, different shapes in plan, Linear Static method, seismic analysis, wind analysis, displacement, storey drift, base shear.

I. INTRODUCTION

The rapid growths of urban population and consequent pressure on limited space have considerably influenced the residential development of city. The high cost of land, the desire to avoid a continuous urban sprawl and the need to preserve important agricultural production have all contributed to drive residential buildings upward. As the height of building increase, the lateral load resisting system becomes more important than the structural system that resists the gravitational loads. Advances in construction technology, materials, structural systems and analytical methods for analysis and design facilitated the growth of high rise buildings. Structural design of high rise buildings is governed by lateral loads due to wind or earthquake. Lateral load resistance of structure is provided by interior structural system or exterior structural system. Braced tube is a variation of the framed tube and was first applied on the 100-story John Hancock Center of 1970 in Chicago. This concept stems from the fact that instead of using closely spaced perimeter columns, it is possible to stiffen the widely spaced columns by diagonal braces to create wall-like characteristics. The framed tube becomes progressively inefficient over 60 stories since the web frames begin to behave as conventional rigid frames. Consequently, beam and column designs are controlled by bending action, resulting in large size. In addition, the cantilever behaviour of the structure is thus undermined and the shear lag effect is aggravated A braced tube overcomes this problem by stiffening the perimeter frames in their own planes. The braces also collect gravity loads from floors and act as inclined columns. The diagonals of a trussed tube connected to columns at each joint effectively eliminate the effects of shear lag throughout the tubular framework. Therefore, the columns can be more widely spaced and the sizes of spandrels and columns can be smaller than those needed for framed tubes, allowing for larger window openings than in the framed tubes .

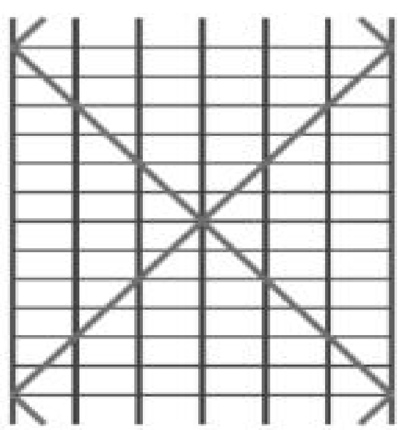


Fig.1 Braced tube structure (John Hancock Center)

A. The Objective of the Paper is to be

1) To carry out wind and seismic analysis of Braced Tube Structure with constant height of structure and variable shapes in plan using E-tab 2015 software.
2) To compare the results of analysis of structures considering parameters such as displacement, base shear and storey drift.

II. STRUCTURAL DATA

A. Structural Configure Ration

1) Plan Dimension: Rectangular plan size 54m X 24m, Square plan size 36m X 36m, Circular plan size 40.62m Dia
2) Height of Floor: 3m
3) Slab Thickness: Deck Slab 120 mm thick
4) Number of Storey: 6
5) Concrete: M20 for deck slab, M40 for infill concret
6) Steel: YST 310 grade for fill and infill tube section , fy 250 for deck section

B. Seismic Data (As per IS: 1893-2002)

1) Zone Factor: 0.16 (Zone III)
2) Response Reduction Factor: 5 (SMRF)
3) Important Factor: 1
4) Type of Soil: II,(Medium Soil)

C. Wind Data (As per I:875-1987)

1) Wind Speed: 39 m/s
2) Terrain Category: 2
3) Structure Class: B
4) Risk Coefficient k: 1
5) Topography Factor k3: 1

D. Loading data (as per IS 875-Part I & II)

1) Wall Load (Cladding): 6 KN/\
2) Parapet Wall Load: 3KN/m
3) Roof Live Load: 1.5 KN/m^2
4) Floor Live Load: 3 KN/m^2
5) Floor Finish: 1 KN/m^2

E. Combinations

TABLE 1
LOAD COMBINATION

TABLE: LOAD COMBINATIONS			
Name	Load Case/Combo	Scale Factor	Type
UDStlS1	DEAD	1.5	Linear Add
UDStlS1	FF	1.5	
UDStlS1	Cladding	1.5	
UDStlS2	DEAD	1.5	Linear Add
UDStlS2	LIVE	1.5	
UDStlS2	FF	1.5	
UDStlS2	Cladding	1.5	
UDStlS3	DEAD	1.2	Linear Add
UDStlS3	LIVE	1.2	
UDStlS3	FF	1.2	
UDStlS3	Cladding	1.2	
UDStlS3	EQX	1.2	
UDStlS4	DEAD	1.2	Linear Add
UDStlS4	LIVE	1.2	
UDStlS4	FF	1.2	
UDStlS4	Cladding	1.2	
UDStlS4	EQX	-1.2	
UDStlS5	DEAD	1.2	Linear Add
UDStlS5	LIVE	1.2	
UDStlS5	FF	1.2	
UDStlS5	Cladding	1.2	
UDStlS5	EQY	1.2	
UDStlS6	DEAD	1.2	Linear Add
UDStlS6	LIVE	1.2	
UDStlS6	FF	1.2	
UDStlS6	Cladding	1.2	
UDStlS6	EQY	-1.2	
UDStlS7	DEAD	1.5	Linear Add
UDStlS7	FF	1.5	
UDStlS7	Cladding	1.5	
UDStlS7	EQX	1.5	
UDStlS8	DEAD	1.5	Linear Add
UDStlS8	FF	1.5	
UDStlS8	Cladding	1.5	

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VII, July 2017- Available at www.ijraset.com

UDStlS8	EQX	-1.5	
UDStlS9	DEAD	1.5	Linear Add
UDStlS9	FF	1.5	
UDStlS9	Cladding	1.5	
UDStlS9	EQY	1.5	
UDStlS10	DEAD	1.5	Linear Add
UDStlS10	FF	1.5	
UDStlS10	Cladding	1.5	
UDStlS10	EQY	-1.5	
UDStlS11	DEAD	0.9	Linear Add
UDStlS11	FF	0.9	
UDStlS11	Cladding	0.9	
UDStlS11	EQX	1.5	
UDStlS12	DEAD	0.9	Linear Add
UDStlS12	FF	0.9	
UDStlS12	Cladding	0.9	
UDStlS12	EQX	-1.5	
UDStlS13	DEAD	0.9	Linear Add
UDStlS13	FF	0.9	
UDStlS13	Cladding	0.9	
UDStlS13	EQY	1.5	
UDStlS14	DEAD	0.9	Linear Add
UDStlS14	FF	0.9	
UDStlS14	Cladding	0.9	
UDStlS14	EQY	-1.5	
UDStlD1	DEAD	1	Linear Add
UDStlD1	FF	1	
UDStlD1	Cladding	1	
UDStlD2	DEAD	1	Linear Add
UDStlD2	LIVE	1	
UDStlD2	FF	1	
UDStlD2	Cladding	1	
DCon1	DEAD	1.4	Linear Add
DCon1	FF	1.4	
DCon1	Cladding	1.4	
DCon2	DEAD	1.2	Linear Add
DCon2	LIVE	1.6	

DCon2	FF	1.2	
DCon2	Cladding	1.2	
DCon3	DEAD	1.4	Linear Add
DCon3	LIVE	1	
DCon3	FF	1.4	
DCon3	Cladding	1.4	
DCon3	EQX	1	
DCon4	DEAD	1.4	Linear Add
DCon4	LIVE	1	
DCon4	FF	1.4	
DCon4	Cladding	1.4	
DCon4	EQX	-1	
DCon5	DEAD	1.4	Linear Add
DCon5	LIVE	1	
DCon5	FF	1.4	
DCon5	Cladding	1.4	
DCon5	EQY	1	
DCon6	DEAD	1.4	Linear Add
DCon6	LIVE	1	
DCon6	FF	1.4	
DCon6	Cladding	1.4	
DCon6	EQY	-1	
DCon7	DEAD	1.4	Linear Add
DCon7	FF	1.4	
DCon7	Cladding	1.4	
DCon7	EQX	1	
DCon8	DEAD	1.4	Linear Add
DCon8	FF	1.4	
DCon8	Cladding	1.4	
DCon8	EQX	-1	
DCon9	DEAD	1.4	Linear Add
DCon9	FF	1.4	
DCon9	Cladding	1.4	
DCon9	EQY	1	
DCon10	DEAD	1.4	Linear Add

DCon10	FF	1.4	
DCon10	Cladding	1.4	
DCon10	EQY	-1	
DCon11	DEAD	0.7	Linear Add
DCon11	FF	0.7	
DCon11	Cladding	0.7	
DCon11	EQX	1	
DCon12	DEAD	0.7	Linear Add
DCon12	FF	0.7	
DCon12	Cladding	0.7	
DCon12	EQX	-1	
DCon13	DEAD	0.7	Linear Add
DCon13	FF	0.7	
DCon13	Cladding	0.7	
DCon13	EQY	1	
DCon14	DEAD	0.7	Linear Add
DCon14	FF	0.7	
DCon14	Cladding	0.7	
DCon14	EQY	-1	

TABLE 2
SECTION PROPERTIES

Sr No	Description	Data / Value
1	Beam	ISB 475X475X50
2	Inner Column	a)storey 1-21 Infill column 2200X2200X50 b)storey 22-33 Infill column 2000X2000X50 c)storey 34-45 ISB 2000X2000X75 d)storey 46-60 ISB 1800X1800X50
3	Peripheral Column	a)storey 1-40 Infill column 900X900X75 b)storey 41-60 ISB 900X900X75
4	Bracing	ISB 850X850X50
5	Deck Slab	120 mm thick

III. ANALYSIS OF BRACED TUBE STRUCTURE

A. Models of Braced Tube Structure

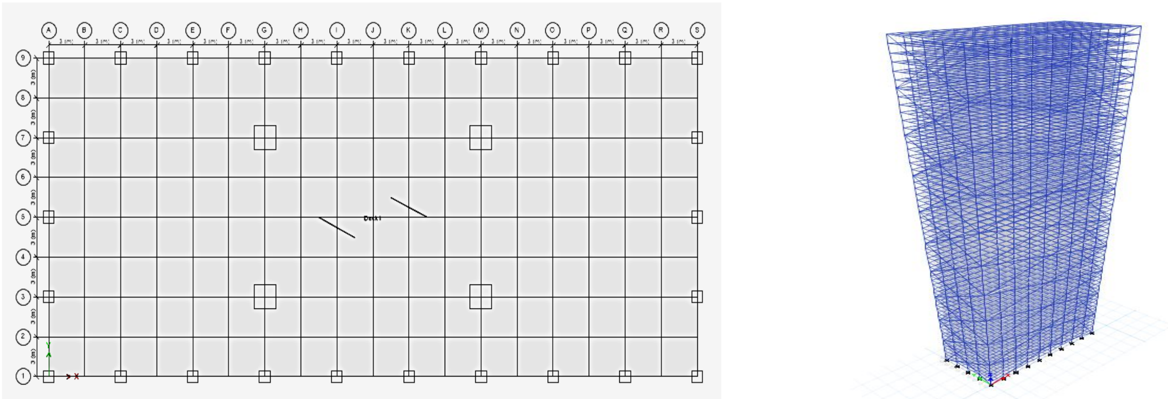


Fig. 2 Model of Rectangular braced tube structure

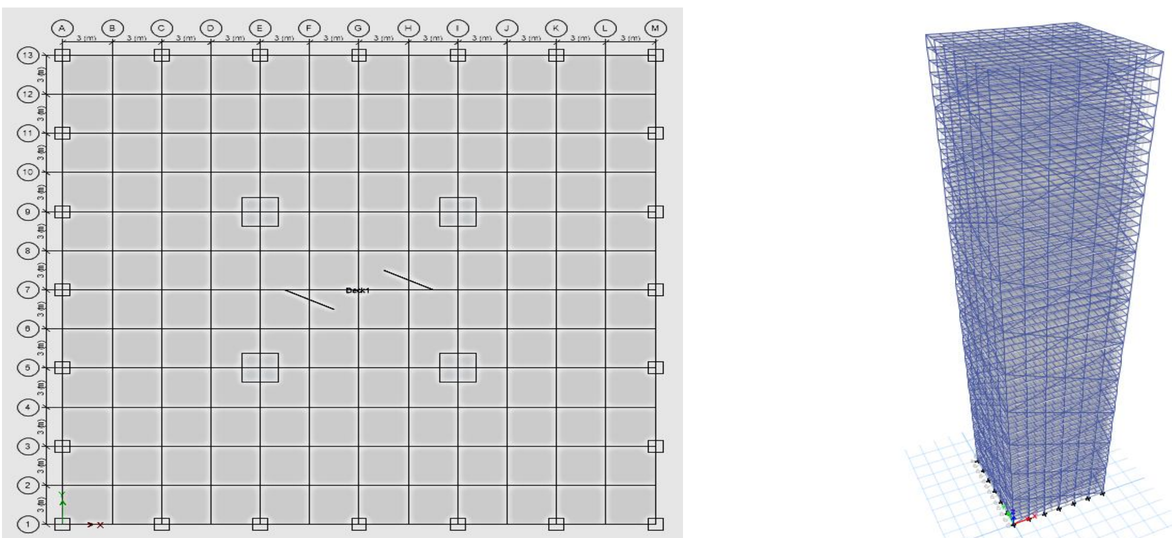


Fig .3 Fig. 3 Model of Square braced tube structure

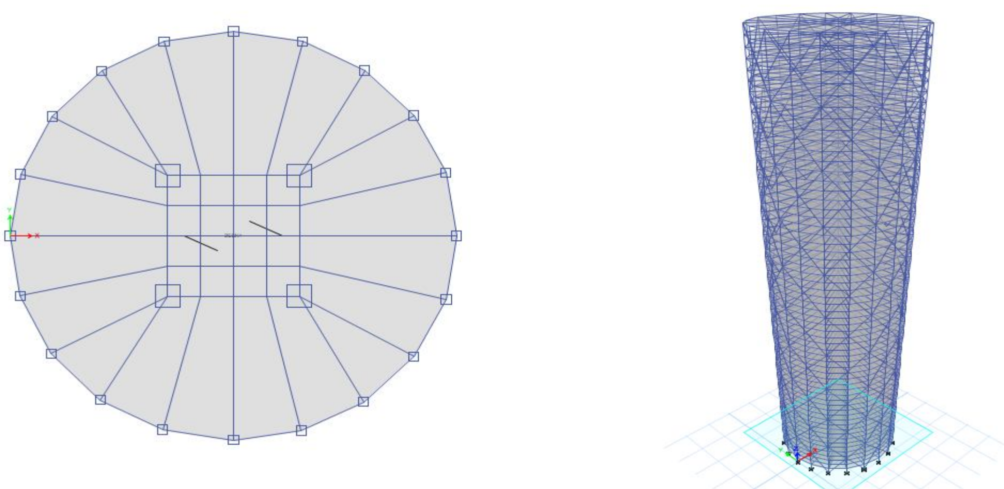


Fig .4 Model of Circular braced tube structure

B. Earthquake Analysis of Braced Tube Structure

TABLE 3
EARTHQUAKE ANALYSIS - Y DIRECTION RESULT

	Circular plan	Square plan	Rectangular plan
Storey displacement (mm)	57.6	73.1	108.8
Storey drift	0.000563	0.000595	0.000878
Base shear(KN)	7029.6259	6261.0379	5941.6315

TABLE 4
EARTHQUAKE ANALYSIS - X DIRECTION RESULT

	Circular plan	Square plan	Rectangular plan
Storey displacement (mm)	56.2	72.8	57.8
Storey drift	0.000554	0.000595	0.000571
Base shear(KN)	7032.8214	6264.4996	7467.7997

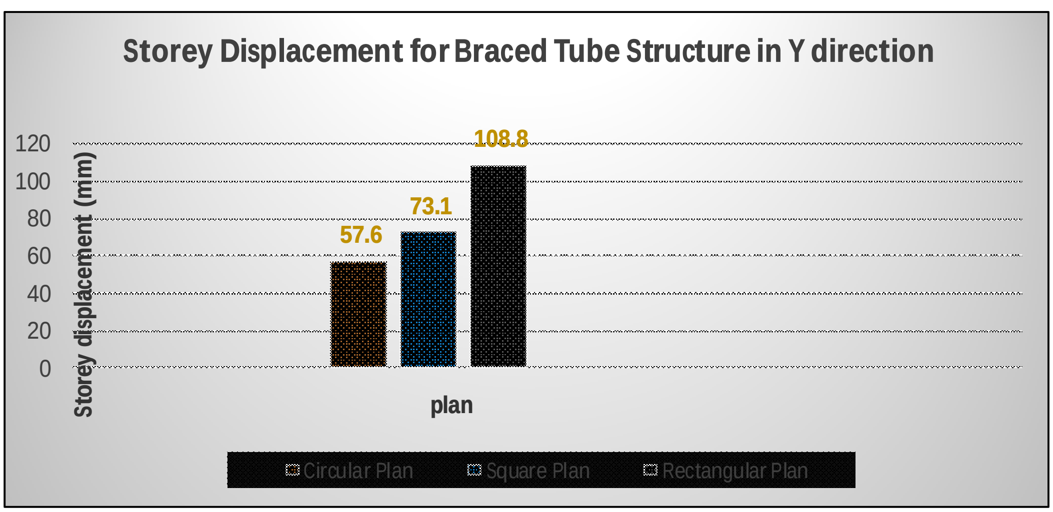


Fig. 5 Comparision of Storey displacement for three shapes in plan in Y direction -Earthquake analysis

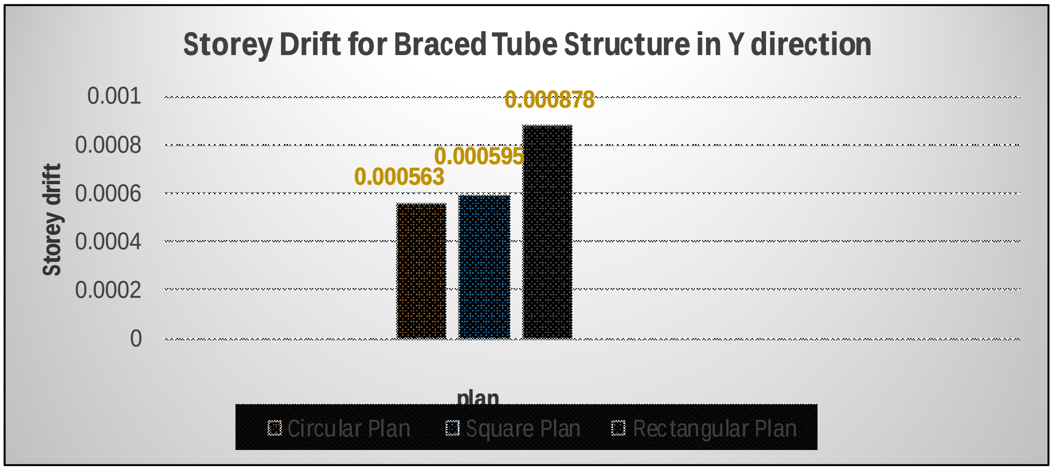


Fig. 6 Comparision of Storey drift for three shapes in plan in Y direction -Earthquake analysis

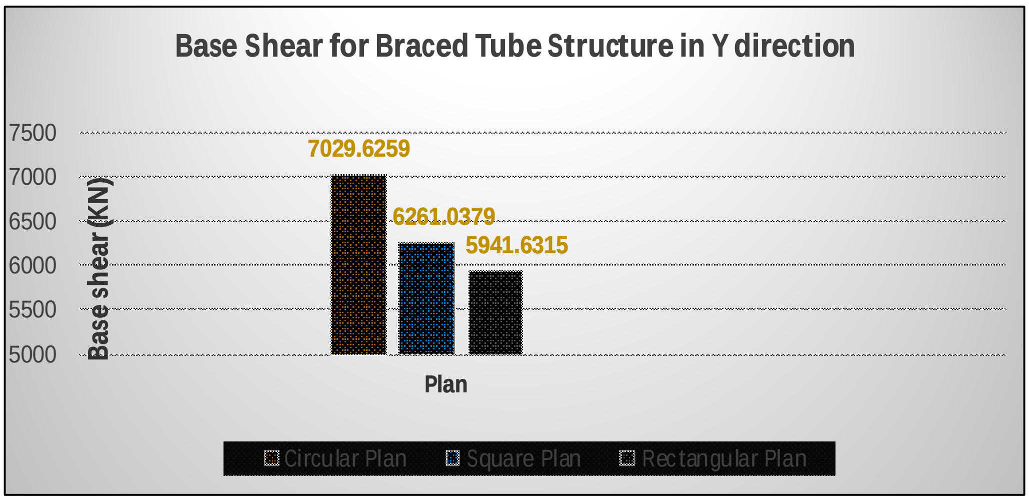


Fig. 7 Comparision of base shear for three shapes in plan in Y direction -Earthquake analysis

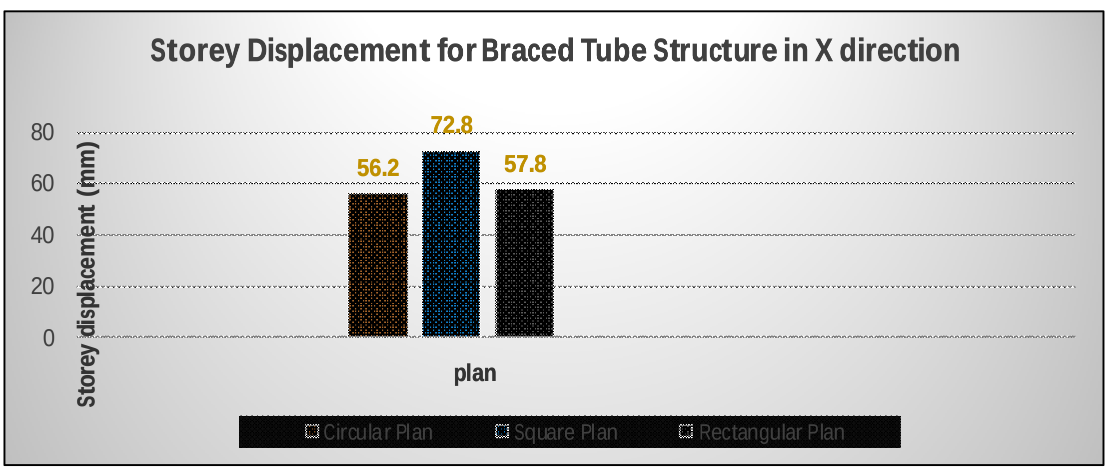


Fig. 8 Comparision of Storey displacement for three shapes in plan in X direction -Earthquake analysis

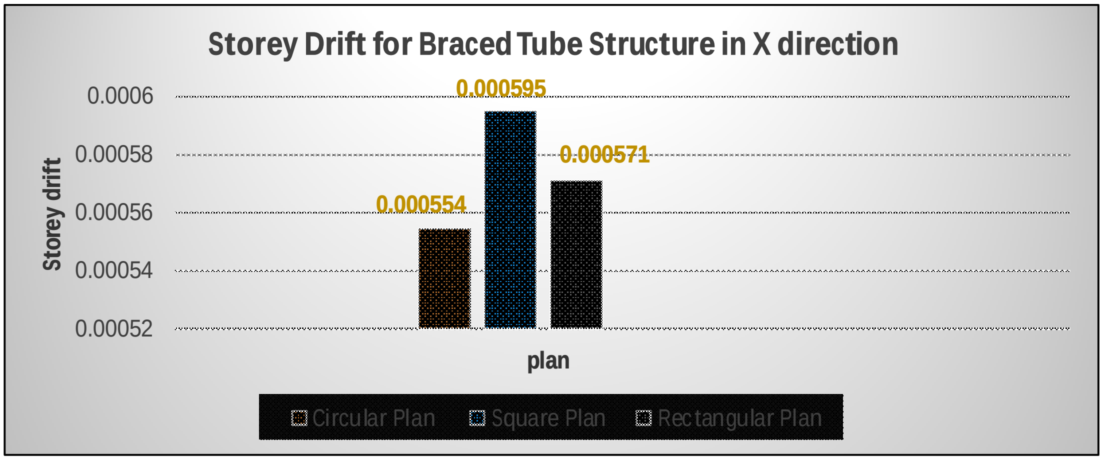


Fig. 9 Comparision of Storey drift for three shapes in plan in X direction -Earthquake analysis

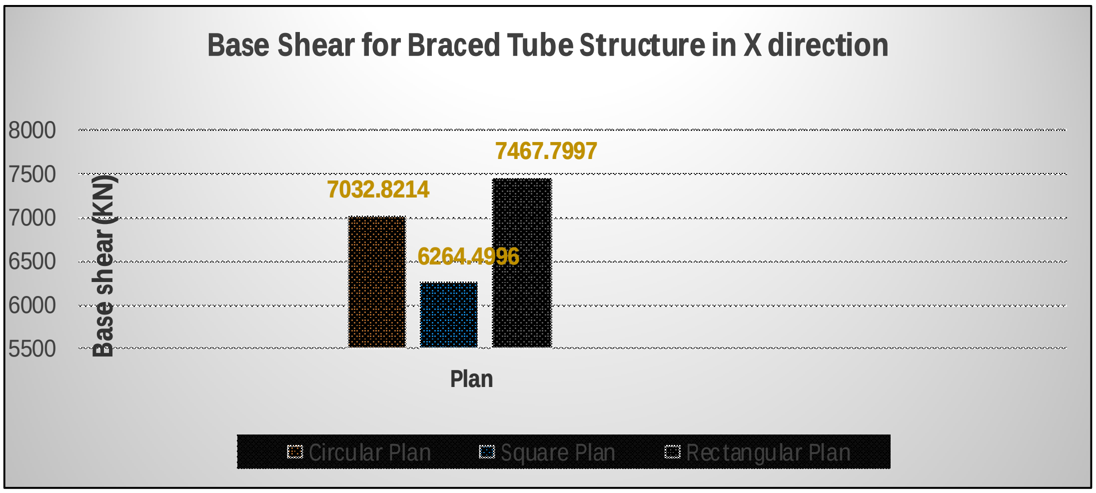


Fig. 10 Comparision of base shear for three shapes in plan in X direction-Earthquake analysis

C. Wind Analysis Result

TABLE 5
WIND ANALYSIS - Y DIRECTION RESULT

	Circular plan	Square plan	Rectangular plan
Storey displacement (mm)	85.2	103.8	226.8
Storey drift	0.000749	0.000826	0.001661

TABLE 6
WIND ANALYSIS - X DIRECTION RESULT

	Circular plan	Square plan	Rectangular plan
Storey displacement (mm)	56.9	68.2	47.3
Storey drift	0.000609	0.000591	0.000493

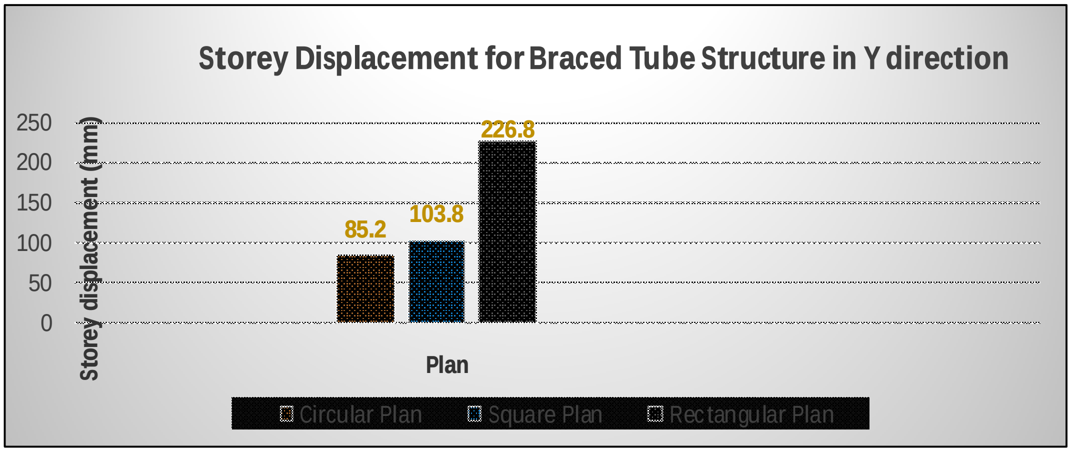


Fig. 11 Comparision of Storey displacement for three shapes in plan in Y direction –Wind analysis

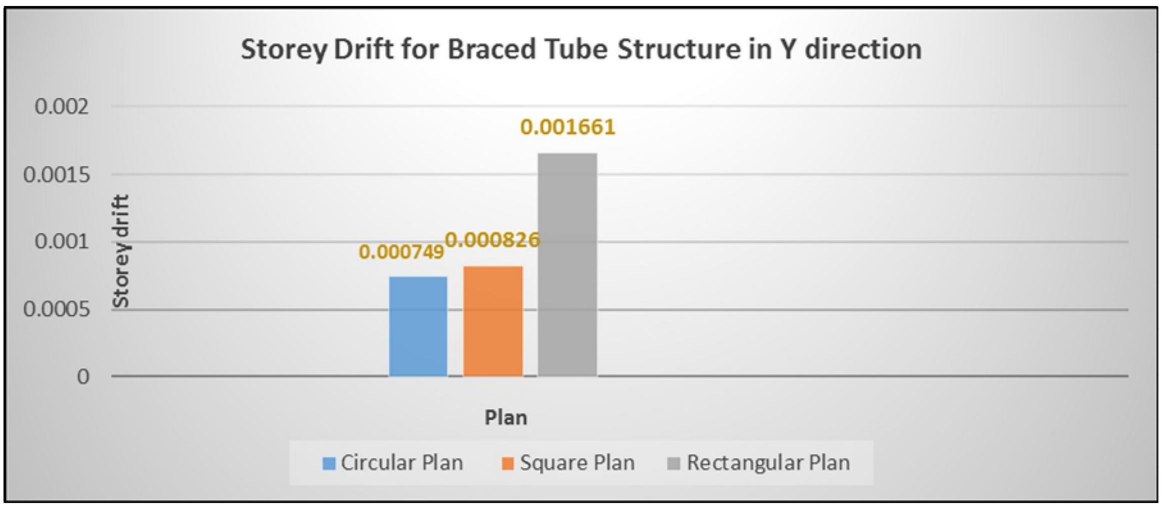


Fig. 12 Comparision of Storey drift for three shapes in plan in Y direction -Wind analysis

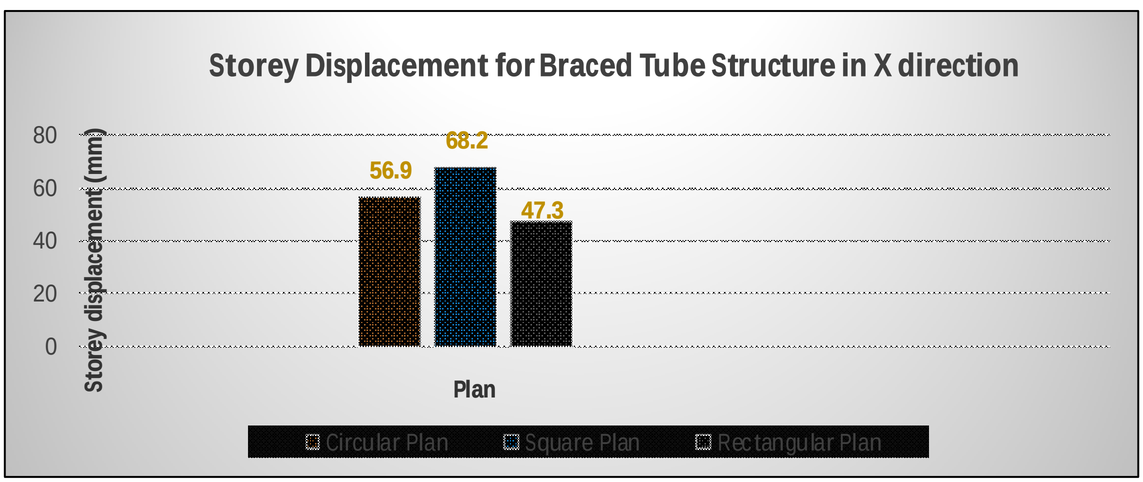


Fig. 13 Comparision of Storey displacement for three shapes in plan in X direction –Wind analysis

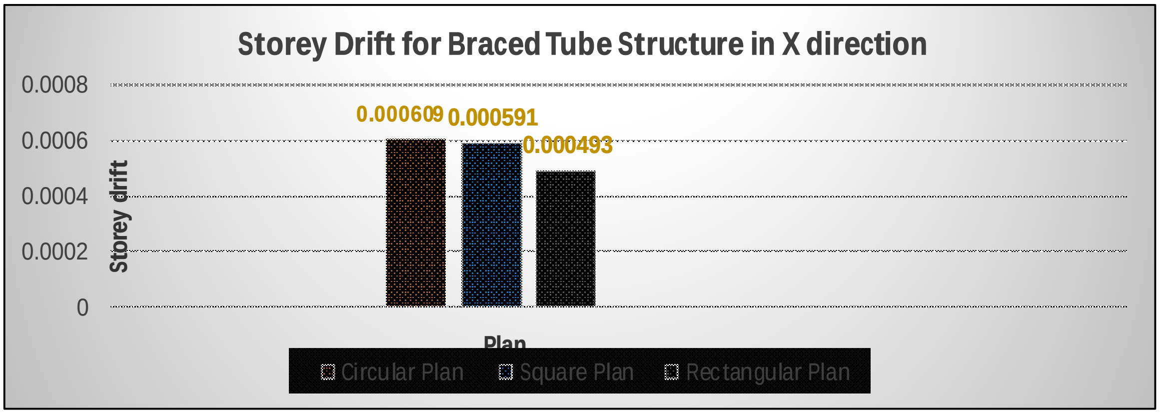


Fig. 14 Comparision of Storey drift for three shapes in plan in X direction -Wind analysis

D. Permissible Values

Maximum Storey displacement is limited to H/500, Where H is the height of the building. For 60 storey Building of 180 m height,

Permissible Maximum Storey displacement = 180/500
= 0.36 m

As per IS 1893 (Part 1): 2002, Clause 7.11.1, the Storey Drift in any storey shall not exceed 0.004 times the storey height (h) . The storey height of the models under study is 3 m.

Permissible Storey Drift = 0.004h
= 0.004 x 3
= 0.012

IV. CONCLUSIONS

In this paper, comparative analysis of 60 storey Braced Tube structural system- Square, Rectangular and Circular in plan are presented. ETABS 2015 software is used for modelling and analysis of structure. Analysis results like storey displacement, storey drift are presented here. Following are the conclusions inferred from the study:

A. For all the buildings considered for the study the storey displacement and storey drift values are within the permissible limit.
B. Square and Circular Braced Tube Buildings have lower Maximum Storey Displacement and Storey Drift values compared to Rectangular braced tube building
C. Circular Braced Tube Buildings have lower Maximum Storey Displacement and Storey Drift values compared to Square Braced tube building
D. Circular Braced Tube buildings perform better than Square Braced Tube Buildings. And both Circular and Square buildings Perform better than Rectangular Braced Tube building.

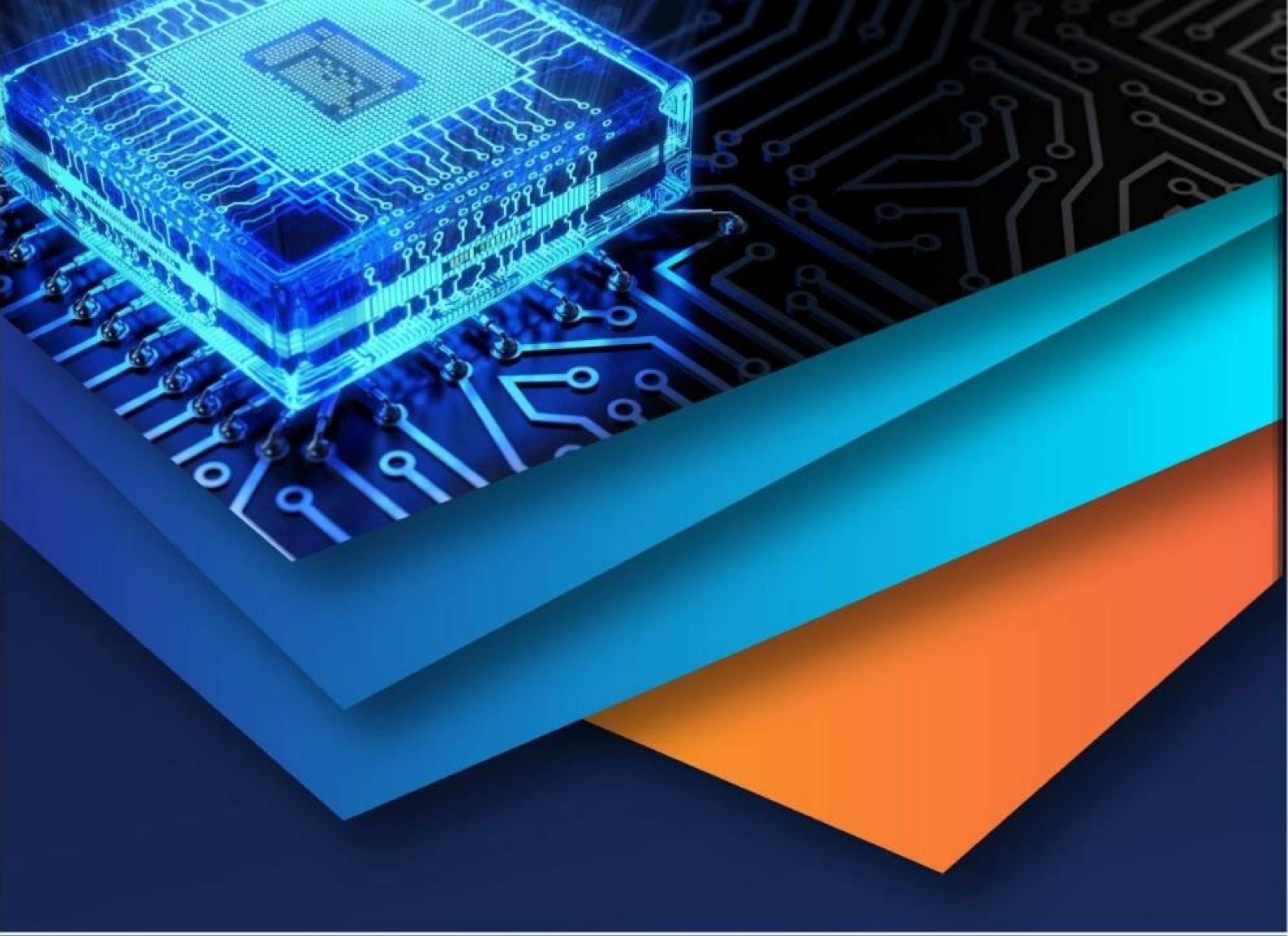
V. ACKNOWLEDGMENT

I am thankful to my guide Prof. M. S. Kakamare Sir for their guidance and providing necessary information with new ideas for this paper. and also thankful to Mr. M. B. Pendhari Sir for their useful guidance. I am very grateful to Prof. Dr. Satishchandra V. Joshi, Principal of P. V. P. I. T. Budhgaon for motivating me for this paper work. Also I am thankful to Prof. V. T. Gaikwad Head of Civil Engineering department for providing necessary facilities for completion of this paper work.
Lastly I am thank all the persons who have guided and helped us directly or indirectly.

REFERENCES

[1] Hardik J. Patel, Prof. A. R. Darji, Prof. (DR). K. B. Parikh, Braced tube structural System:A Review, International Journal of Science & Engineering Reasearch, Volume 6, Issue 12,December-2015.
[2] Dhanapalagound Patil, Naveena M P., Dynamic analysis of steel tube structure with bracing system, IJRET: International Journal of Research in Engineering and Technology, Volume: 04, Issue: 08, August-2015.
[3] M.Alaghmandan,N.A.Pehlivan,M.Elnimeiri, “Architectural and Structural Development of Tall Buildings,” ATINER Conference paper series No ARC 2013: 0758 ISSN 2241-2891,16/12/2013.
[4] Iman Mazinani, Mohd Zamin Jumaat, Z. Ismail and Ong Zhi Chao, “Comparison of shear lag in structural steel building with framed tube and braced tube” Structural Engineering and Mechanics, Vol. 49, No. 3 (2014) 297-309

[5] IS 800:2007, Indian Standard Code of Practice for General Construction in Steel,Bureau of Indian Standards, New Delhi.
[6] IS 1893:2002 (Part I), Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.
[7] IS 875:1987(Part II), Indian Standard Code of Practice for Design loads (Other than Earthquake) for buildings and structures, Bureau of Indian Standards, New Delhi.
[8] IS 875:1987(Part III), Indian Standard Code of Practice for Design loads (Other than Earthquake) for buildings and structures, Bureau of Indian Standards, New Delhi
[9] https://en.wikipedia.org/wiki/Tube_(Structures)



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY