Seismic and Wind Performance of Braced Tube Structure

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Abstract : The RC frame braced tube structure are the combination of RCC shear wall and steel bracing are being provided to resist the lateral load acting on the structure. The different types of bracing systems are used for the strengthening the RCC frame against lateral loading which is a viable solution for the enhancement of performances of the structure. In the present paper, seismic analysis of G+39, G+49, G+59 stories building are carried out, various types of bracing such as X, V, inverted V, parallel and zigzag bracing are being used. The sections of bracings used are pipe and tube sections. The analysis is carried out by using ETABS software, the method used for analysis is dynamic response spectrum method for earthquake dynamic loading. Seismic analysis is carried for G+39, G+49 and G+59 stories buildings. While as wind dynamic analysis is carried out for G+49 and G+59 stories buildings. A comparison is being carried out between building with bracings and without bracings. The models are being analyzed in seismic zone V. The various parameters such as displacement, storey drift, base shear and time period of various model buildings are obtained and interpretation of results is being carried out to find out the most suitable type of bracing system. The current study shows that the performance of X bracing is better than other systems.

Key Words – time period, X bracing, parallel bracing, zigzag bracing etc.

I. INTRODUCTION

With the scarcity of urban land and rapidly increasing population is the basic cause for the development of the high-rise buildings in the metropolitan area. This is being achieved by advanced construction techniques and evolution of the efficient structure systems to resist the gravity as well as lateral loads. Along with the gravity load, the lateral loads i.e. earthquake loads and wind loads requires special attention in design of high-rise structures. The framed tube and braced tube structural systems resist the lateral loads acting on it by the structural elements provided on the periphery of the building. The selected structural system should be able to utilize the structural elements effectively while satisfying design requirements and its compliances. The Braced tube is a structural system which acts as a hollow cylindrical cantilever placed perpendicular to the ground. The main aim of braced tube structure is to arrange the various structural elements in such a manner that the system can resist the loads imposed on the structure efficiently particularly the horizontal loads. Braced tube structure is the advancement of the tubular structure. The columns are being connected to diagonal of braced tube at each intersection, which eventually eliminates the effect of the shear lag in flange and web. In the present study three buildings G+39, G+49 and G+59 are analyzed with different types of bracings X. V, inverted V, parallel and zigzag bracings. The models are analyzed for seismic and wind static and/or dynamic forces acting on them. The sections of the bracings used are pipe and tube sections.The Parameters such as displacement, storey drift, base shear and time period of various model buildings are obtained and the suitable bracings for resisting the laterals loads are found out.

II. MODELLING AND ANALYSIS OF BUILDINGS.

Table 1 - Data for problem formulation

Various details	No of storeys		
	G+39	**G+49**	**G+59**
Plan size	48m x 32m	48m x 32m	48m x 32m
Typical floor height	3.5m for G.L. and 3m for all above floors	3.5m for G.L. and 3m for all above floors	3.5m for G.L. and 3m for all above floors
Main beam size	400mm x 800mm	450mm x 850mm	500mm x 800mm
Secondary beam size	350mm x 500mm	350mm x 500mm	350mm x 500mm
Column size	Upto 20 storeys – (1100m x 1250mm, 750mm x 950mm, 500mm x 600mm) Above 20 storeys – (950mm x 1150mm, 550mm x 750mm, 450mm x 550mm)	Upto 25 storeys – (1200mm x 1350mm, 1000mm x 1100mm, 700mm x 850mm) Above 25 storeys – (1100mm x 1250mm, 700mm x 850mm, 600mm x 700mm)	Upto 20 storeys – (1400mm x 1600mm, 1150mm x 1250mm, 950mm x 1150mm) From 20 to 40 storeys – (1250mm x 1400mm, 950mm x 1150mm, 750mm x 850mm) From 40 to 60 storeys – (950mm x 1150mm, 650mm x 850mm, 500mm x 600mm)

Slab	150mm	150mm	150mm
Shear periphery wall	350mm	350mm	350mm
Tube bracing	300mm x 300 mm x 18mm	250mm x 250mm x 16mm	300mm x 300mm x 25mm
Pipe bracing	300mm x 25mm	250mm x 18mm	300mm x 30mm
Dead load	5 kN/m^2.	5 kN/ m^2.	5 kN/ m^2.
Live load	3 kN/ m^2.	3 kN/ m^2.	3 kN/ m^2.
Grade of concrete	M 30	M 30	M 30
Grade of steel	Fe 415	Fe 415	Fe 415
Seismic zone factor	5		5
Soil type	Medium	Medium	Medium
Response reduction factor (R)	5	5	5

2.1 PLAN AND TYPES OF BRACINGS

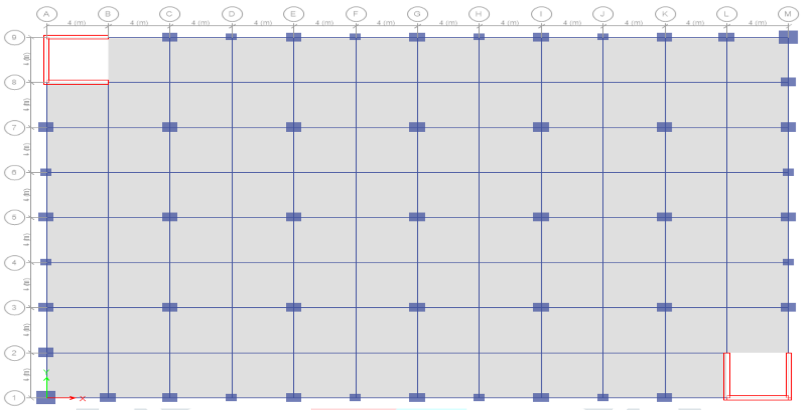

Fig 1. A typical Plan of building

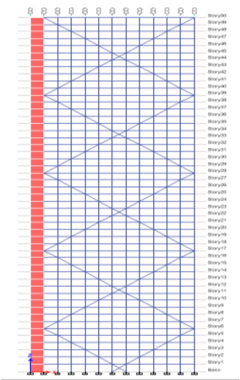

Fig 2. X bracing

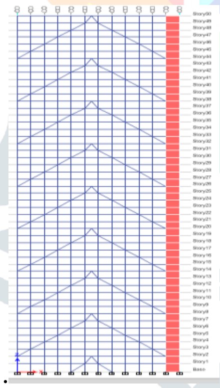

Fig 3. Inverted V bracing

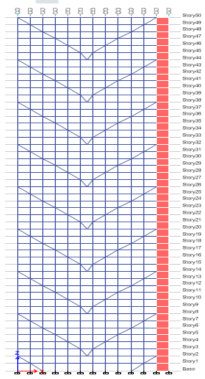

Fig 4. V bracing

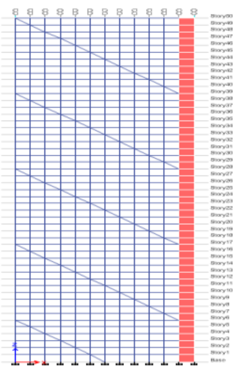

Fig 5. Parallel bracing

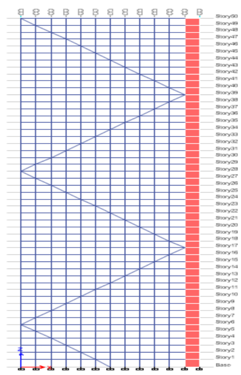

Fig 6. Zigzag bracing

III. RESULTS

- **Seismic analysis for 40 storey building.**

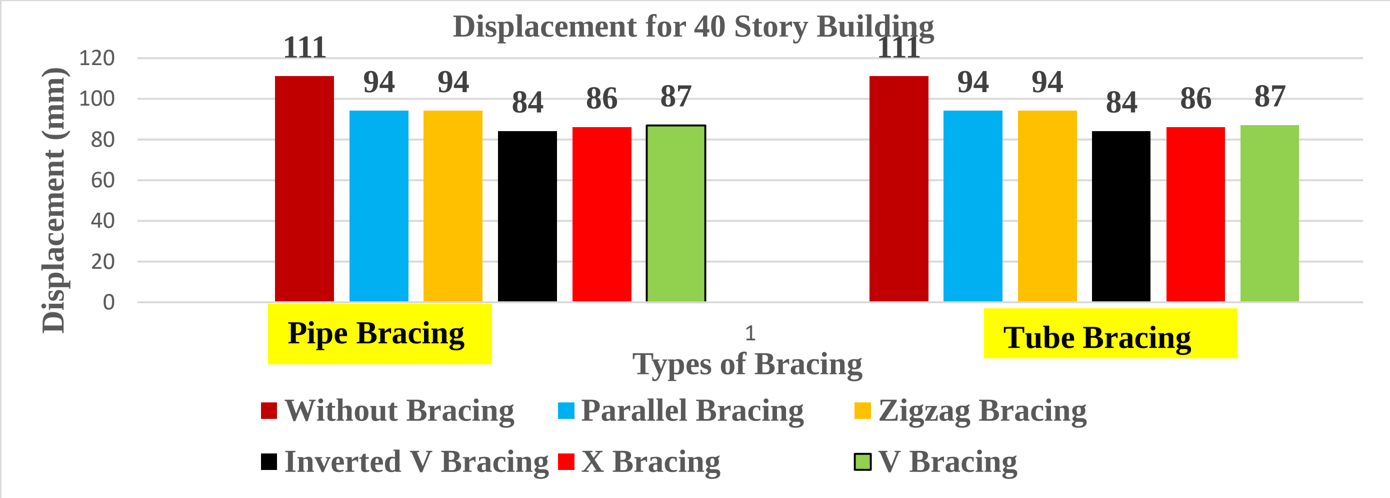

Chart 1. Displacement(mm)

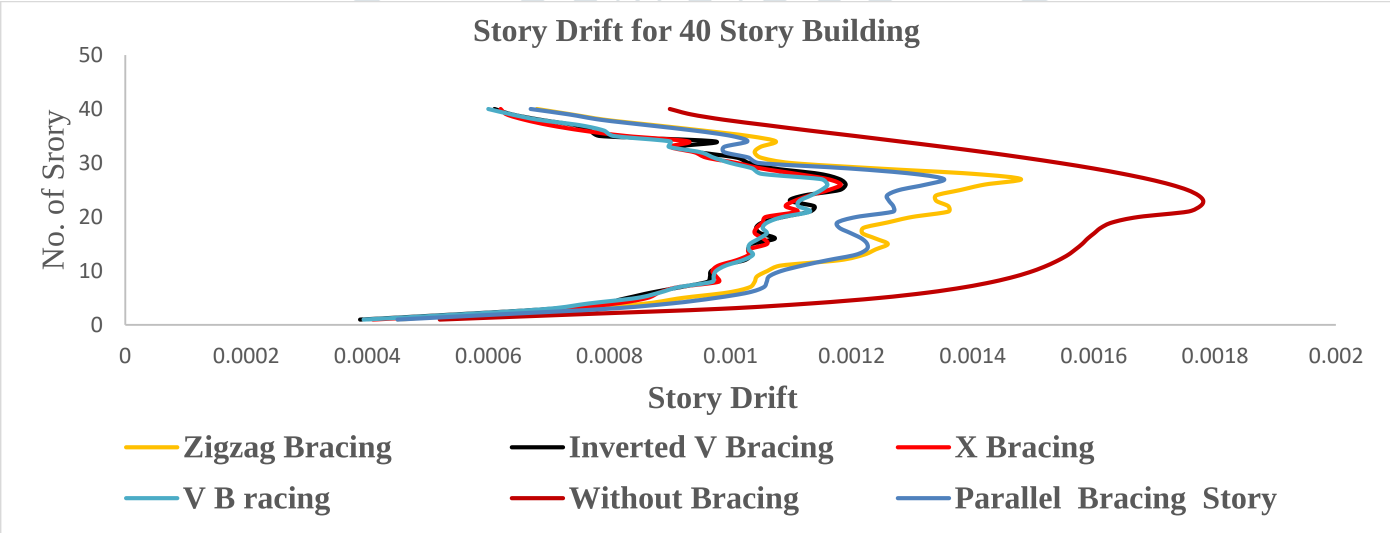

Chart 2. Storey Drift

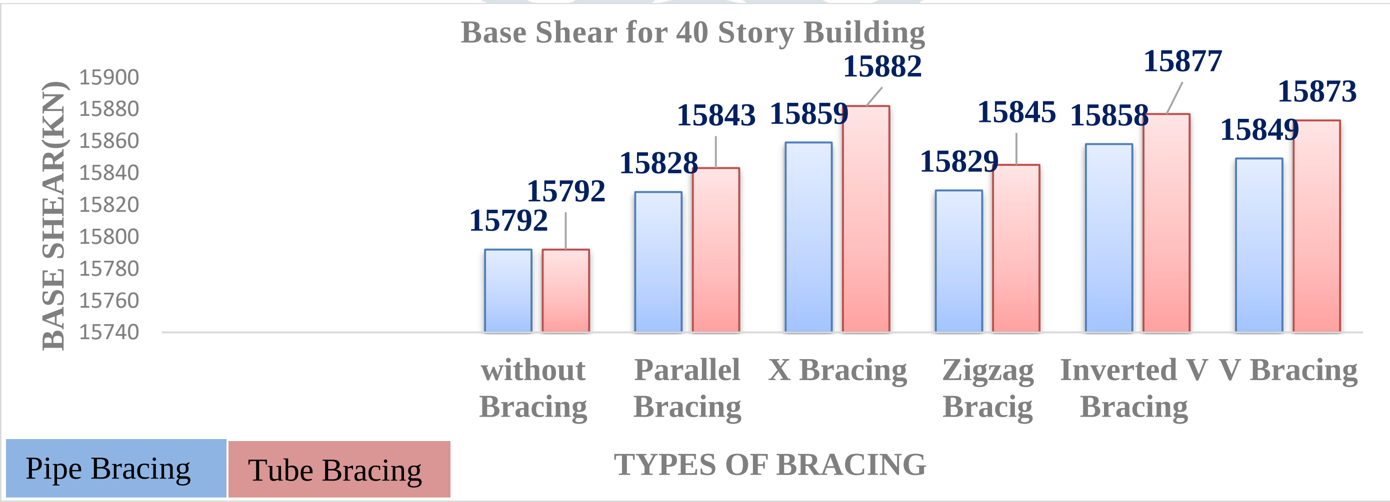

Chart 3. Base shear(kN)

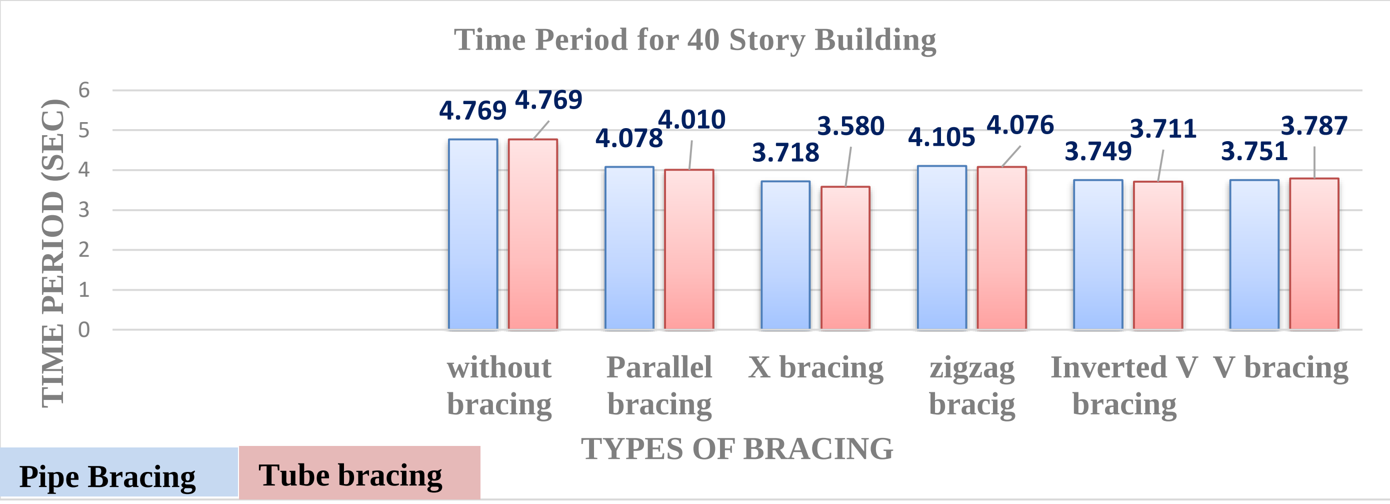

Chart 4. Time period (seconds)

- **Seismic analysis for 50 storey building**

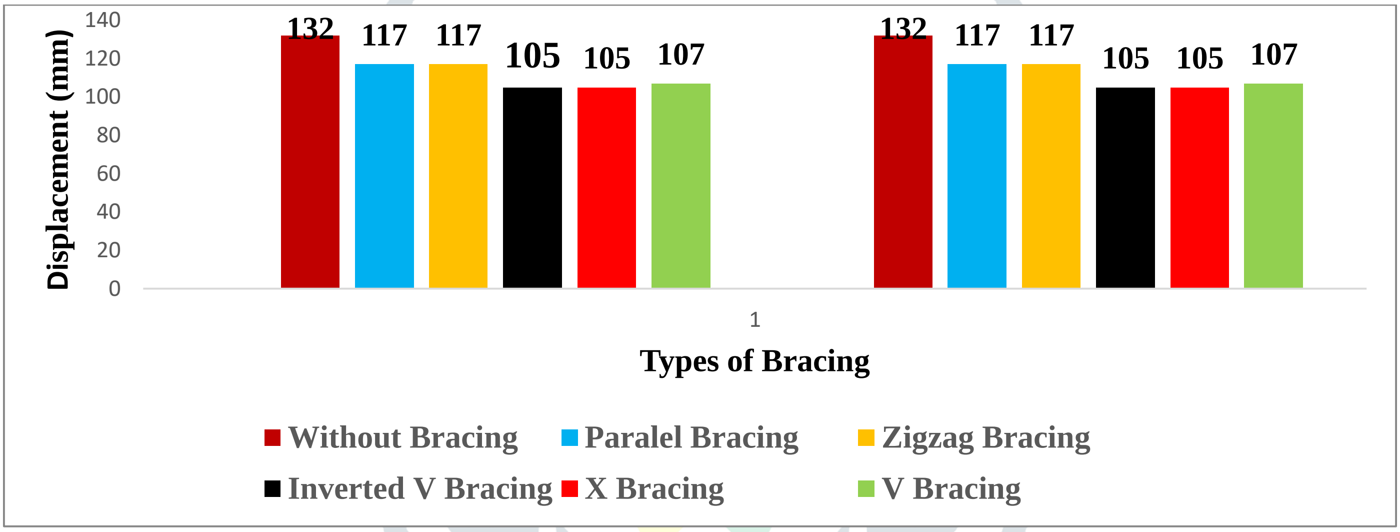

Chart 5. Displacement(mm)

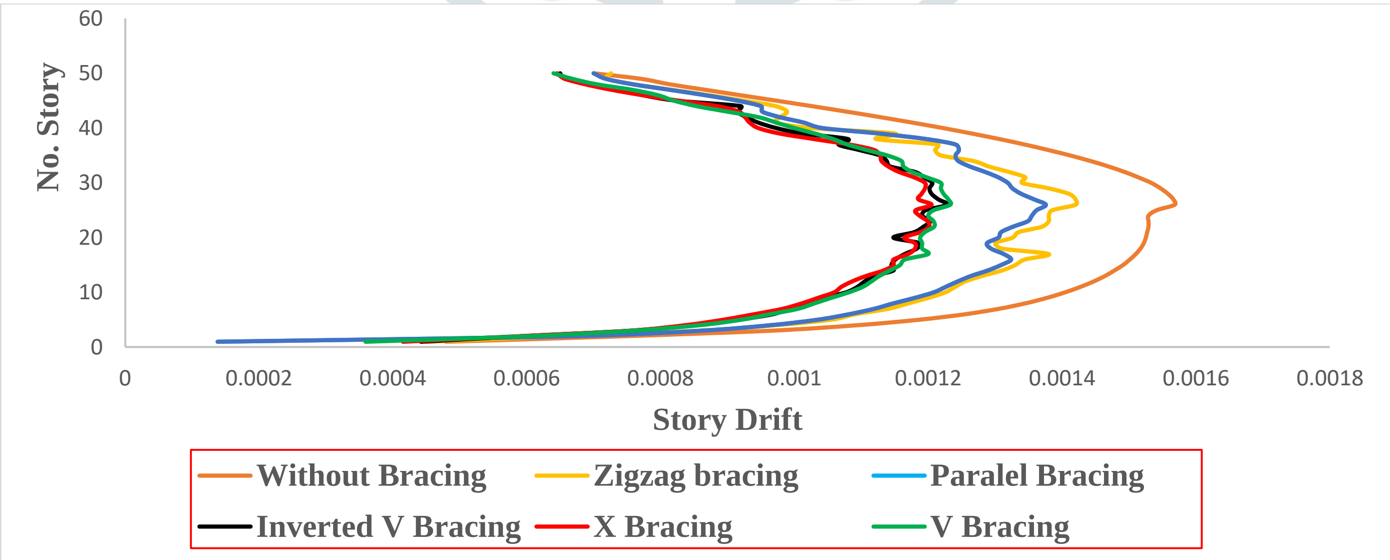

Chart 6. Storey Drift

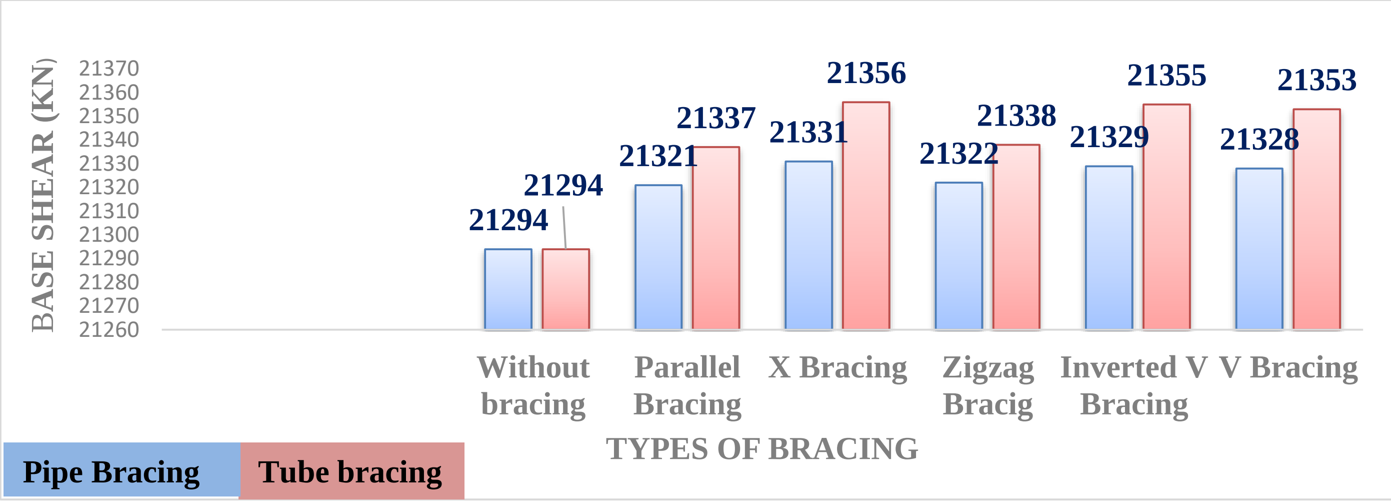

Chart 7. Base shear(kN)

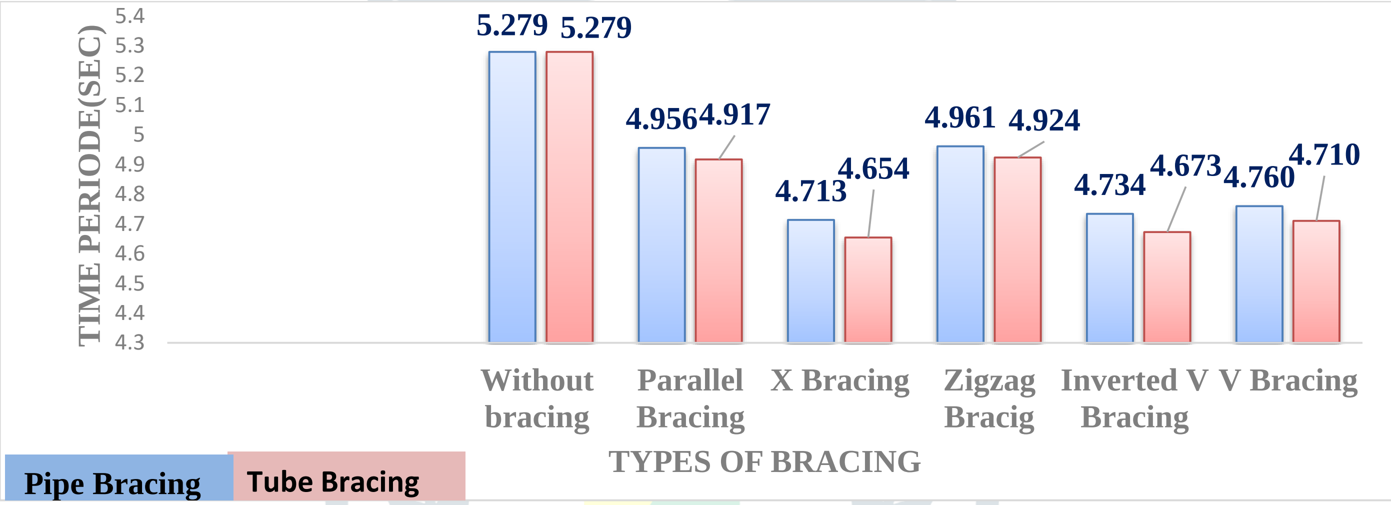

Chart 8. Time period (seconds)

- <u>**Seismic analysis for 60 storey building**</u>

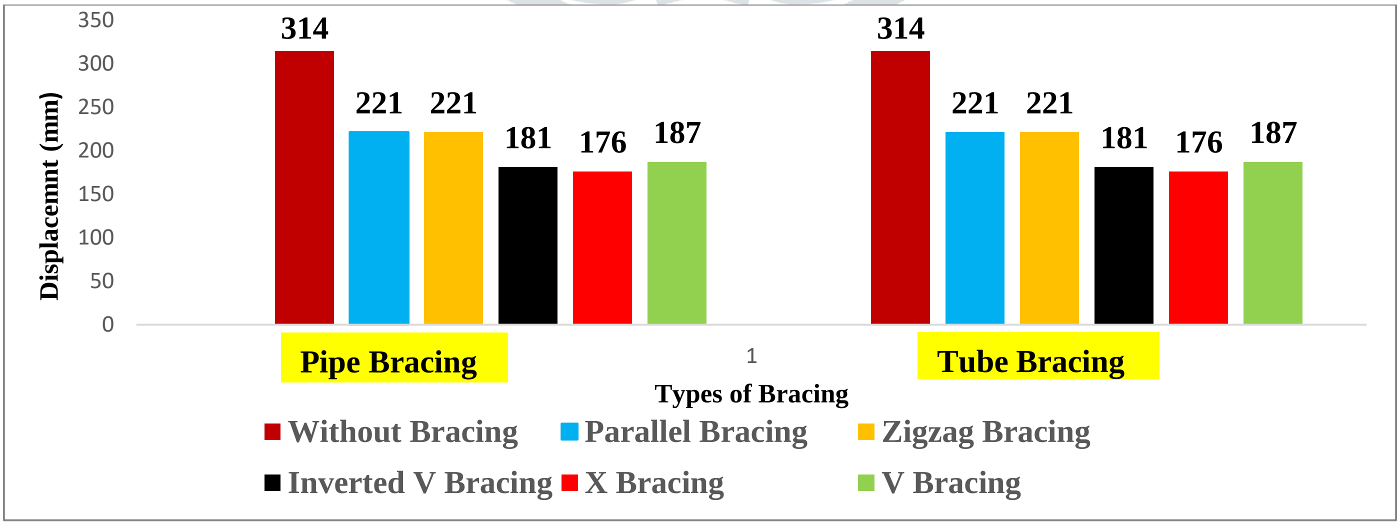

Chart 9. Displacement(mm)

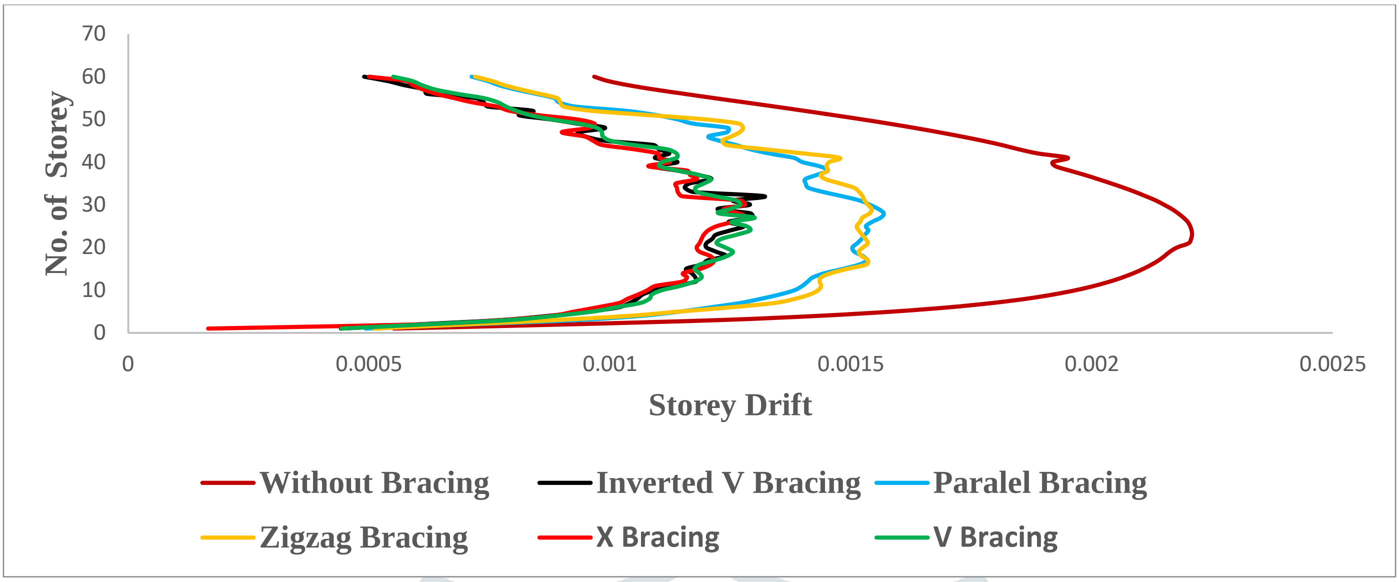

Chart 10. Storey Drift

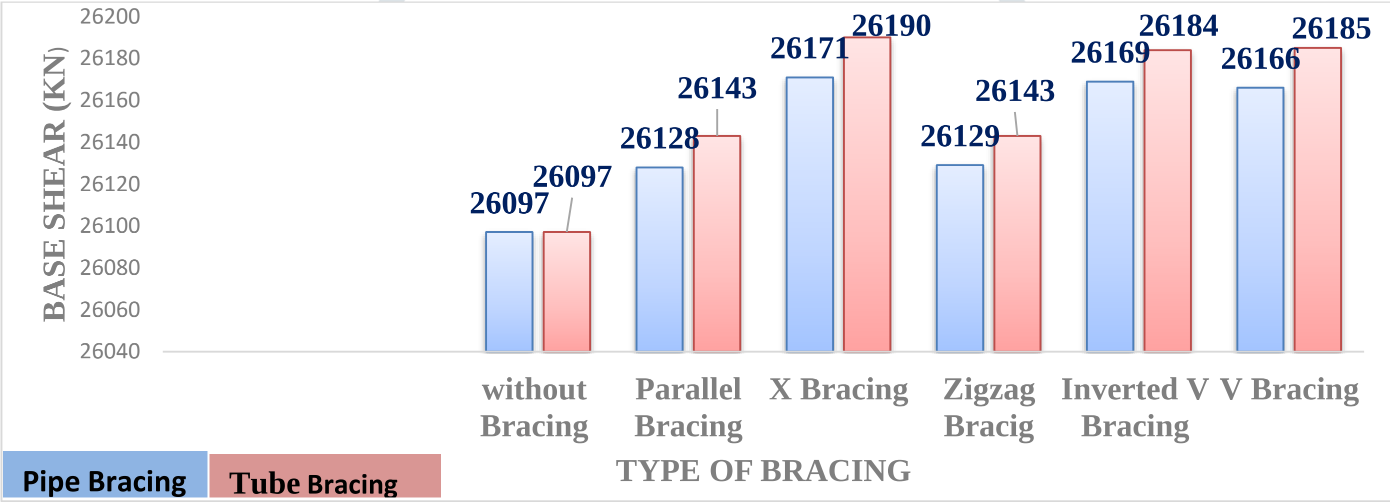

Chart 11. Base shear(kN)

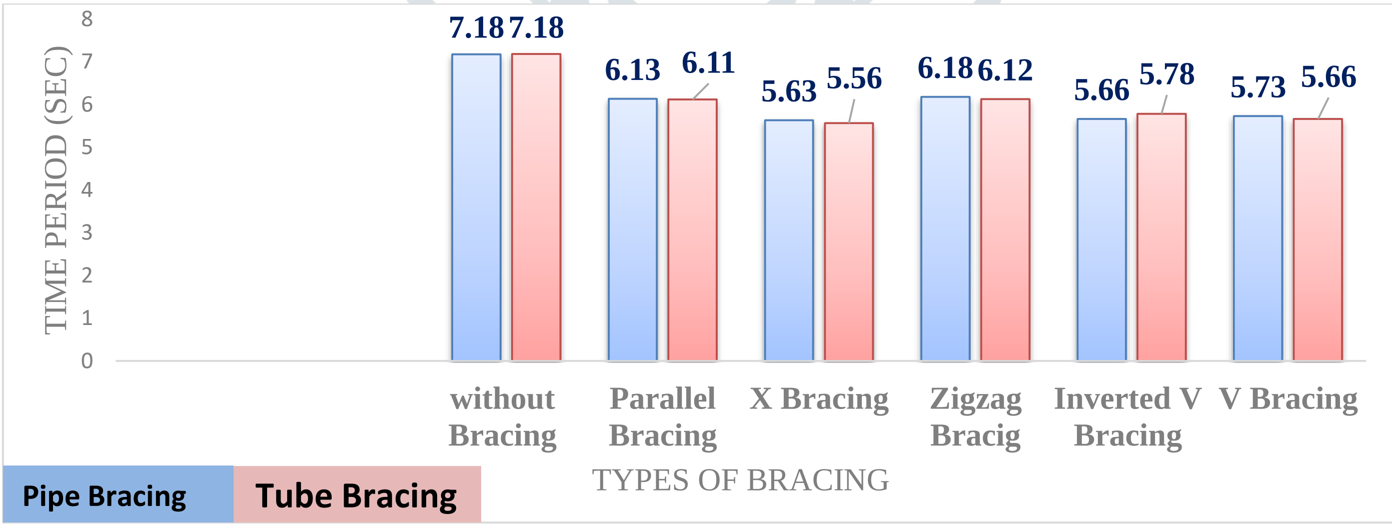

Chart 12. Time period (seconds)

- **Wind analysis for 50 storey building**

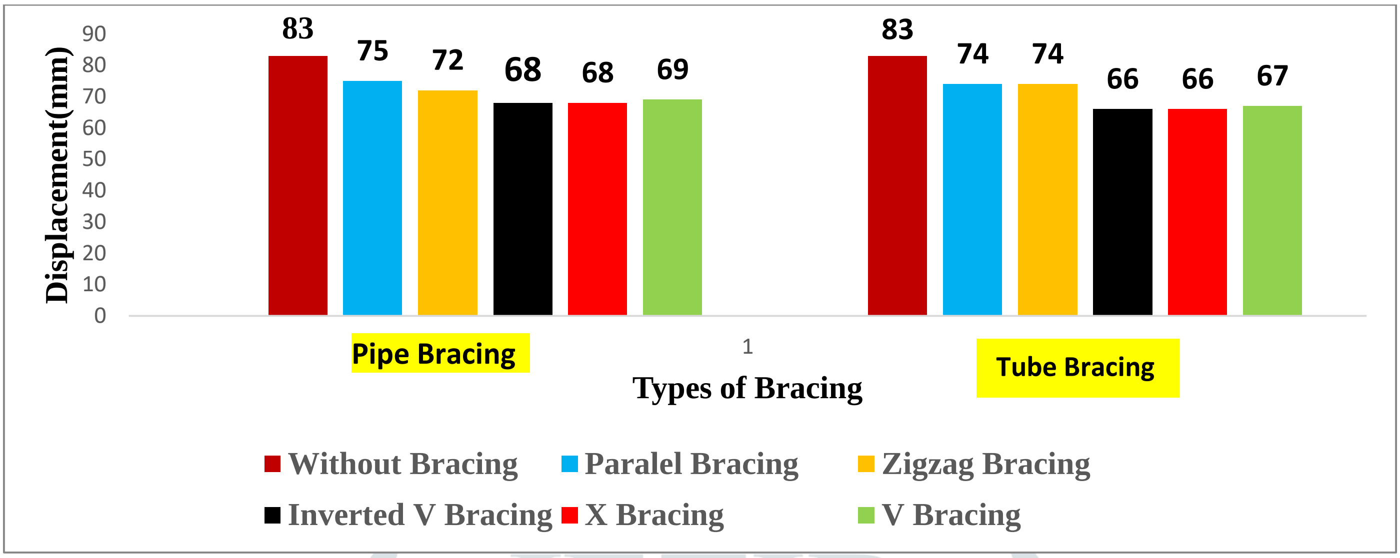

Chart 13. Displacement(mm)

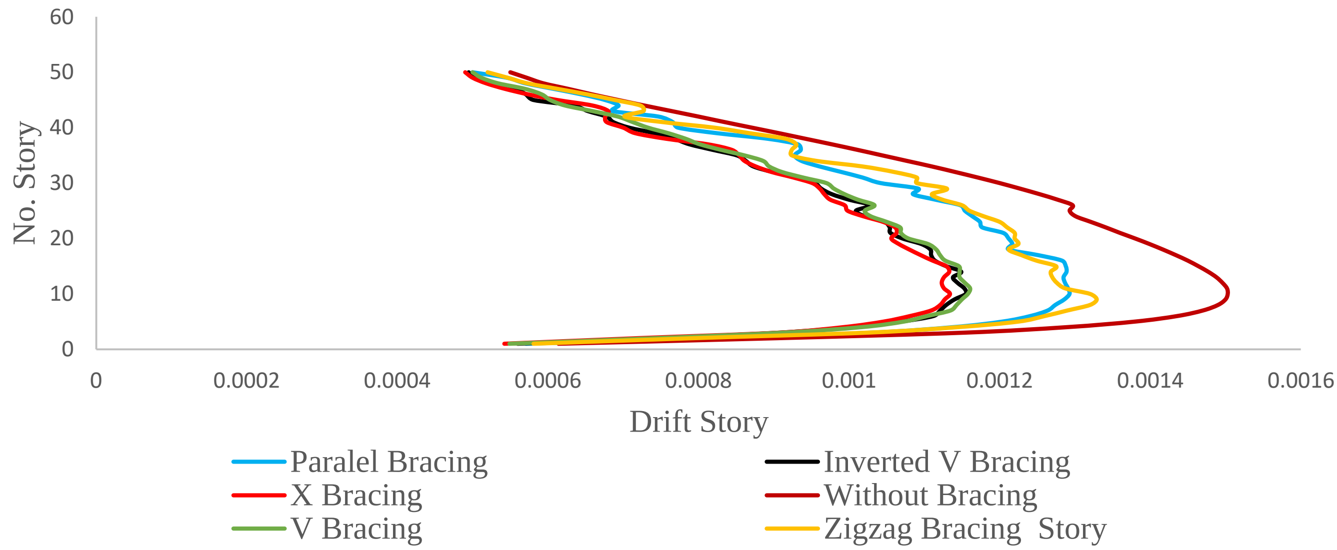

Chart 14. Storey Drift

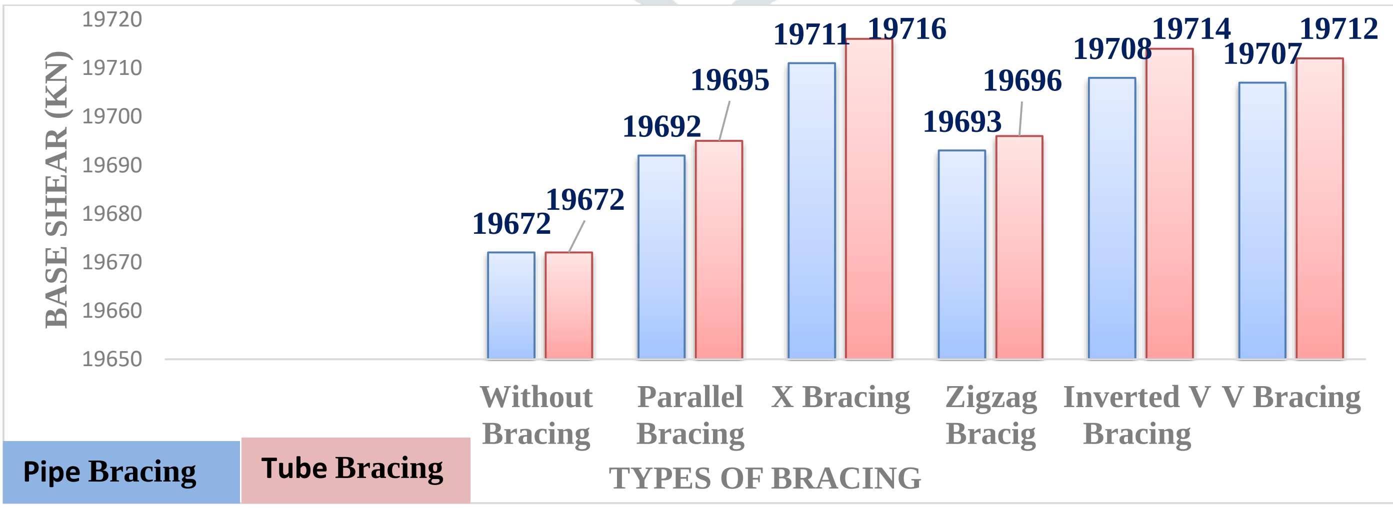

Chart 15. Base shear(kN)

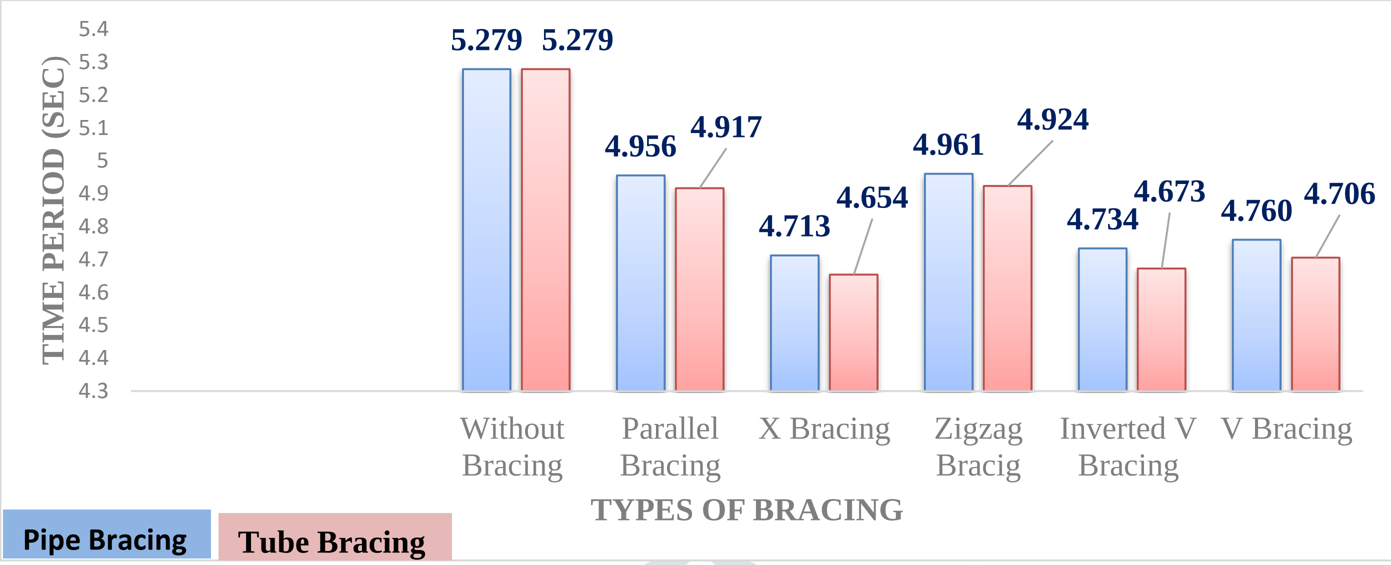

Chart 16. Time period (seconds)

- **Wind analysis for 60 storey building**

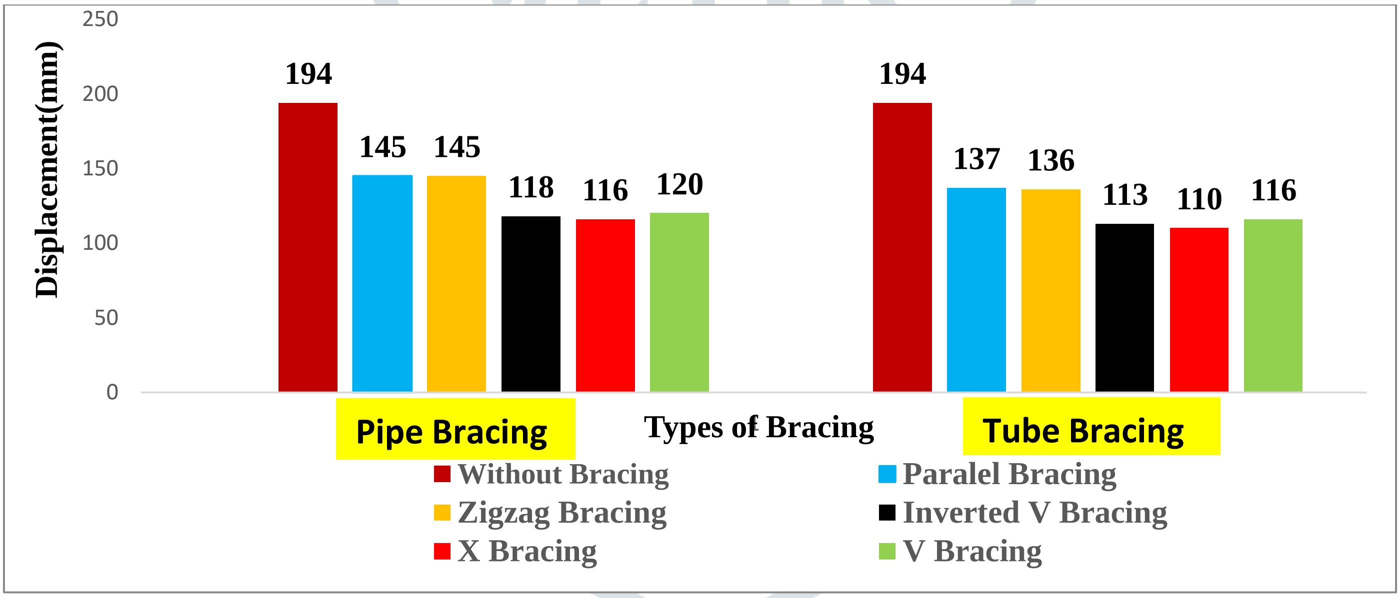

Chart 17. Displacement(mm)

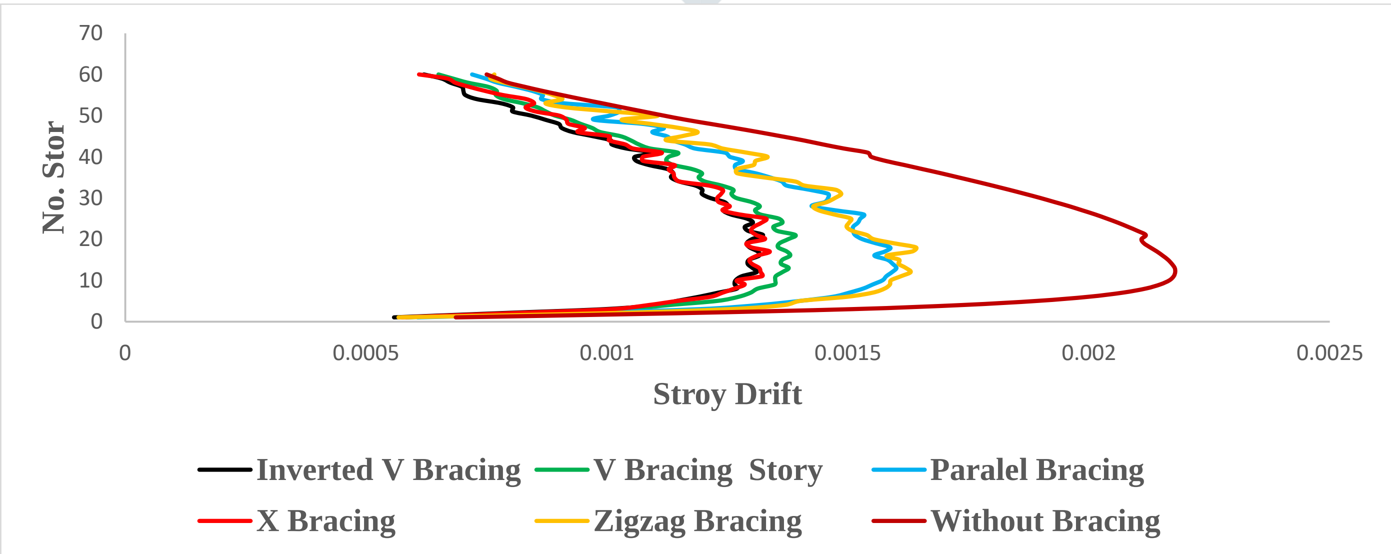

Chart 18. Storey Drift

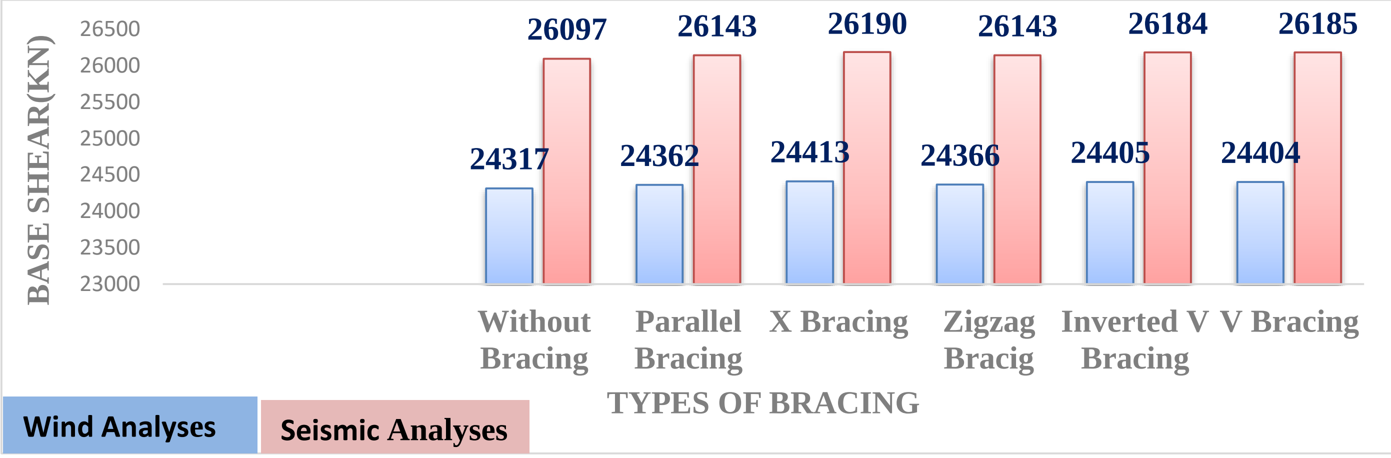

Chart 19. Base shear(kN)

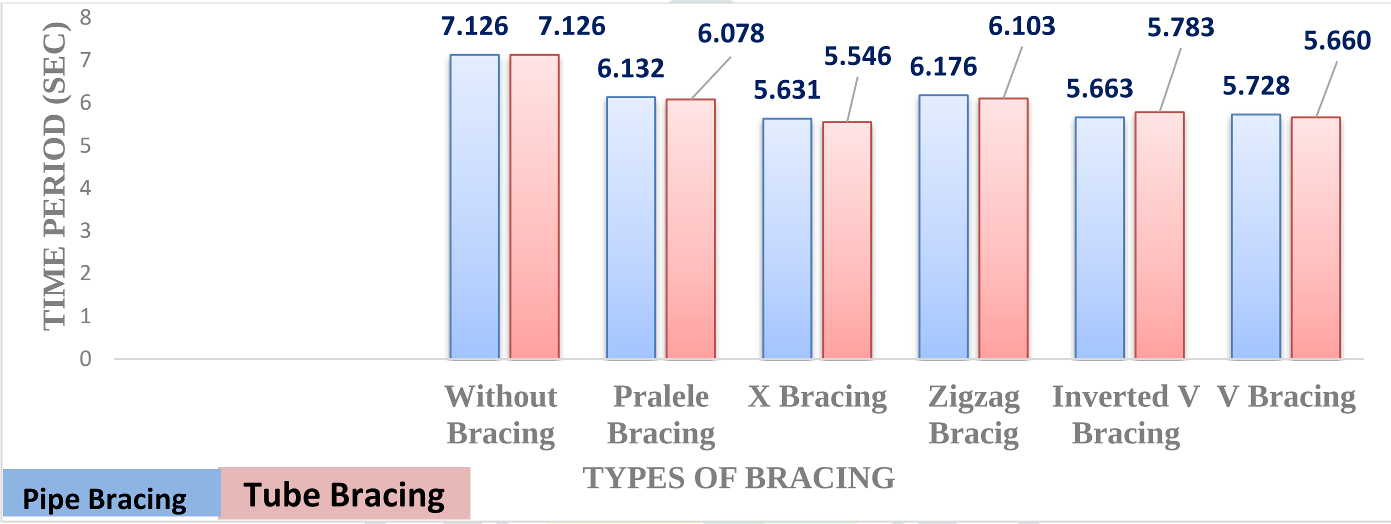

Chart 20. Time period (seconds)

- **<u>Comparison of seismic analysis and wind analysis for 60 storey building.</u>**

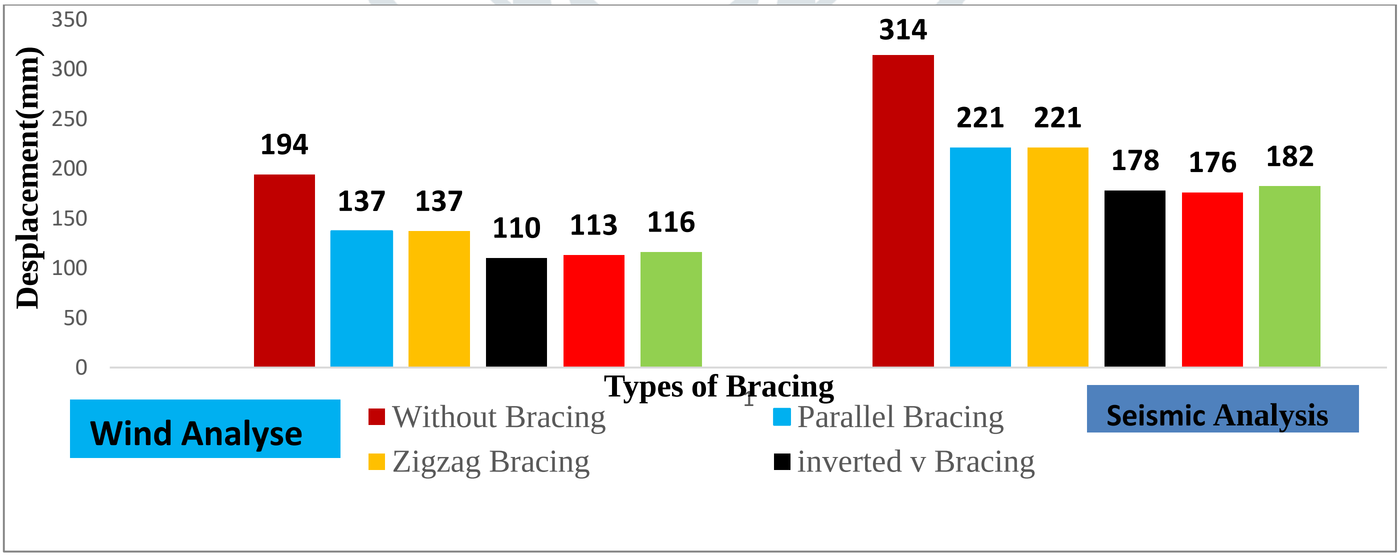

Chart 21. Displacement(mm)

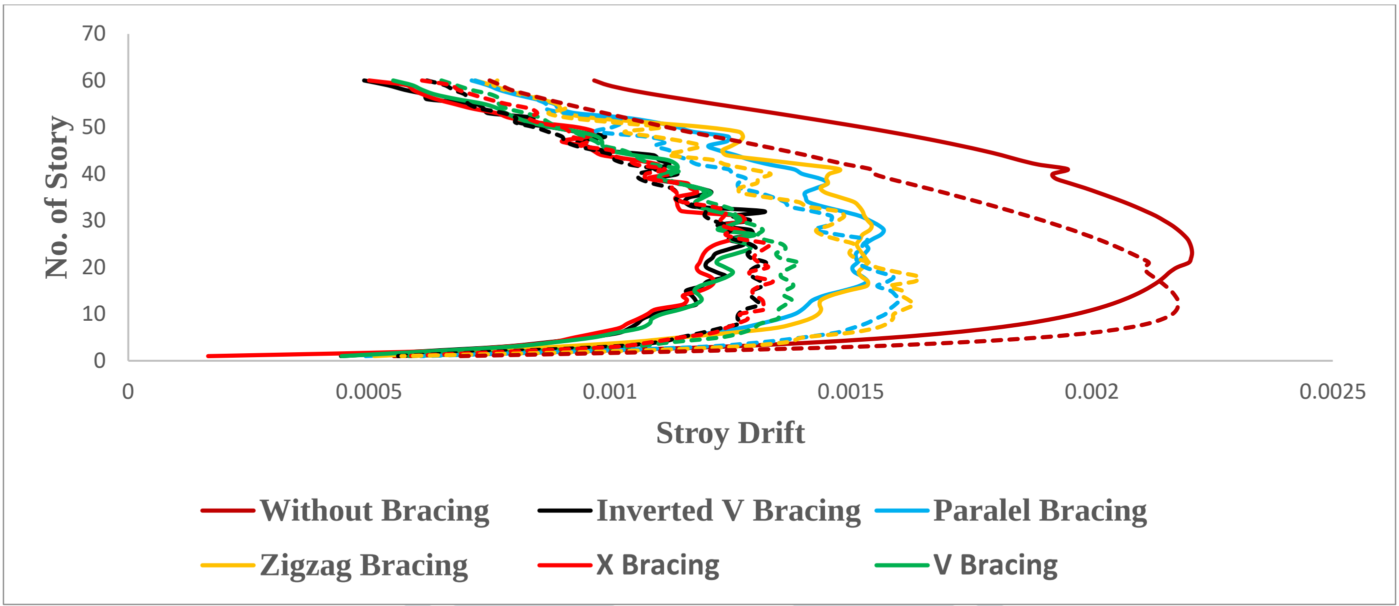

Chart 22. Storey Drift

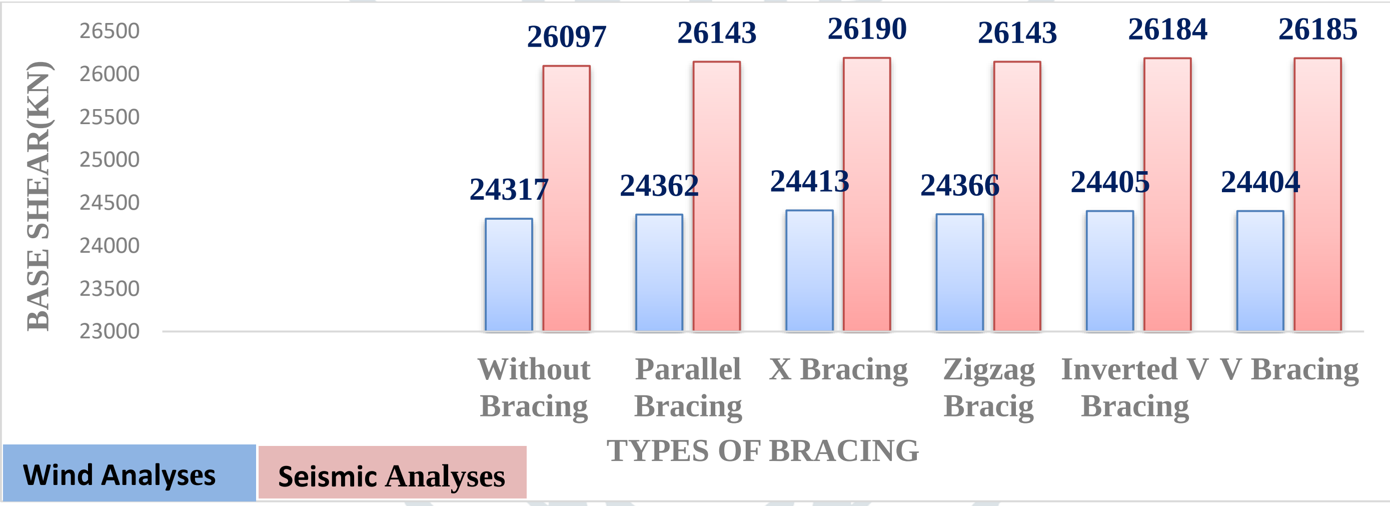

Chart 23. Base shear(kN)

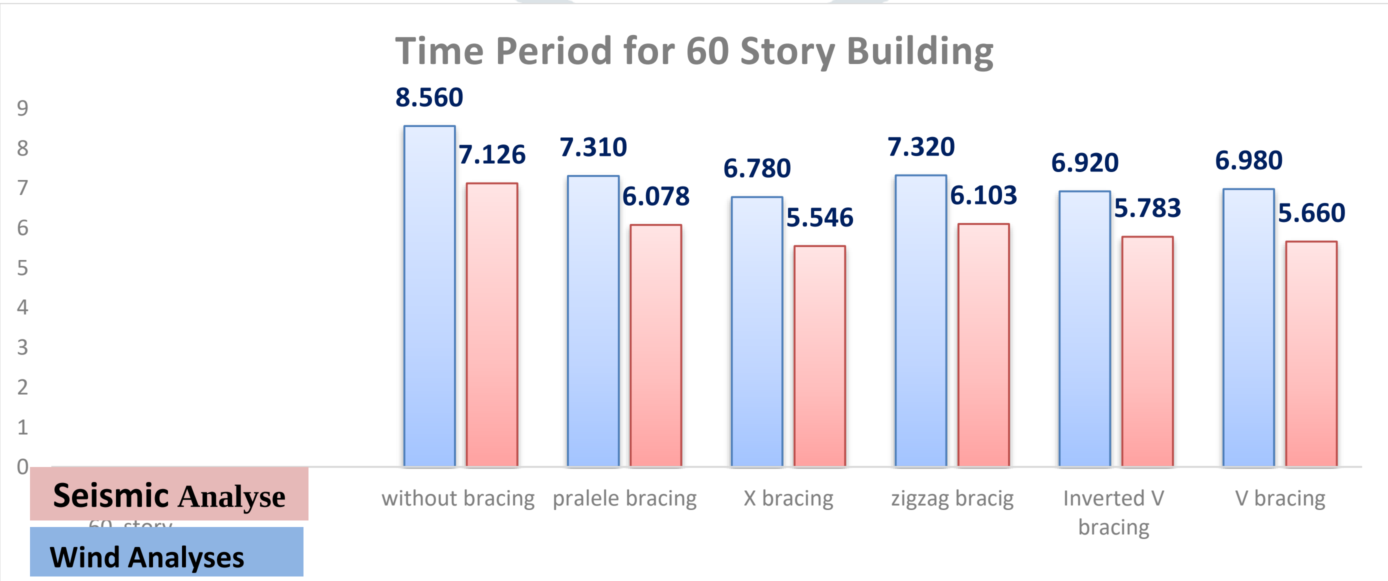

Chart 24. Time period (seconds)

IV. CONCLUSIONS

In this study performance of different type of bracing configuration and different height buildings are studied. Models are analyzed for different bracing configuration subjected to wind & earthquake load. To check the performance of these different buildings' models time period, maximum top displacement, story drift and base shear are evaluated and analyzed.

[1] X- Type of bracing are found to be more effective than concentric bracing, eccentric bracing. This type of bracing is more effective to reduce displacement, base shear, time period.

[2] From seismic and wind analysis for G+50 and G+60 storey buildings it can be concluded that the earthquake load governs the analysis and design of buildings than wind load.

[3] Seismic response is same in G+40 building without bracings and with bracings. Hence it is not necessary to provide bracings in this height limit.

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