Analytical Study on the Storey Drift of Steel Concrete Composite Structures for G+25 Storeys using ETABS

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Published in IJIRMPS (E-ISSN: 2349-7300), Volume 11, Issue 4, (July-August 2023)

Abstract

The research aims to address the growing demand for reliable analysis methods in the design of high-rise structures. By conducting a comprehensive literature review, the study identifies key knowledge gaps and emphasizes the importance of considering material properties and geometric aspects in predicting structural behavior. A numerical model of a G+25 steel concrete composite building is created and calibrated using available data, experimental results, and relevant design codes. Parametric studies investigate the effects of design parameters on storey drift, including concrete slab thickness, steel beam and column sizes, shear connectors, and composite action. The study offers valuable insights for structural engineers and designers, showcasing the significance of appropriate design parameters and accurate modelling techniques. The findings contribute to optimizing the design process and promoting safer and more efficient high-rise structures.

Keywords: ETABS, High-rise Structures, Storey Drift

1. Introduction

Steel-concrete composite structures have gained significant popularity in the field of civil engineering due to their numerous advantages and versatility. This structural system combines the beneficial properties of steel and concrete to create efficient and robust building solutions. By integrating the strength and stiffness of steel with the durability and fire resistance of concrete, composite structures offer enhanced structural performance, increased design flexibility, and reduced construction time.

Steel-concrete composite structures have proven to be highly suitable for a wide range of applications, including high-rise buildings, bridges, industrial facilities, and infrastructure projects. These structures provide exceptional strength-to-weight ratio, allowing for the construction of lightweight yet durable elements. The composite action between steel and concrete results in improved load-carrying capacity, increased resistance to lateral loads, and enhanced overall stability. Moreover, the combination of different materials allows for efficient use of resources and the reduction of material quantities, making composite structures more sustainable and cost-effective.

2. Literature Review

[1] Siddhant et al. (2022) done an analysis and design of steel concrete composite structure and its comparison with RCC structure and concluded that composite structure has more resistant against RCC structures, and composite structure has less storey drift than RCC structure. RCC structure has more storey shear compared to composite structure. RCC structure has more bending moment and shear force compared to composite structure. The cost comparison results shows that cost of composite structure is 6.22 % less as compared to RCC structure.

[2] Hatim et al. (2019) done a comparative study on high rise building for various geometrical shapes subjected to wind load of RCC and composite structure using ETABS and concluded that the size of the steel beams of Steel-Concrete composite frame structure reduces by about 25% approximately than RCC frame structure. Thus, dead load of the composite structure is less as compared to RCC frame structure, which gives economical foundation design. Also, as time required for construction of composite structures is less compared to that of RCC structures as no formwork is required. Thus Steel-Concrete Composite structures are more economical in case of high-rise buildings. Steel-Concrete Composite frame follows strong column weak beam behaviour, as hinges are formed in beam element rather than column element. Composite columns are also used widely in practice to resist predominantly compressive loading and appear in different form including concrete filled section, recently using high strength high performance concrete.

[3] Vedha et al. (2019) conducted a study of seismic and wind effects on multistorey RCC, steel and composite using ETABS and concluded that the beam S.F. and B.M. is more in the RCC, steel and composite building. But, when we use the composite beam, the forces are reduced due to the reduced section. The section S.F. and B.M. is increase due to the member size increase and self-weight because forces are increase in the member. Comparison of all models' buildings shows that composite buildings are more economic for all other buildings structure.

[4] Shaikh et al. (2017) done an analysis and design of multistoried building subjected to seismic loading using composite and RCC structures and concluded that the floor displacement is maximum for composite building compared to RCC building. RCC building has the lowest values of displacement because of its high stiffness. Story drift in equivalent static analysis along X and Y direction is more for composite building compared to RCC building. RCC frame has the lowest values of story drift because of its high stiffness. The differences in story drift for different stories along X and Y direction are owing to orientation of column sections. Moment of inertia of column section is different in both directions.

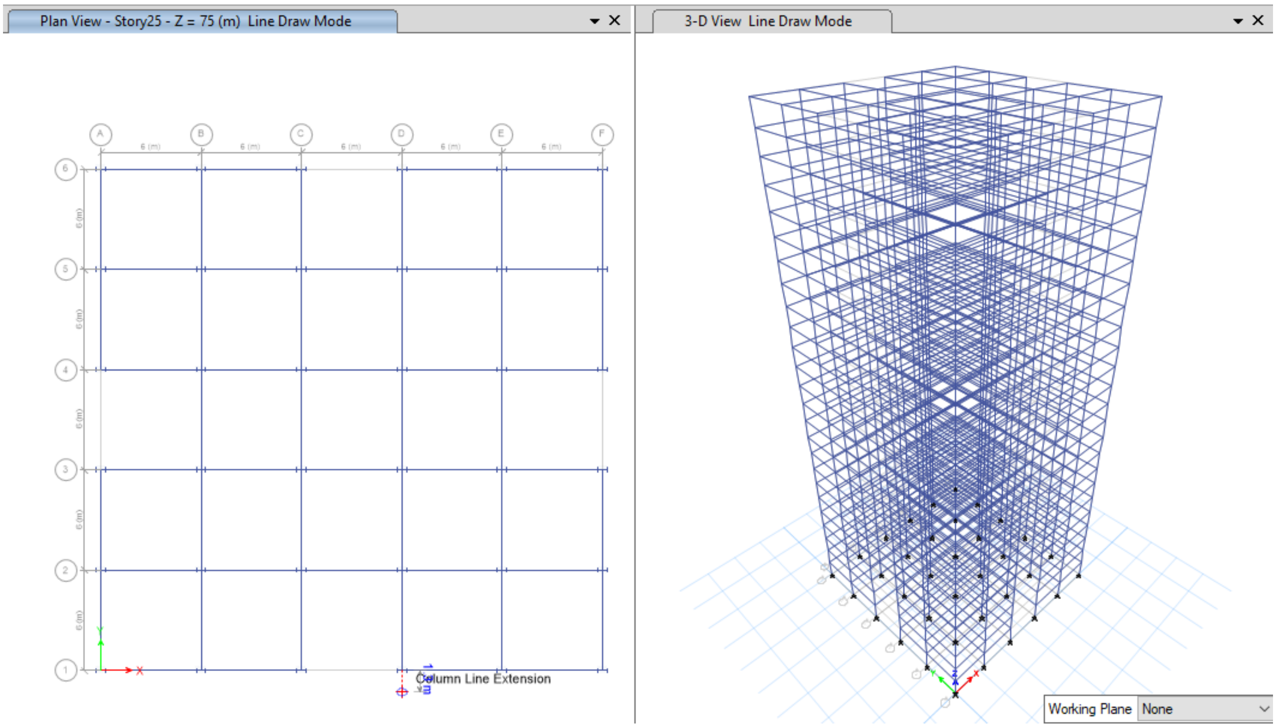
3. Methodology

(1) Literature collections
(2) Modelling of G+25 structures in ETABS
(3) Material properties
(4) Selection and assigning of frame sections
(5) Assigning the different load cases and load combinations
(6) Model checking without warnings

(7) Analysis of the structure

(8) Results and Conclusions

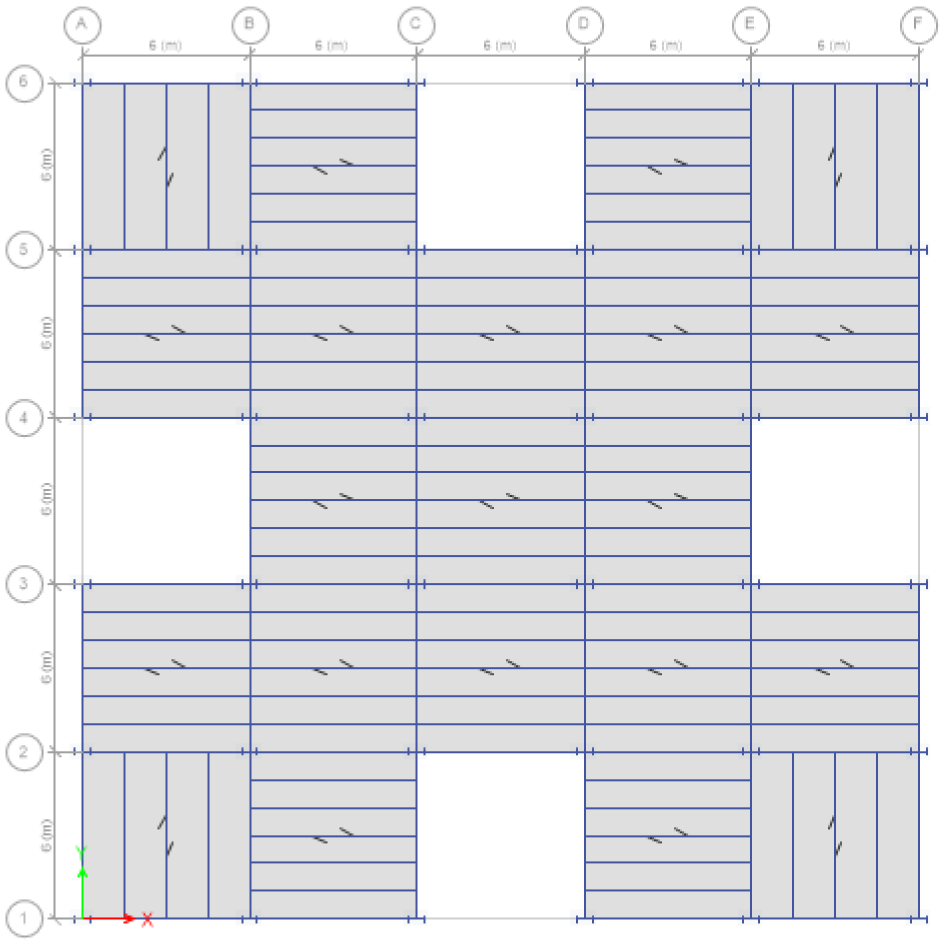
4. Modelling of G+25 Structures in ETABS



5. Material Properties

S.No.	Name of the Material	Grade	Strength
1	Structural Steel	Fe 345	Fy = 345 Mpa
2	Concrete	M30	Fck = 30 Mpa
3	Rebars	HYSD 550	Fy = 550 Mpa

6. Selection and Assigning of Frame Sections



7. Assigning the Different Load Cases and Load Combinations

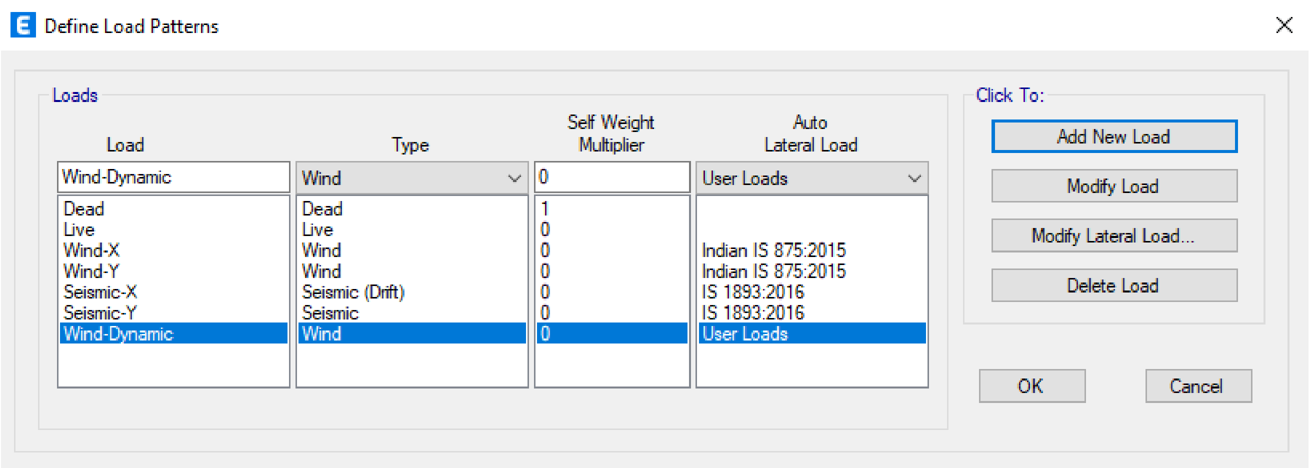
Various load cases are Dead load, Live load, Wind load and Earthquake load based on the IS code provisions given for the structures

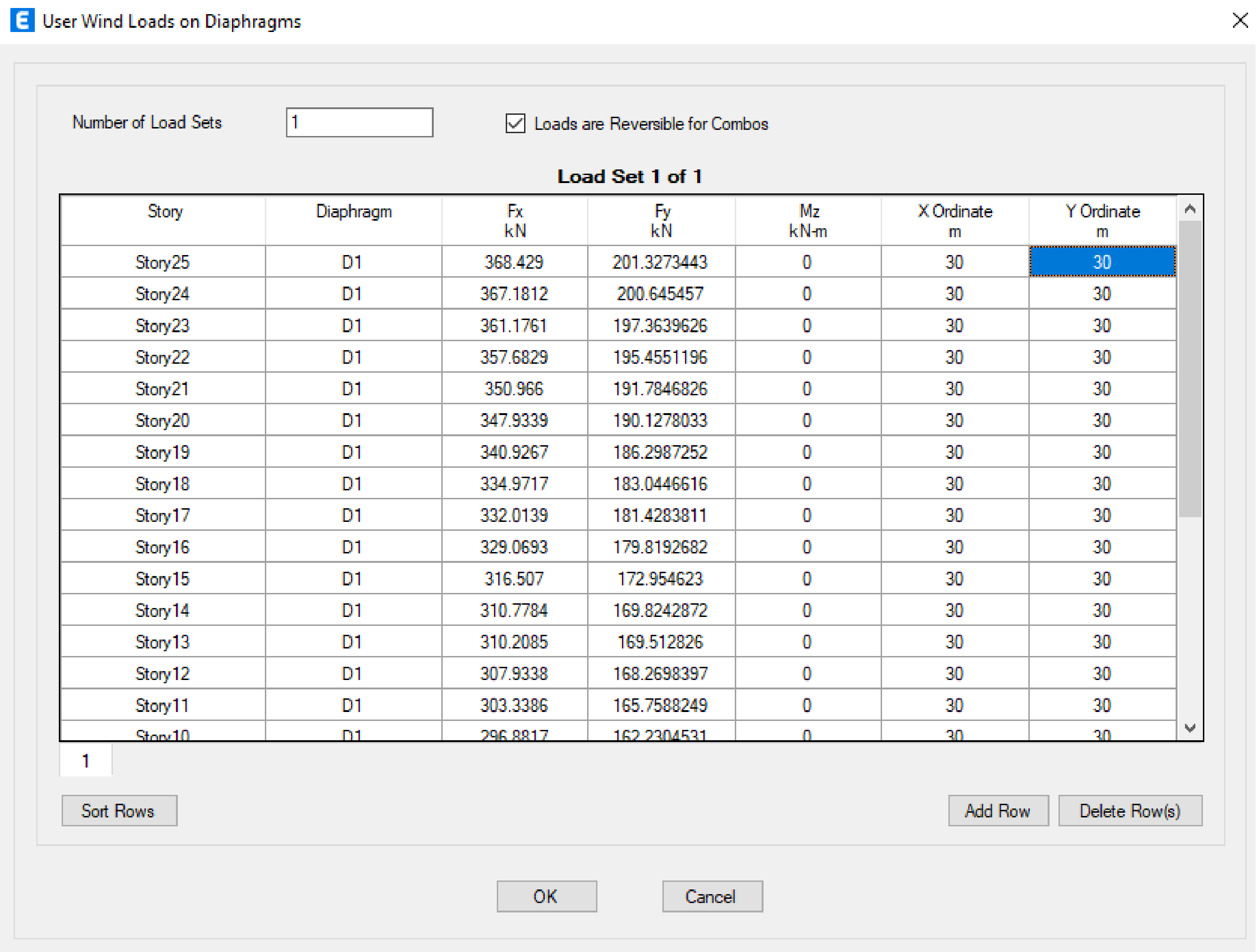
Dead load: IS 875 Part 1

Live load: IS 875 Part2

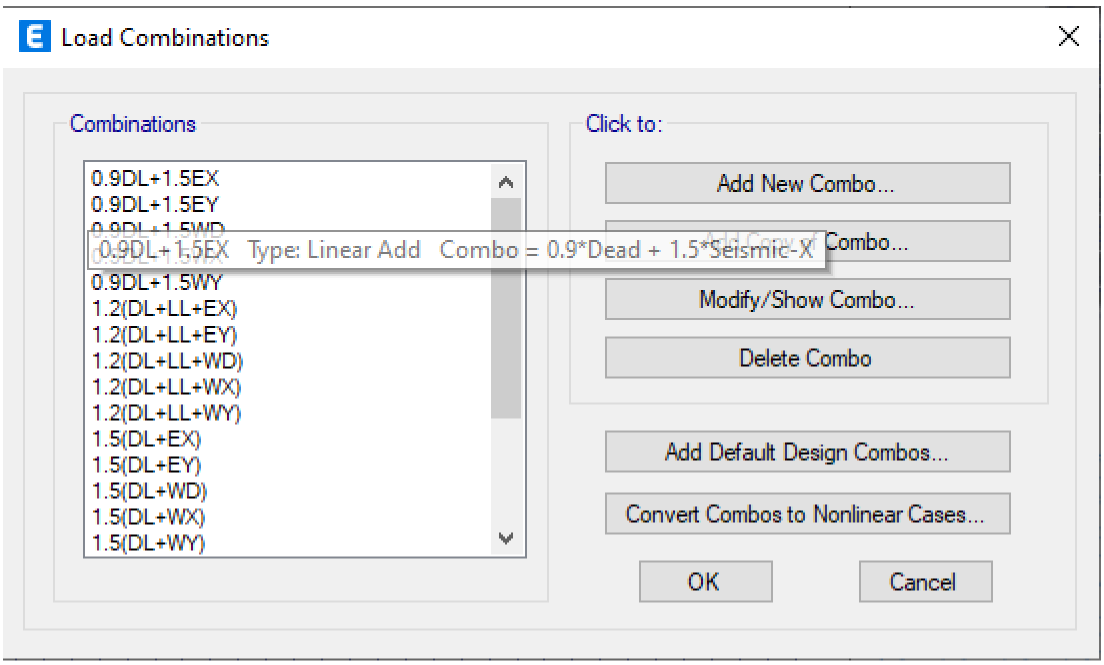
Wind load: IS 875 Part 3:2015

Earthquake load: IS 1893:2016

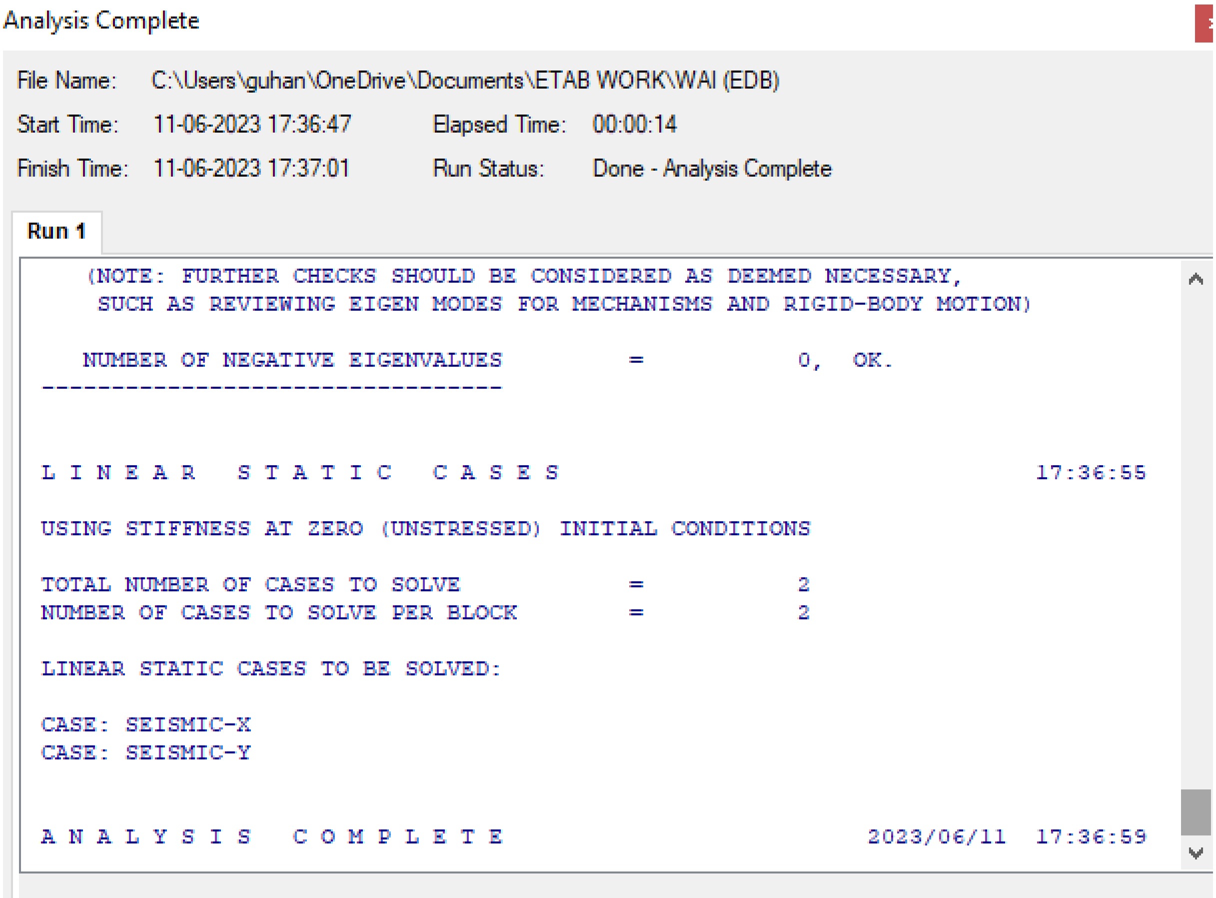




Story	Diaphragm	Fx kN	Fy kN	Mz kN-m	X Ordinate m	Y Ordinate m
Story25	D1	368.429	201.3273443	0	30	30
Story24	D1	367.1812	200.645457	0	30	30
Story23	D1	361.1761	197.3639626	0	30	30
Story22	D1	357.6829	195.4551196	0	30	30
Story21	D1	350.966	191.7846826	0	30	30
Story20	D1	347.9339	190.1278033	0	30	30
Story19	D1	340.9267	186.2987252	0	30	30
Story18	D1	334.9717	183.0446616	0	30	30
Story17	D1	332.0139	181.4283811	0	30	30
Story16	D1	329.0693	179.8192682	0	30	30
Story15	D1	316.507	172.954623	0	30	30
Story14	D1	310.7784	169.8242872	0	30	30
Story13	D1	310.2085	169.512826	0	30	30
Story12	D1	307.9338	168.2698397	0	30	30
Story11	D1	303.3386	165.7588249	0	30	30
Story10	D1	296.8817	162.2304531	0	30	30



8. Analysis of the Structure

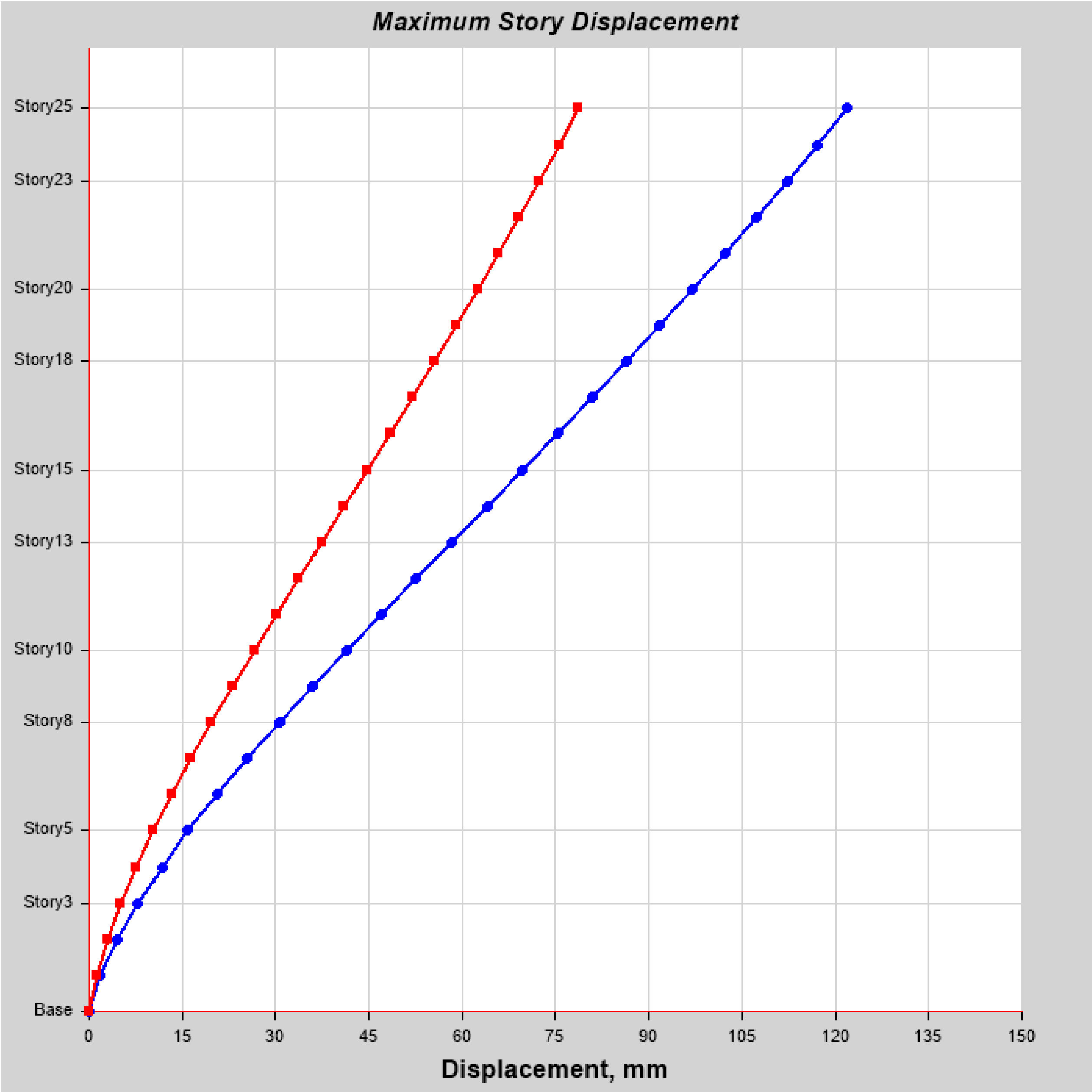


9. Results and Conclusions

Storey Displacement

Story displacement is the absolute value of displacement of the storey under action of the lateral forces.

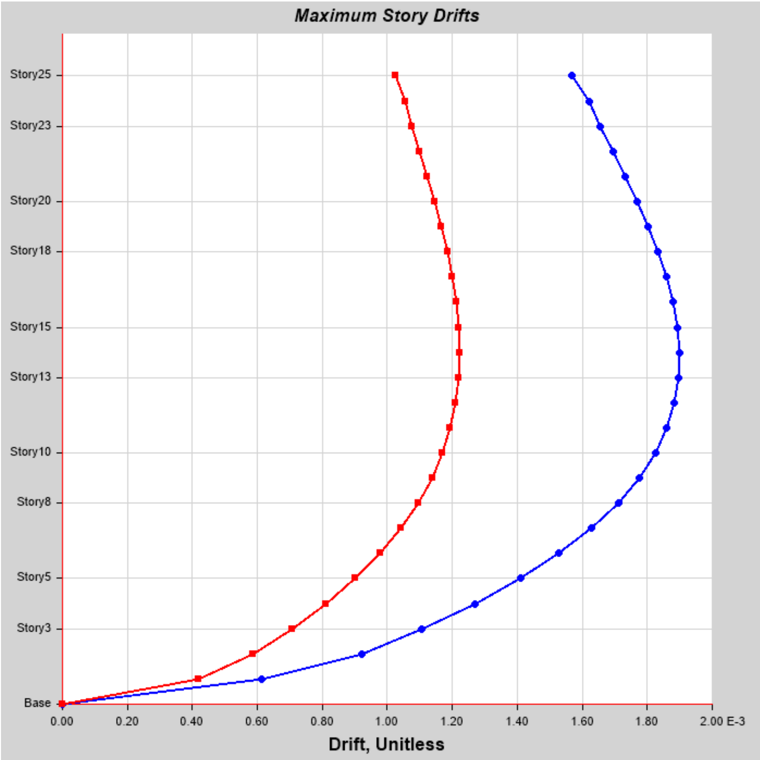
Story Response - Maximum Story Displacement (For Critical Load Combinations)



Storey Drift

Storey Drift is a measure of the relative displacement between adjacent floors or storeys.

Story Response - Maximum Story Drifts (For Critical Load Combinations)



10. Conclusion

- The results highlight the significance of appropriate lateral load distribution systems. Moreover, the study emphasizes the role of accurate modelling and analysis techniques for predicting and optimizing the storey drift.
- Overall, this research contributes to advancing the understanding and design practices of steel concrete composite structures, providing valuable information for engineers and researchers involved in the design and construction of high-rise buildings.

11. References

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