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A Comparative Study on Seismic Performance of RCC and Composite Structures in Different Seismic Zones by Response Spectrum Method

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Abstract: In the present study, seismic performance of RCC and Composite structures is investigated using ETABS software. Seismic parameters viz. storey displacement, drift ratio, stiffness, shear, overturning moment and time period for the developed RCC and composite models are obtained in both X and Y directions by response spectrum analysis as per IS 1893-Part 1 (2016) in seismic zones II to V. In both directions, maximum storey stiffness is observed in composite models as compared to RCC models. Maximum storey displacement, drift ratio and overturning storey moments are increases with increase in seismic zones for both RCC and Composite models. However, due to high stiffness, Composite models show less displacement, drift ratio, shear and overturning storey moment values as compared to RCC models for all the seismic zones in both directions.
Keywords: RCC and Composite structure, ETABS software, Response spectrum analysis, Seismic zones II-V.

I. INTRODUCTION

Earthquake is one of the most devastating of all the natural hazards and is considered to be the most powerful disaster which is unavoidable. IS 1893–Part 1 (2016) stipulates the criteria for earthquake resistant design of structures. RCC has better compressive and tensile strength when compared to other building materials. RCC can be moulded into any shape before the hardening of concrete mix. Composite structures are the structures in which composite sections are made up of different types of materials. In steel-concrete composite structures, steel section is encased in concrete for columns and the concrete slab is connected to the steel beam with the help of shear connectors to act as a single unit. For high rise constructions, RCC structures are bulkier and having more seismic weight and are less ductile in nature as compare to composite structure.

II. BUILDING DESCRIPTION

Table 1 Shows the parameters of the developed RCC and Composite Models.

Table 1 : Parameters of the developed RCC and Composite models

Sl. No.	Parameter	Remarks	
		RCC	Composite
1	Structure type	G+10	G+10
2	Total No. of stories	11	11
3	Total height of building from ground floor to terrace	34.1 m	34.1 m
4	Size of column	300 x 750 mm	300 x 750 mm
5	Size of beam	300 x 600 mm	-
6	Thickness of slab/deck slab	150 mm	150 mm

Sl. No.	Parameter	Remarks	
		RCC	Composite
7	Wall thickness	300 mm	300 mm
8	Typical storey height	3.1 m	3.1 m
9	Base storey height	1.5 m	1.5 m
10	Height of parapet wall	0.9 m	0.9 m
11	Grade of concrete	M 30	M 30
12	Grade of steel (rebar)	Fe 500	Fe 500
13	Steel section (for beam and column)	-	ISMB 600
14	Density of RCC	25 kN/m^3	25 kN/m^3
15	Density of steel	7850 kg/m^3	7850 kg/m^3
16	Live load on each floors except terrace	4 kN/m^2	4 kN/m^2
17	Live load on terrace	1.5 kN/m^2	1.5 kN/m^2
18	Floor finish on each floors except terrace	1.5 kN/m^2	1.5 kN/m^2
19	Floor finish on terrace	2.4 kN/m^2	2.4 kN/m^2
20	Soil type	Medium	Medium
21	Seismic zones	II-V	II-V
22	Importance factor (EQ)	1	1
23	Response factor value	5 (SMRF)	5 (SMRF)

Table 2 shows the identity for the developed RCC frame models.

Table 2 : Identity for the developed RCC and Composite models

Sl. No.	Model ID	Seismic Zone	Description
1	RS-II	II	RCC building
2	RS-III	III	
3	RS-IV	IV	
4	RS-V	V	
5	CS-II	II	Composite building
6	CS-III	III	
7	CS-IV	IV	
8	CS-V	V	

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Figure 1 to 4 shows the plan and elevation of the developed models.

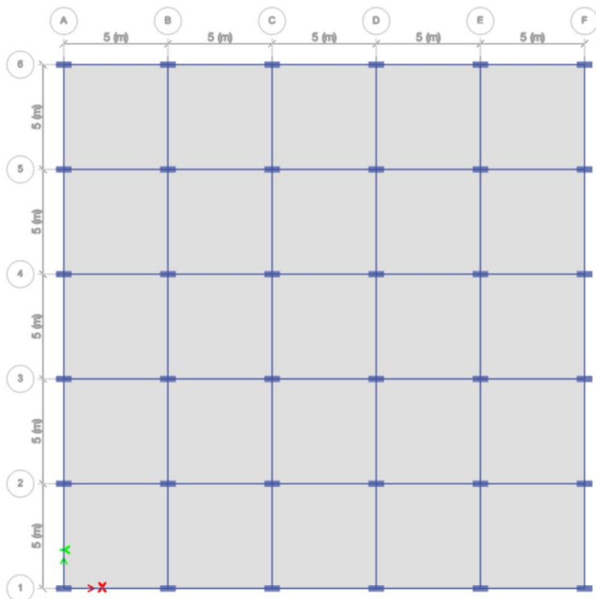

Fig. 1 Plan of RCC model

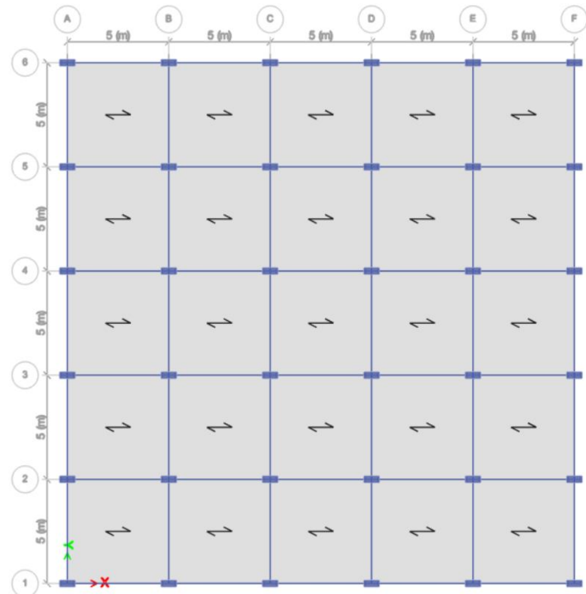

Fig. 2 Plan of Composite model

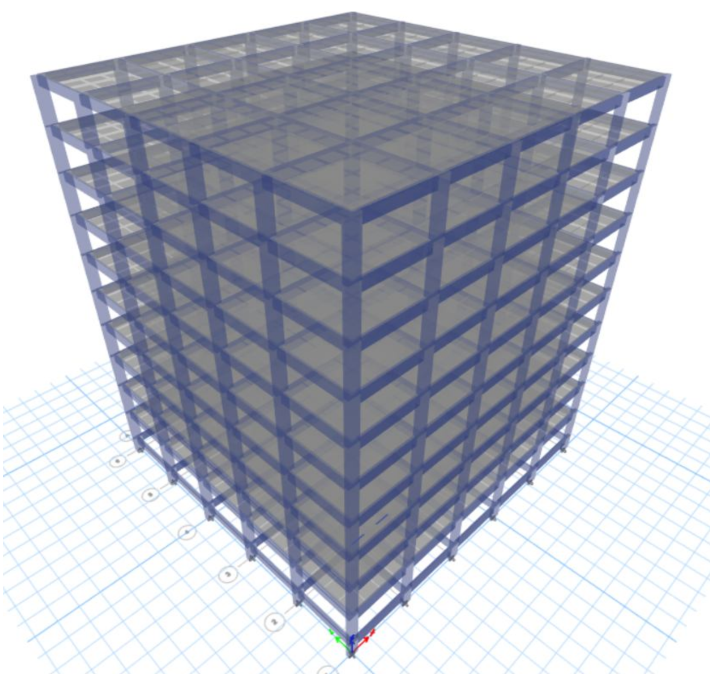

Fig. 3 Elevation of RCC model

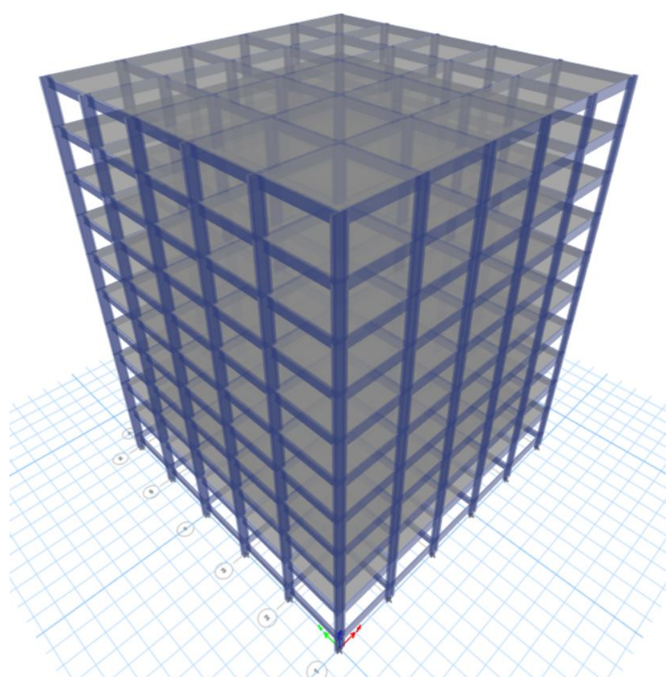

Fig. 4 Elevation of Composite model

III.SEISMIC ANALYSIS OF RCC AND COMPOSITE MODELS

Using ETABS 2018 software, the developed RCC and Composite models are subjected to response spectrum analysis as per IS 1893–Part 1 (2016). Seismic parameters viz. storey displacement, drift ratio, stiffness, shear, overturning moment and time period are obtained from the analysis for all the developed models in different seismic zones II-V.

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IV. RESULTS AND DISCUSSION

Figures 5 to 15 show the variation of storey displacement, drift ratio, stiffness, shear and overturning moment over the number of stories in both X and Y directions obtained for all the RCC models by response spectrum analysis.

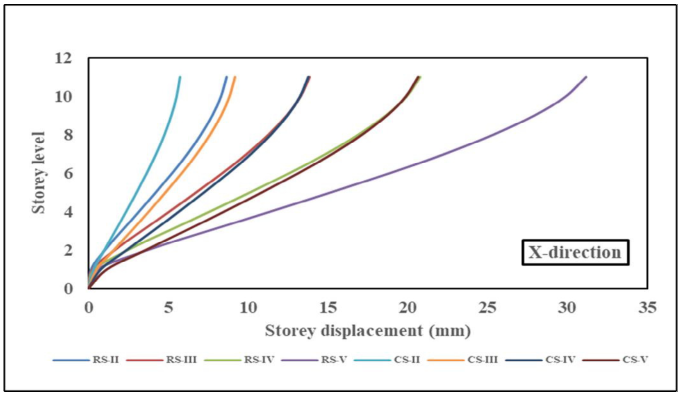

Fig. 5 Storey displacement in X–direction of all the models

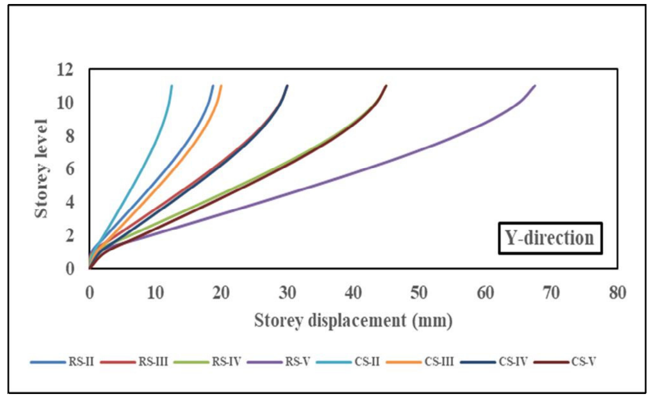

Fig. 6 Storey displacement in Y–direction of all the models

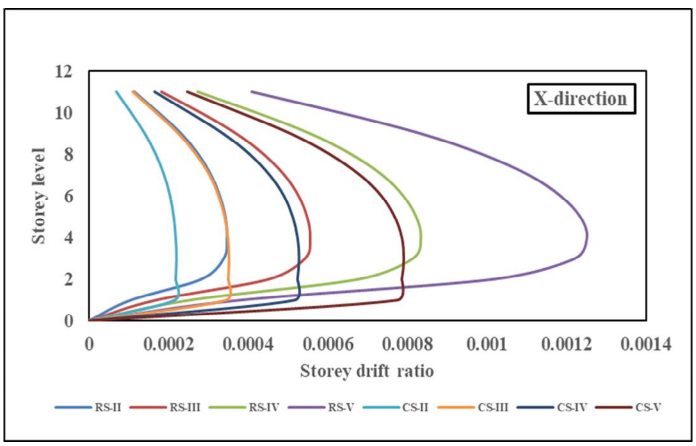

Fig. 7 Storey drift ratio in X–direction of all the models

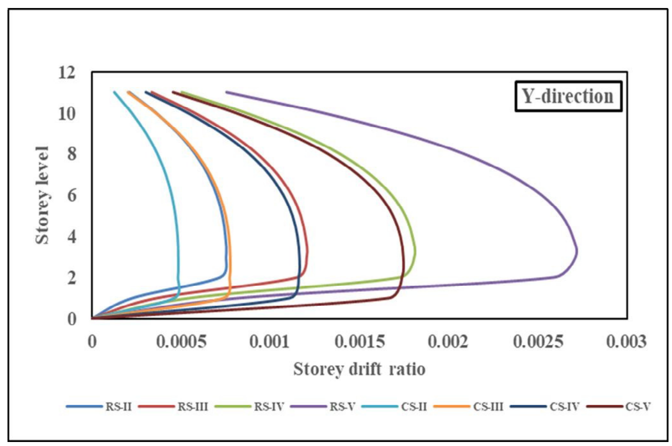

Fig. 8 Storey drift ratio in Y–direction of all the models

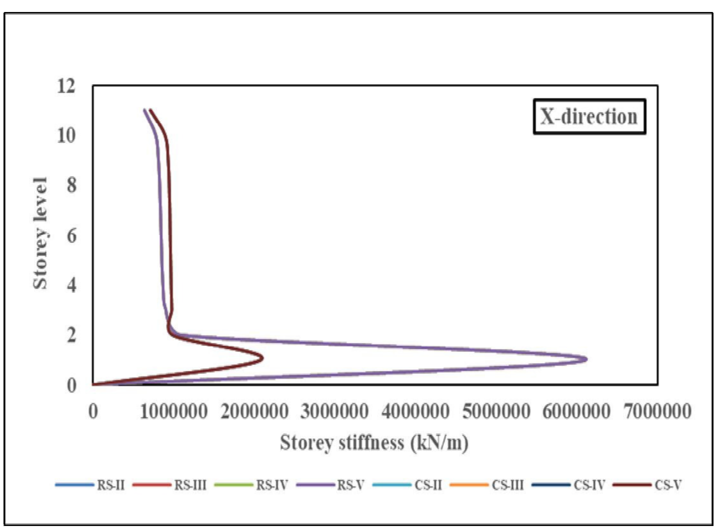

Fig. 9 Storey stiffness in X–direction of all the models

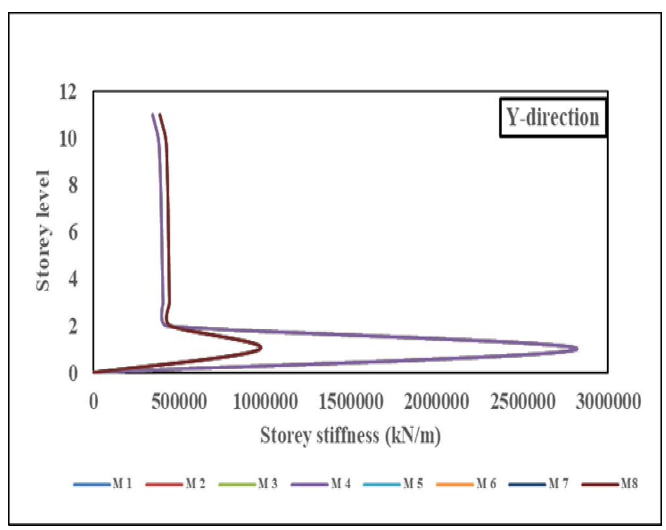

Fig. 10 Storey stiffness in Y–direction of all the models

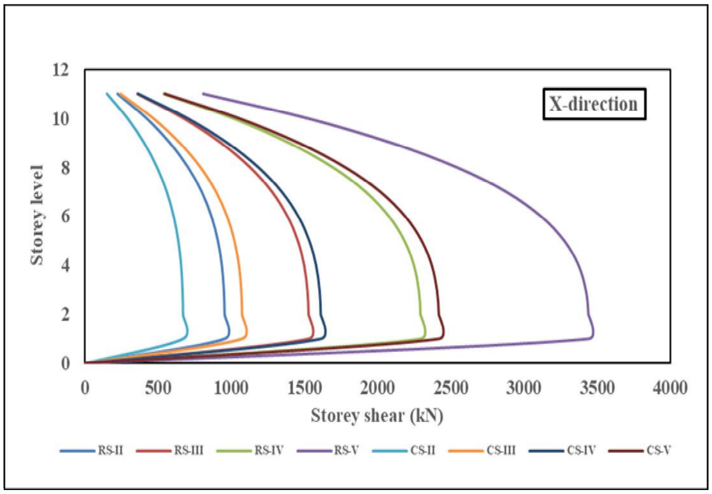

Fig. 11 Storey shear in X–direction of all the models

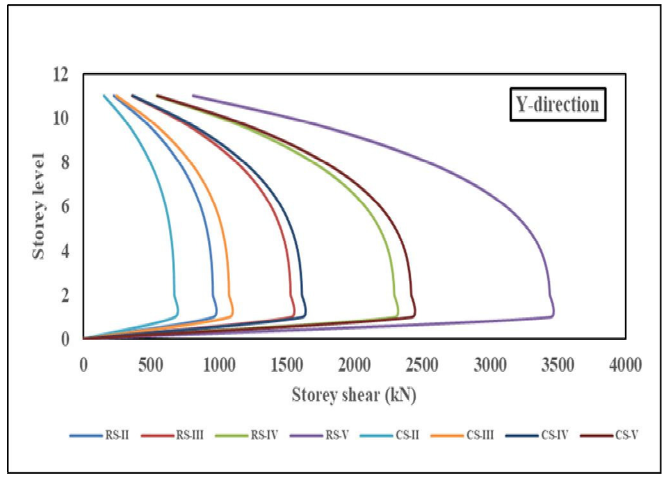

Fig. 12 Storey shear in Y–direction of all the models

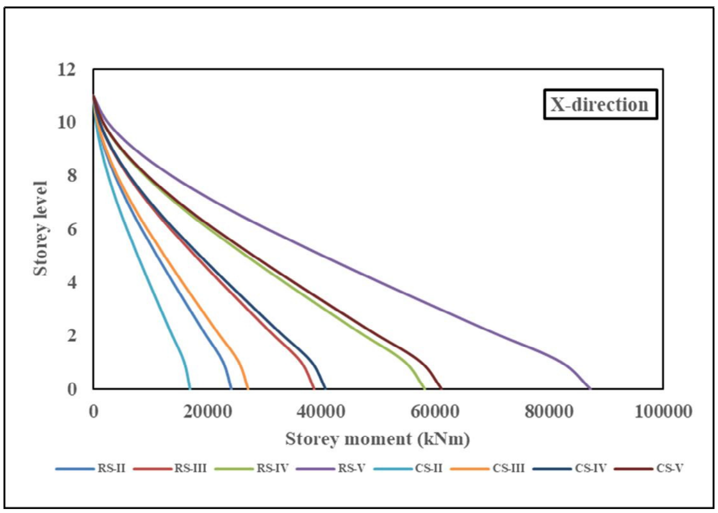

Fig. 13 Overturning storey moment in X–direction of all the models

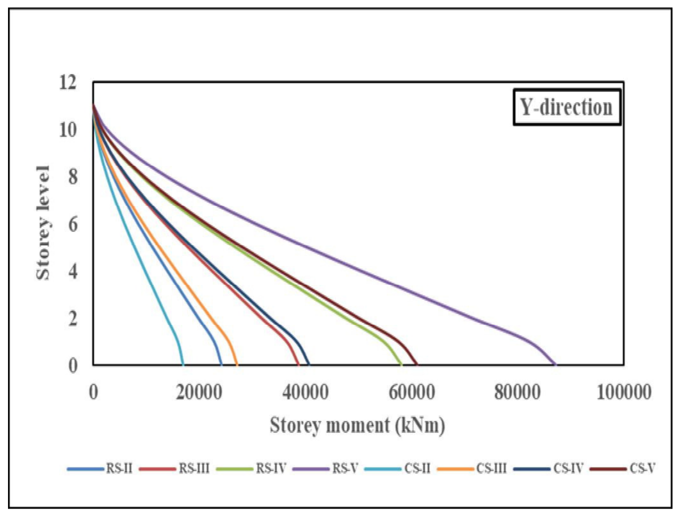

Fig. 14 Overturning storey moment in Y–direction of all the models

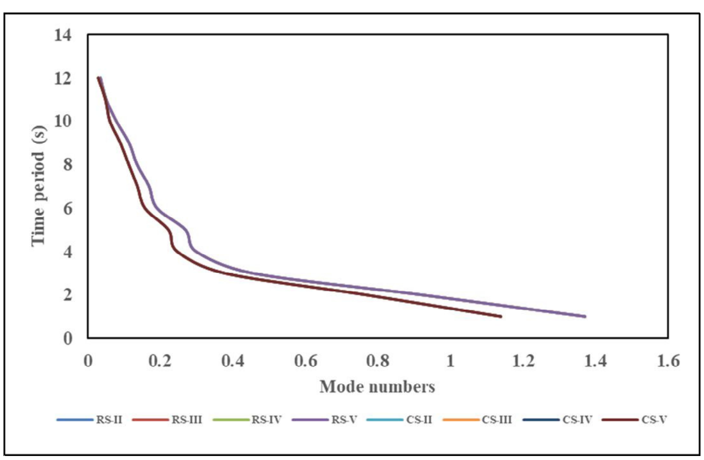

Fig. 15 Time period of all the models

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From Figs. 5 and 6 for the seismic zones II-V, it is observed that all the models exhibit similar kind of variation in storey displacement. However, Storey displacement in Y–direction is found to be more than that of X–direction.
From Figs. 7 and 8 for the seismic zones II-V, it is observed that all the models exhibit similar kind of variation in storey drift ratio. However, Storey drift ratio in Y–direction is found to be more than that of X–direction.
From Figs. 9 and 10 for the seismic zones II-V, it is observed that all the models exhibit similar kind of variation in stiffness. However, Storey stiffness in X–direction is found to be more than that of Y–direction.
From Figs. 11 and 12 for the seismic zones II-V, it is observed that all the models exhibit similar kind of variation in storey shear in both the directions.
From Figs. 13 and 14 for the seismic zones II-V, it is observed that all the models exhibit similar kind of variation in overturning storey moment in both the directions.

Figures 16 to 30 show the variation of maximum storey displacement, drift ratio, stiffness, shear, overturning storey moment and time period for all the RCC and Composite models by response spectrum analysis.

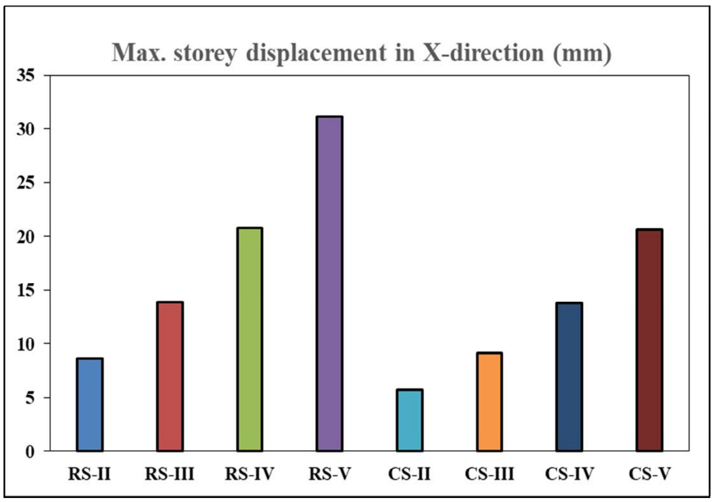

Fig. 16 Maximum storey displacement in X–direction of all the models

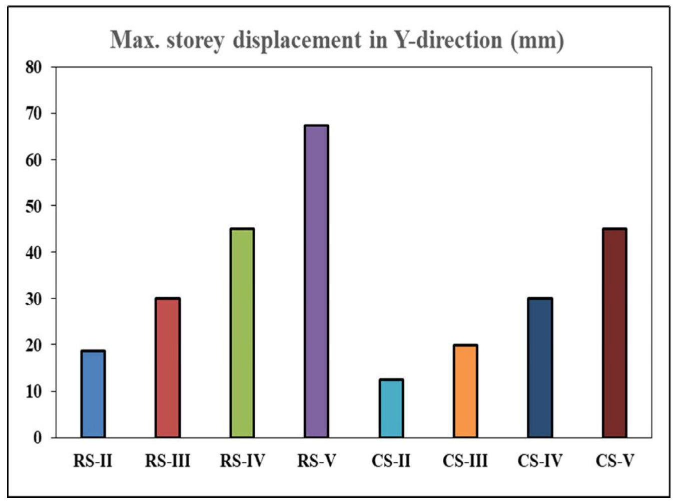

Fig. 17 Maximum storey displacement in Y–direction of all the models

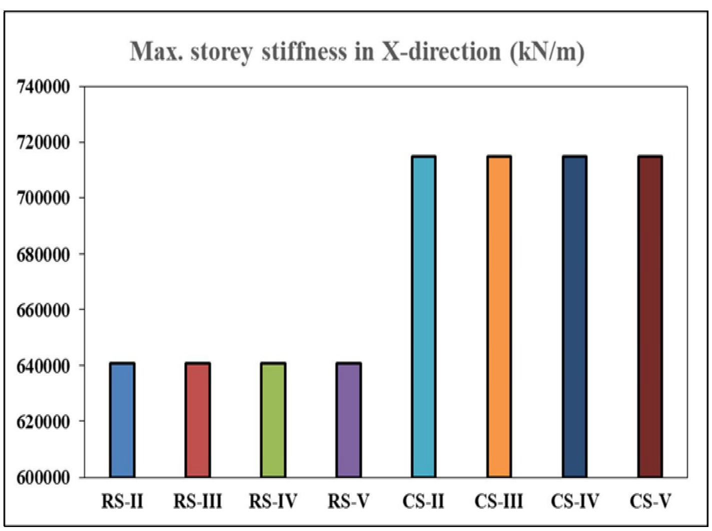

Fig. 18 Stiffness at top storey in X–direction

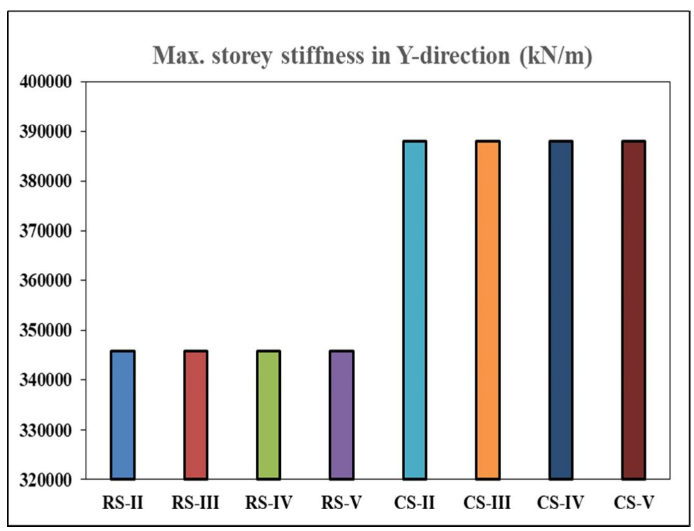

Fig. 19 Stiffness at top storey in Y–direction

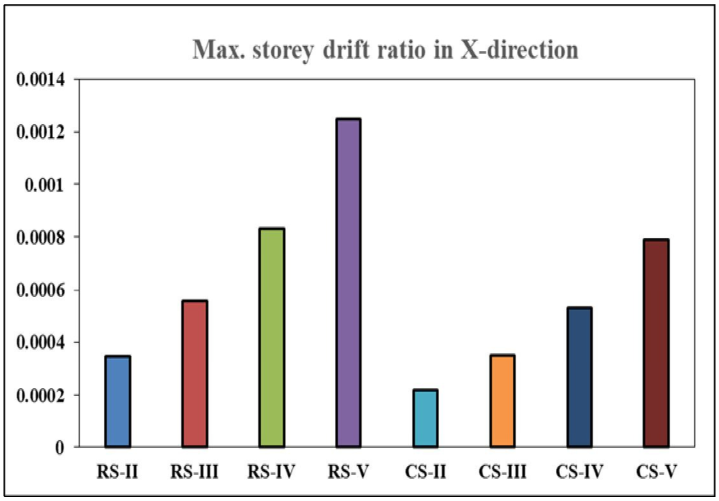

Fig. 20 Maximum storey drift ratio in X–direction of all the models

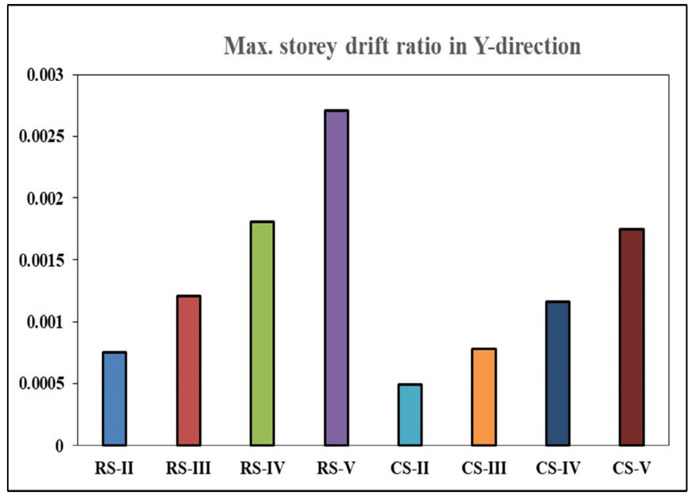

Fig. 21 Maximum storey drift ratio in Y–direction of all the models

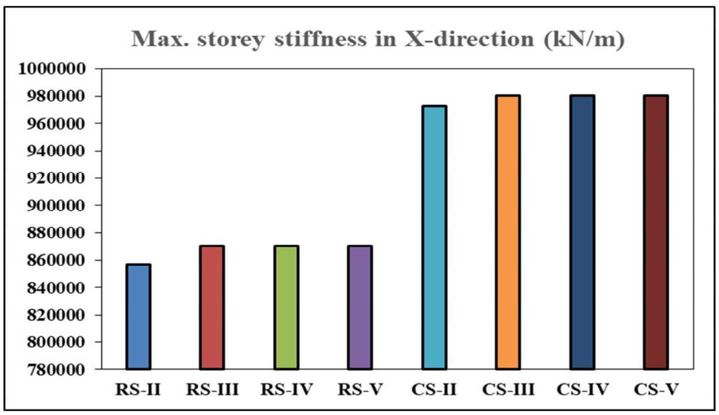

Fig. 22 Stiffness at the position on maximum drift ratio in X–direction

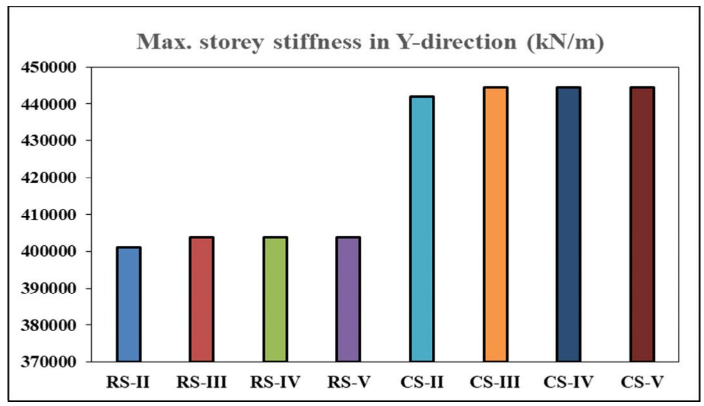

Fig. 23 Stiffness at the position on maximum drift ratio in Y–direction

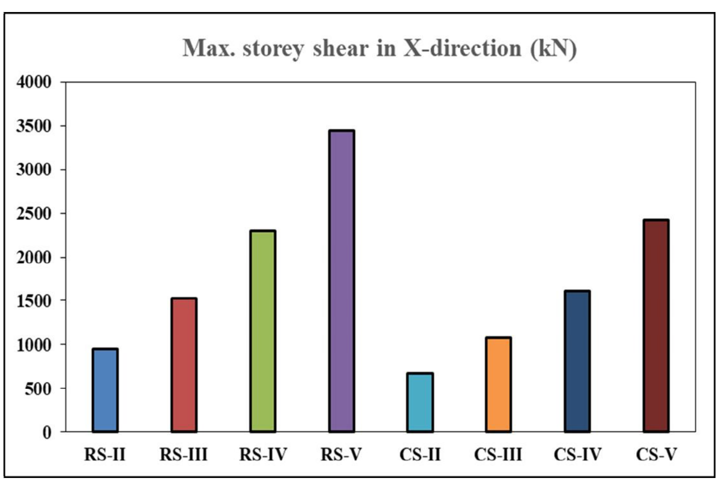

Fig. 24 Maximum storey shear in X–direction of all the models

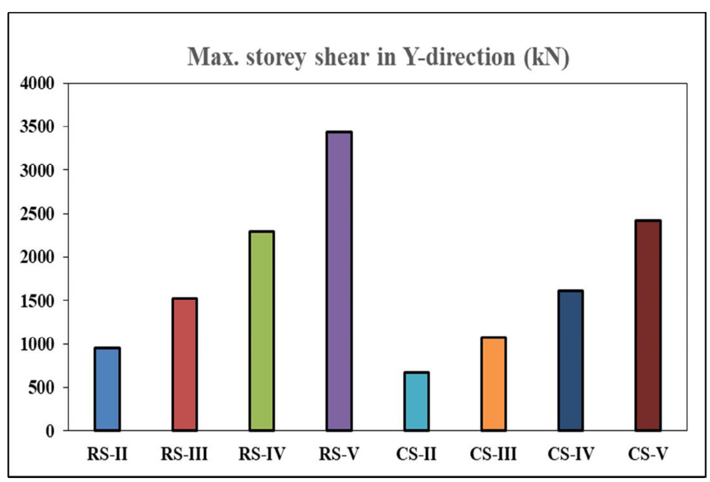

Fig. 25 Maximum storey shear in Y–direction of all the models

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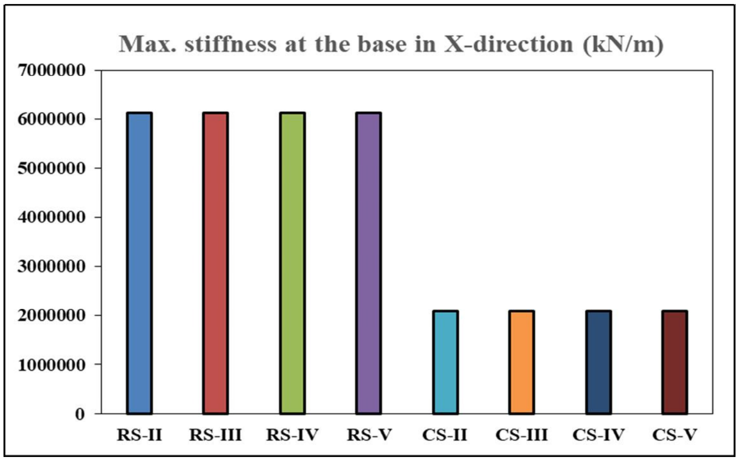


Fig. 26 Stiffness at the base in X–direction

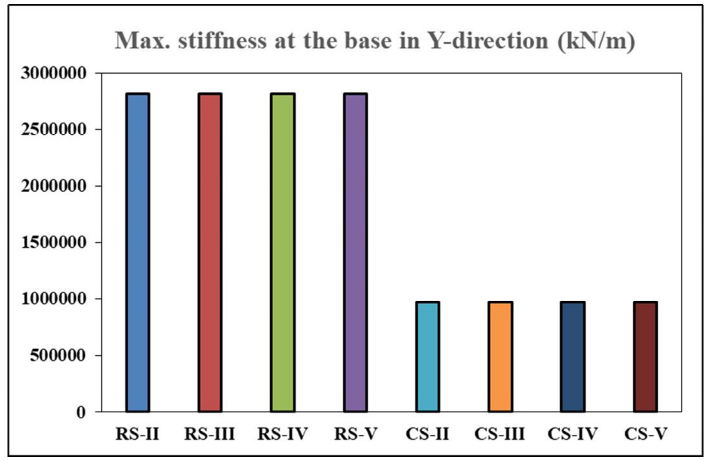


Fig. 27 Stiffness at the base in Y–direction

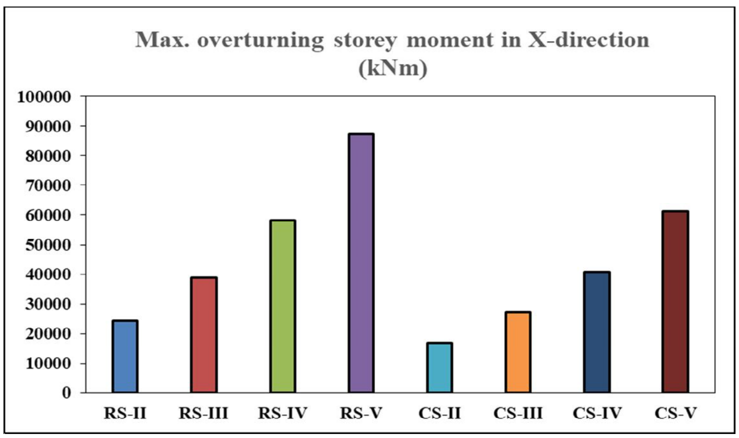


Fig. 28 Maximum overturning storey moment in X–direction of all the models

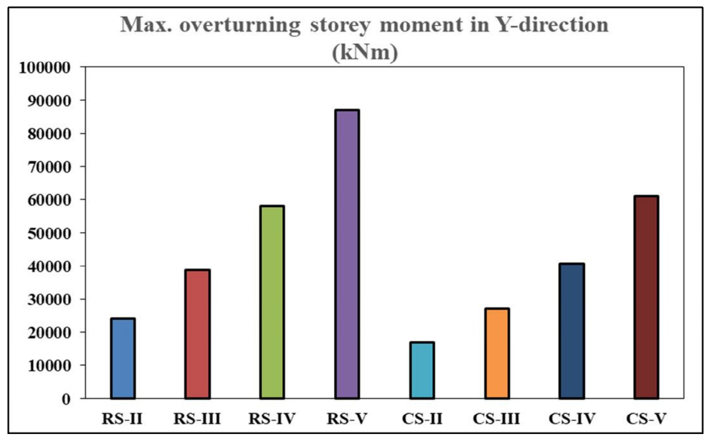


Fig. 29 Maximum overturning storey moment in Y–direction of all the models

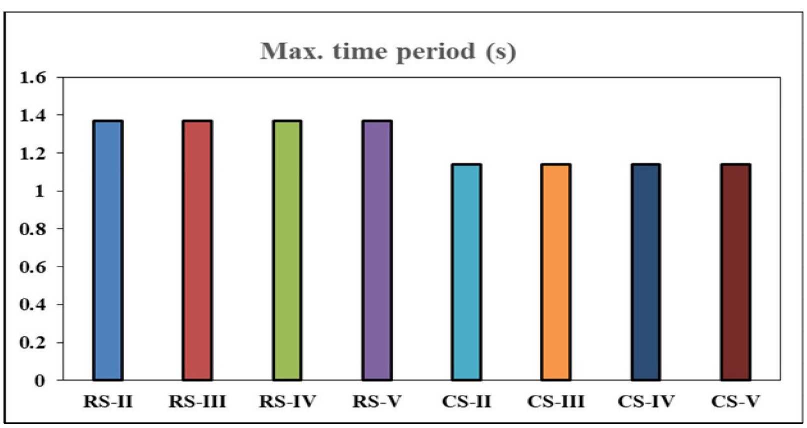


Fig. 30 Maximum time period of all the models

From Figs. 16 and 17, maximum storey displacement increases with increase in seismic zones for both RCC and Composite models. Due to high stiffness (Figs. 18 and 19), Composite models show less value of storey displacement as compared to RCC models for all the seismic zones in both directions.

From Figs. 20 and 21, maximum storey drift ratio increases with increase in seismic zones for both RCC and Composite models. Due to high stiffness (Figs. 22 and 23), Composite models show less value drift ratio as compared to RCC models for all the seismic zones in both directions. However, in all the seismic zones, maximum storey drift ratio value in all the models is within the allowable limit of 0.004 as specified in Cl. 7.11.1 of IS 1893-Part 1 (2016).
From Figs. 24 and 25, maximum storey shear increases with increase in seismic zones for both RCC and Composite models. However, due to high stiffness (Figs. 26 and 27), Composite models show less shear value as compared to RCC models for all the seismic zones in both directions.
From Figs. 28 and 29, maximum over turning storey moment increases with increase in seismic zones for both RCC and Composite models. However, due to high stiffness (Figs. 26 and 27), Composite models show less over turning moment value as compared to RCC models for all the seismic zones in both directions.
From Fig. 30, maximum time period is independent of seismic zones for both RCC and Composite models. However, due to high stiffness, Composite model shows less time period value as compared to RCC model.

V. CONCLUSIONS

In the presence study, seismic performance of RCC and Composite structures is investigated using ETABS software. Seismic parameters viz. storey displacement, drift ratio, stiffness, shear, overturning moment and time period for the developed RCC and composite models are obtained in both X and Y directions by response spectrum analysis as per IS 1893-Part 1 (2016) in seismic zones II to V.

The important conclusions drawn from the present study are as follows.

1) Similar variation of storey displacement, drift ratio, stiffness, overturning moments and time period is observed in both directions for all the models.
2) In both directions, maximum storey stiffness is observed in composite models as compared to RCC models.
3) Maximum storey displacement increases with increase in seismic zones for both RCC and Composite models. Due to high stiffness, Composite models show less value of displacement as compared to RCC models for all the seismic zones in both directions.
4) Maximum storey drift ratio increases with increase in seismic zones for both RCC and Composite models. Due to high stiffness, Composite models show less value drift ratio as compared to RCC models for all the seismic zones in both directions. However, maximum storey drift ratio value in all the models is within the allowable limit of 0.004 as specified in Cl. 7.11.1 of IS 1893-Part 1 (2016).
5) Maximum storey shear increases with increase in seismic zones for both RCC and Composite models. However, due to high stiffness, Composite models show less shear value as compared to RCC models for all the seismic zones in both directions.
6) Maximum over turning moment increases with increase in seismic zones for both RCC and Composite models. However, due to high stiffness, Composite models show less over turning moment value as compared to RCC models for all the seismic zones in both directions.
7) Maximum time period is independent of seismic zones for both RCC and Composite models. However, due to high stiffness, Composite model shows less time period value as compared to RCC model.

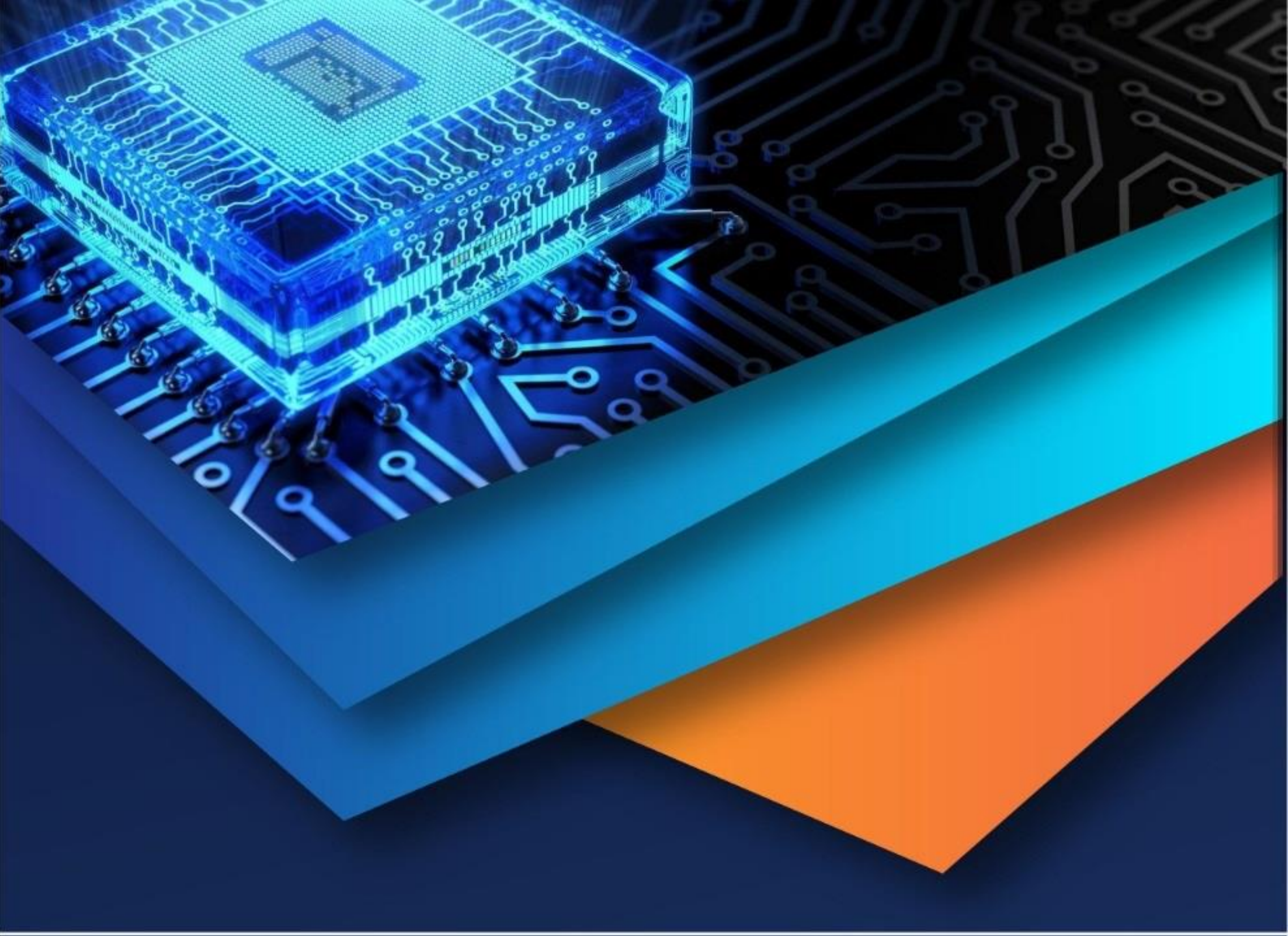
A. Concluding Remarks

For the considered plan, number of stories and dimensions of structural components, both RCC and composite models safely resist the earthquake with respect to storey drift ratio in all the seismic zones as the maximum value is within the permissible limits as specified by IS 1893-Part 1 (2016). Due to high stiffness, composite models show lesser value of storey displacement, drift ratio, shear and over turning moment as compared to RCC models. Hence, steel and concrete composite framed structures are preferred in high seismic zones and are best suited for high rise structures as they show high structural performance in resisting displacement, drift, shear and over turning moment.

REFERENCES

[1] Krunal Suthar P and Arjun Butala M (2020), "Comparative Study on Seismic Analysis of (G+10) RCC, Steel And Steel-Concrete Composite Building", International Research Journal of Engineering and Technology, Vol. 7, Issue 5, pp. 662-666.
[2] Panchal D R and Marathe P M (2011), "Comparative Study of R.C.C, Steel and Composite (G+30 Storey) Building", International conference on current trends in technology, pp. 1-6.

[3] Pavankumar Raikar and Mogali M B (2016), "Comparative Study of Seismic Analysis of RCC and Composite Building with Asymmetry in Plan", Bonfring International Journal of Man Machine Interface, Vol. 4, Issue 7, pp. 182-186.
[4] Siddhant Shirsath D and Rathi V R (2022), "Analysis and Design of Steel Concrete Composite Structure and Its Comparison with RCC Structure", International Journal for Research in Applied Science and Engineering Technology, Vol. 10, Issue 6, pp. 767-774.
[5] Syed Fahad Ali and Bhalchandra S A (2015), "Study on Seismic Analysis of RCC and Steel-Concrete Composite Structure and Cost Comparison with Different Support Conditions", International Journal for Scientific Research & Development, Vol. 3, Issue 9, pp. 354-359.
[6] Vedha M and Umar Farooq Pasha (2019), "Study of Seismic and Wind Effects on Multi-Storey RCC, Steel and Composite Materials Buildings Using ETABS", International Journal of Engineering Technology, Vol. 7, Issue 9, pp. 1-6.
[7] IS 456 (2000), "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standard, New Delhi, India.
[8] IS 875-Part 1 (1987), "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures. Part 1 Dead Loads-Unit Weights of Building Materials and Stored Materials", Bureau of Indian Standard, New Delhi, India.
[9] IS 875-Part 2 (1987), "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures. Part 2 Imposed Loads", Bureau of Indian Standard, New Delhi, India.
[10] IS 1893-Part 1 (2016) "Criteria for Earthquake Resistant Design of Structures part 1 General Provision and Building", Bureau of Indian Standard, New Delhi, India.
[11] IS 11384 (2022), "Composite Construction in Structural Steel and Concrete", Bureau of Indian Standard, New Delhi, India.



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