Comparative Study on Lateral Load Analysis of RCC and Composite Building with Bracing, Damper and Shear Wall

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Abstract - **The present study focuses on the performance of RCC and Composite building in terms of structure with single diagonal forward encased-bracing, damper ,shear wall systems. The effectiveness of bracing, damper ,shear wall system on the RCC and Composite building has also been investigated. For this study, a G+20 storied RCC and Composite buildings are analyzed under lateral loading using ETABS 2017 software. The performance of the RCC and Composite building in terms of structure has been investigated using single diagonal forward encased-bracing, damper ,shear wall system. A comparative study is carried out on Time period, Story displacement, Base shear and Story drift at various location with single diagonal forward encased-bracing, damper ,shear wall for RCC and Composite buildings. Seismic analysis using linear static (Equivalent static method) and linear dynamic (Response spectrum method) methods has been performed.**

The time period for different models is obtained by IS code and ETABS analysis results were compared. Further, the Story displacement, Base shear and Story drift are determined by Equivalent static method and Response spectrum method for various models for RCC and Composite buildings. Among all models with different location along X and Y direction shows the most efficient performance against the seismic loading.

Index Terms - **Single diagonal encased forward – bracings, damper, shear wall, composite structures, storey displacement, storey drift, base shear, time period.**

I.INTRODUCTION

A building should have four main attributes, which are basically simple and regular layout, background strength, hardness and softness. As well as the layout of buildings, buildings with regular geometry in height have suffered far less damage than irregular layouts. A building will be considered unorganized according to 1893-2002, if it is inconsistent and there is a discrepancy between geometry, mass or load-bearing elements. These irregularities can cause problems with the flow of power and the continuity of tension. Structural analysis is primarily concerned with finding out the behavior of a structure when it is targeted. Dynamic loads include wind, waves, traffic, earthquakes and explosions. Any structure can be subjected to dynamic loading, the balance of poor performance structure of buildings under severe seismic loading can be a major cause, disproportionate lateral growth, increase in member forces and ultimately plays a significant role in building collapse. The project deals with seismic analysis and the study of multi-storey balance building design. The G + 20-storey reinforced concrete symmetrical frame building has been structurally analyzed with the help of Etabs software. This building is considered as a multistory building. In the present study, Response Spectrum Analysis (RSA) of regular and irregular RC building frames compares results and Time History Analysis (THA) and compares it with regular building response spectrum analysis and on its stability. Perform oriented design.

II. OBJECTIVES OF STUDY

1. To study the seismic behavior of the multistory building and Maximum Storey Displacement, Base Shear and Storey Drift.
2. To study the effect of providing single diagonal encased forward -bracings in RC framed building and Composite building.
3. To study the effect of providing damper in RC framed building and Composite building.

4. To study the effect of providing shear wall in RC framed building and Composite building.
5. Comparison of seismic behavior of RCC and Composite building

III. METHODOLOGY

This is an attempt to investigate the effect of erratic planning for a multi-dimensional reinforced concrete building and composite building model. The project mainly focuses on the analysis of a multi-storey building (G + 20) which is a 20-story R.C.C regular in both planning and elevation modeling. RCC and composite building will be done on ETABS software for analysis. Post structure analysis such as maximum story displacement, base share, story drift, maximum base and then compare all cases analyzed.

Here in this study we have considered eight models for the study.

1. RCC building (i,e bare frame)
2. RCC building + Bracing in X direction and Y direction
3. RCC building + Damper in X direction and Y direction
4. RCC building + Shear wall in X direction and Y direction
5. Composite building (i,e bare frame)
6. Composite building + Bracing in X direction and Y direction
7. Composite building + Damper in X direction and Y direction
8. Composite building + Shear wall in X direction and Y direction

IV. ANALYTICAL MODELING

4.1 BUILDING DETAILS

TYPE OF BUILDING	RCC BUILDING	COMPOSITE BUILDING
Type of frame	Moment resisting frame	Moment resisting frame
Number of stories and height of building	22 stories 69.2m	22 stories 69.2m
Thickness of wall	230mm	230mm
Live load	3 KN/m2	3 KN/m2
Grade of concrete	M30	M30
Grade of reinforced Steel	Fe550, Fe415	Fe550, Fe415
Density of brick masonry	18 KN/m3	18 KN/m3
Size of columns	C1-600X800mm C2-400X650mm C3-400X500mm	C1-400x800mm Encased With– ISWB600-1 C2-400x600mm Encased With - ISHB-450-1 C3-400x550mm Encased With - ISHB-400-1
Size of beams	B1-300X600mm	B1-ISWB600-1 B2-ISMB250
Thickness of slab	150mm	150mm
Zone	V	V
Soil type	II	II
Importance factor	1	1
Response reduction	5	5
Seismic zone factor	0.36 for zone V	0.36 for zone V
Damping ratio	5%	5%

4.2 DESCRIPRION OF THE MODELS

Model number	Description
1	RCC building (i,e bare frame)
2	RCC building + Bracing in X direction and Y direction
3	RCC building + Damper in X direction and Y direction
4	RCC building + Shear wall in X direction and Y direction
5	Composite building (i,e bare frame)
6	Composite building + Bracing in X direction and Y direction
7	Composite building + Damper in X direction and Y direction
8	Composite building + Shear wall in X direction and Y direction

4.3 PLAN OF THE MULTISTOREY BUILDING

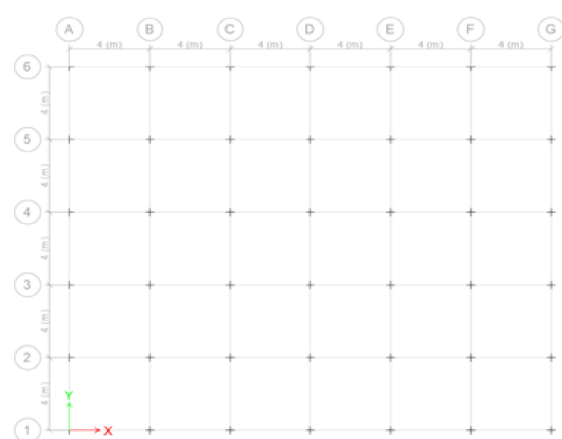

Fig 1: Plan of the building

4.4 Modelling Different Model in Etabs Software

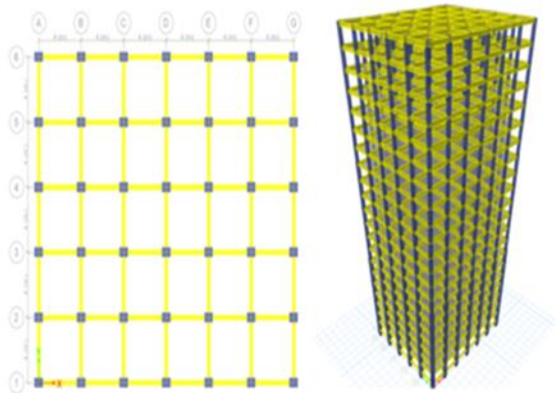

Fig 2: conventional RCC building

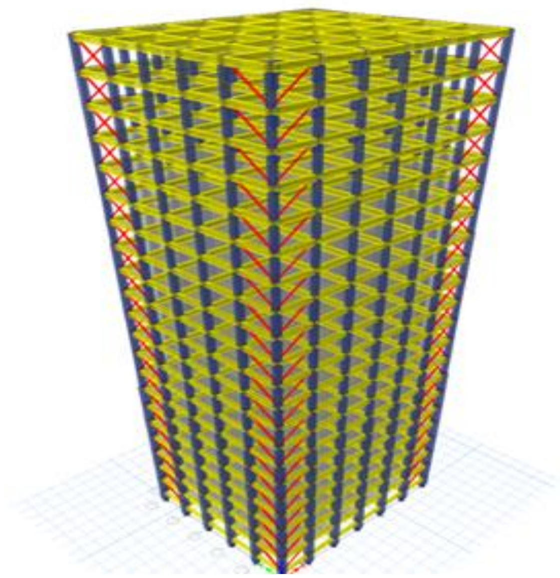

Fig 3: RCC building + Bracing along X & Y direction

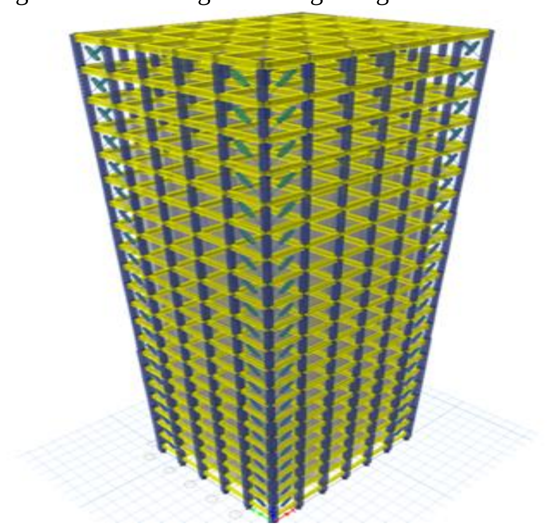

Fig 4: RCC building + Damper along X & Y direction

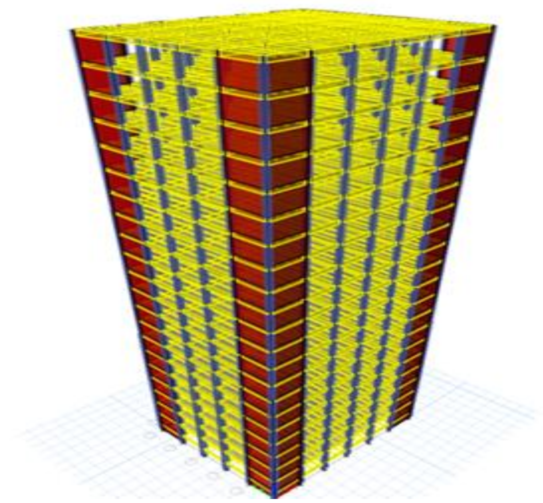

Fig 5: RCC building + Shear wall along X & Y direction

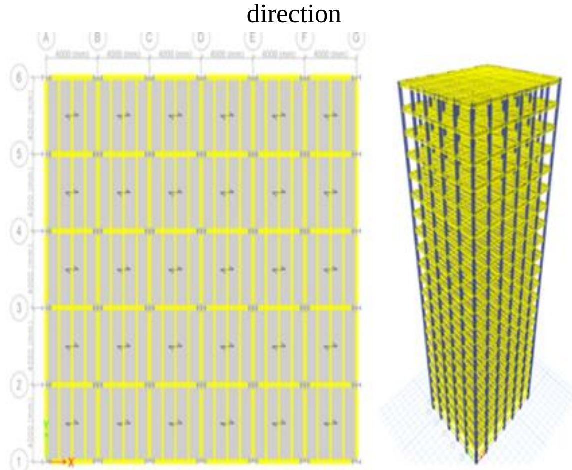

Fig 6: composite building

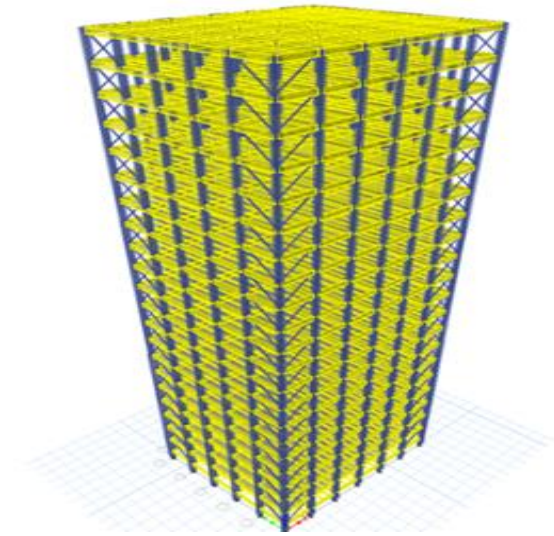

Fig 7: Composite building + Bracing along X & Y direction

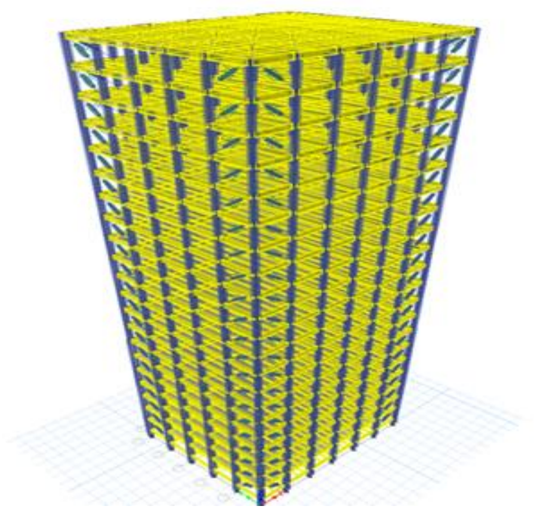

Fig 8: Composite building + Damper along X & Y direction

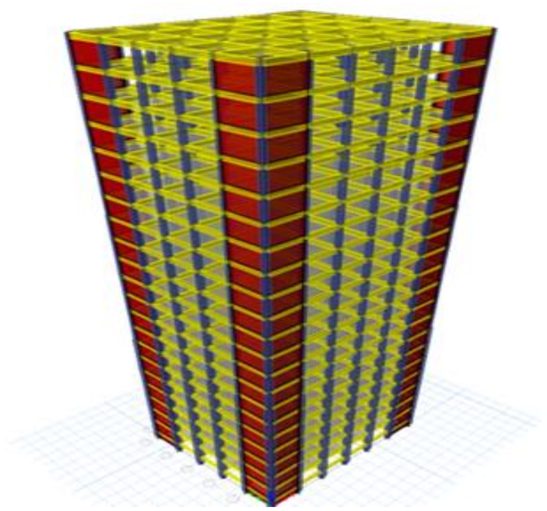

Fig 9: Composite building + Shear wall along X & Y direction

V. RESULTS AND DISCUSSION

5.1 FUNDAMENTAL TIME PERIOD

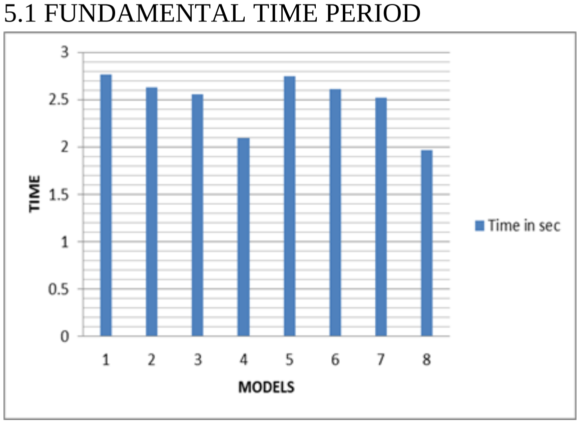

Chart 1 : Fundamental Time Period of Various Rcc and Composite Models

From the chart it is observed that time period is maximum for bare frame model (Model 1) compared to other models. When bracing, damper, shear wall was added individually time period decreases for other three models. The percentage decrease in time period for model 8 is 85.38% when compared to model 5.

The Fundamental Time Period is highest for the bare frame model (Model 1) less for the model 8 i.e, composite model with bracing, damper , shear wall individually along X and Y direction respectively.

The Fundamental Time Period is found to be decrease when the influence of bracing, damper , shear wall is considered individually.

5.2 MAXIMUM STOREY DISPLACEMENT

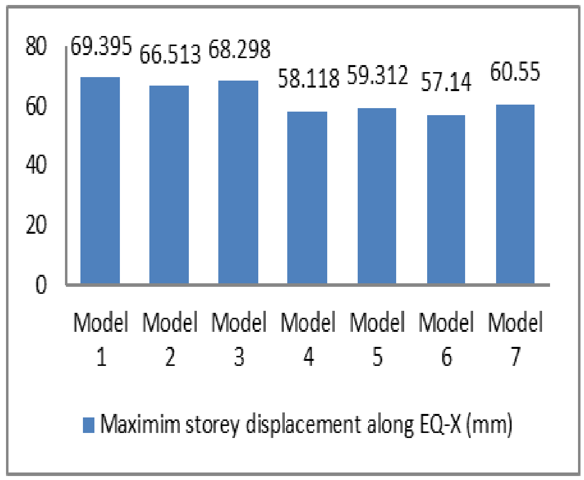

Chart 2: Storey displacement for ESA for along EQ-X (mm)

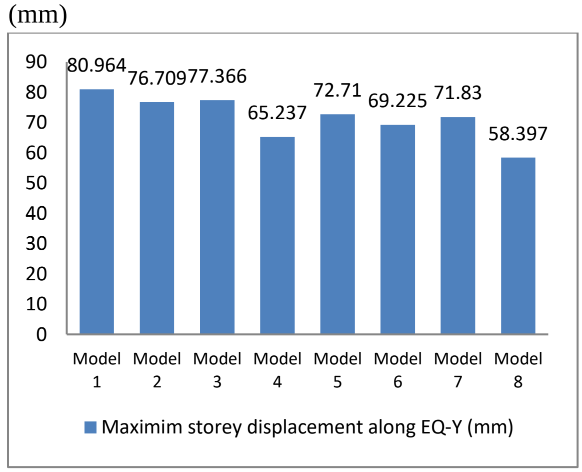

Chart 3: Storey displacement for ESA for along EQ-Y (mm)

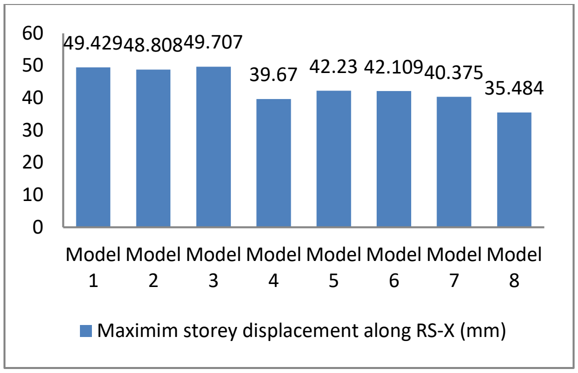

Chart 4: Storey displacement for RSA for along RS-X (mm)

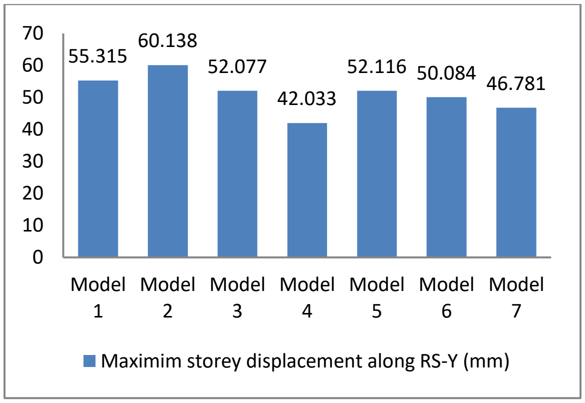

Chart 5: Storey displacement for RSA for along RS-Y (mm)

The Story Displacement Results are Summarised as Follows.

	Equivalent Static Analysis(mm)		Response Spectrum Analysis(mm)	
Model No.	EQX	EQY	RSX	RSY
1	69.395	80.964	49.429	55.315
2	66.513	76.709	48.808	60.138
3	68.298	77.366	49.707	52.077
4	58.118	65.237	39.67	42.033
5	59.312	72.71	42.23	52.116
6	57.14	69.225	42.109	50.084
7	60.55	71.83	40.375	46.781
8	49.75	58.397	35.484	39.056

Table 2: Story displacement of various RCC & Composite models

From the chart it is observed that, the maximum storey displacement is more for model 1 and less for model 8. The permissible Maximum displacement as per IS code is given by L/500-69200/500-138.4mm where L is total height of the building. The Storey displacement is maximum for model 1 i.e., RCC bare frame model along X and Y direction compared to Composite Bare frame model along X and Y direction (model 5).

1) The Storey displacement is maximum for model 1(RCC). And is reduced for model 2 with 4.15% and 5.25% along X and Y direction for ESA. Whereas the displacement is maximum for model 5 (COMPOSIT) is reduced for model 6 with 3.66% and 4.79% along X and Y direction for ESA. The Storey displacement is maximum for model 14(RCC). And is reduced for model 2 with 1.25% and 8.01% along X and Y direction for RSA. Whereas the displacement is maximum for model 5 (COMPOSIT) is reduced for model 6 with 0.28% and 3.89% along X and Y direction for RSA

2) The Storey displacement is maximum for model 1(RCC). And is reduced for model 3 with 1.58% and 4.44% along X and Y direction for ESA. Whereas the displacement is maximum for model 5 (COMPOSIT) is reduced for model 7 with 2.04% and 1.21% along X and Y direction for ESA. The Storey displacement is maximum for model 14(RCC). And is reduced for model 3 with 0.55% and 5.85% along X and Y direction for RSA. Whereas the displacement is maximum for model 5 (COMPOSIT) is reduced for model 7 with 4.39% and 10.23% along X and Y direction for RSA

3) The Storey displacement is maximum for model 1(RCC). And is reduced for model 4 with 16.25% and 19.42% along X and Y direction for ESA. Whereas the displacement is maximum for model 5 (COMPOSIT) is reduced for model 8 with 16.12% and 19.68% along X and Y direction for ESA. The Storey displacement is maximum for model 14(RCC). And is reduced for model 4 with 19.71% and 24.01% along X and Y direction for RSA. Whereas the displacement is maximum for model 5 (COMPOSIT) is reduced for model 8 with 15.97% and 25.05% along X and Y direction for RSA

5.3 BASE SHEAR

	ESA		RSA	
Model No.	EQX	EQY	RSX	RSY
1	3517.507	3074.542	3585.5236	3132.3615
2	3650.117	3235.875	3720.6866	3720.3196
3	4566.228	4126.281	4654.2677	4203.6726
4	4513.171	4135.769	4600.5569	4214.3547
5	3422.493	2712.199	3488.4355	2764.5955
6	3530.648	2858.486	3598.9547	2911.4413

7	4497.151	3769.782	4582.0186	3842.8874
8	4443.287	3864.575	4529.0247	3939.144

Table 3: Base shear of various RCC & Composite models

The Base shear is maximum for model 3 i.e., RCC bare model + damper in X and Y directions when compared to all other models. It is observed that the Composite bare frame model with single diagonal-Bracings along X and Y direction (model 5) has minimum base shear value compared to model 3 in Equivalent static analysis (ESA) in X and Y directions, The percentage decrease in Base shear for model 5 in X and Y directions is 25.04% for ESA when compared to model 3.

5.4 MAXIMUM STORY DRIFT

	ESA		RSA	
Model No.	EQX	EQY	RSX	RSY
1	0.001306	0.00169	0.00098	0.00125
2	0.001221	0.00153	0.00095	0.00129
3	0.001289	0.00151	0.00094	0.00102
4	0.001059	0.00122	0.00073	0.0008
5	0.001085	0.00133	0.00088	0.0013
6	0.001028	0.00123	0.00094	0.00153
7	0.001103	0.00126	0.00113	0.0024
8	0.000916	0.00107	0.00066	0.00072

Table 4: Story drift of various RCC & Composite models

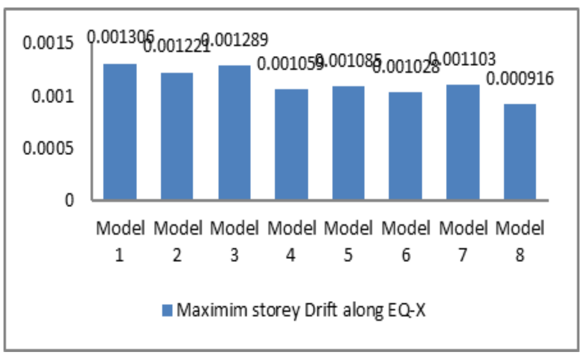

Chart 6: Storey drift for ESA for along EQ-X

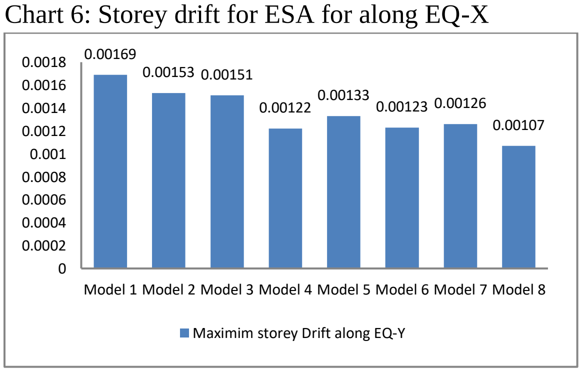

Chart 7: Storey drift for ESA for along EQ-Y

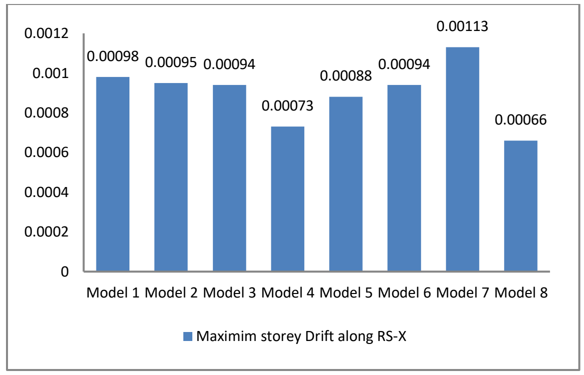

Chart 8: Storey drift for RSA for along RS-X

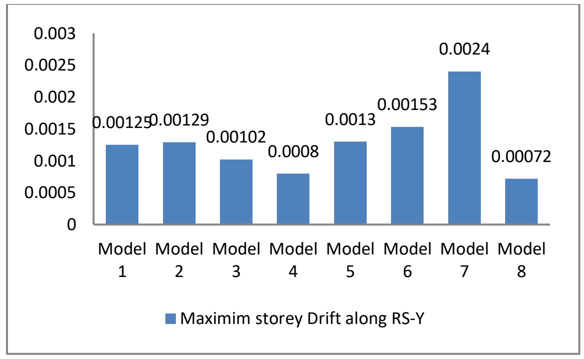

Chart 9: Storey drift for RSA for along RS-Y

1. The Storey drift is maximum for model 1(RCC). And is reduced for model 2 with 6.50% and 9.63% along X and Y direction for ESA. Whereas the drift is maximum for model 5 (COMPOSIT) is reduced for model 6 with 5.25% and 7.37% along X and Y direction for ESA. The Storey drift is maximum for model 4(RCC). And is reduced for model 2 with 3.15% and 3.11% along X and Y axis for RSA. Whereas the drift is maximum for model 5 (COMPOSIT) is reduced for model 6 with 6.99% and 14.89% along X and Y direction for RSA Hence if we compare RCC & composite building the drift in X- direction for ESA decreases.
2. The Storey drift is maximum for model 1(RCC). And is reduced for model 3 with 1.30% and 10.52% along X and Y direction for ESA. Whereas the drift is maximum for model 5 (COMPOSIT) is reduced for model 7 with 1.63% and 5.04% along X and Y direction for ESA. The Storey drift is maximum for model 4(RCC). And is reduced for model 3 with 4.06% and 17.83% along X and Y direction for RSA. Whereas the drift is maximum for model 5 (COMPOSIT) is reduced for model 7 with 22.59% and 45.73%

along X and Y direction for RSA Hence if we compare RCC & composite building the drift in X- direction for ESA increases.

3. The Storey drift is maximum for model 1(RCC). And is reduced for model 4 with 18.91% and 28.09% along X and Y direction for ESA. Whereas the drift is maximum for model 5 (COMPOSIT) is reduced for model 8 with 15.57% and 19.56% along X and Y direction for ESA. The Storey drift is maximum for model 4(RCC). And is reduced for model 4 with 25.53% and 36.06% along X and Y direction for RSA. Whereas the drift is maximum for model 5 (COMPOSIT) is reduced for model 8 with 24.74% and 44.58% along X and Y direction for RSA

VI. CONCLUSION

1. The maximum storey displacement ,storey drift, Base shear and Time period is more for the RCC Building when compared to the Composite Building.
2. The maximum storey displacement, Storey drift, Base shear and Time period is more for model 1 i.e., RCC bare frame and less for model 8 i.e., Composite Building with shear wall provided in both X and Y directions.
3. The maximum storey displacement, Storey drift, Base shear and Time period is more for model 1 i.e., RCC bare frame and less for model 8 i.e., Composite Building with shear wall provided in both X and Y directions.
4. The storey displacement, Storey drift, Base shear and Time period is reduces with model 1 to model 8 i.e., bare frame, bare frame with bracing, bare frame with damper and bare frame with shear wall for both RCC and Composite Building.
5. The self-weight of Composite structure is less as compared to RCC structure which helps in reducing the foundation cost.
6. The Base shear for the composite structure is less as compared to RCC structure because the self-weight of RCC structure is more as compared to composite structure.
7. The model 8 i.e., Composite Building with shear wall provided along X and Y direction is most effective model due to reduction in frame sizes, increase in floor area ,less displacement.

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