Comparative Analysis of RCC and Composite Building Subjected to Lateral Load

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Abstract - *Steel-concrete composite structures are important in modern building because of their synergistic benefits. These constructions provide outstanding load carrying capacity, structural efficiency, and design flexibility by combining the high tensile strength of steel with the compressive strength of concrete. They are resistant to dynamic loads such as earthquakes and wind forces, making them excellent for resilient and safe construction. So when compared to RCC Structures, steel concrete composite structures are being more popular. In this paper, an attempt was made to evaluate and compare the performance of G+25 storey's RCC and Composite Structures subjected to seismic load using ETABS 2020 Software. A total of six models were prepared, 3 models are of RCC and 3 models are of composite buildings, in which lateral load resisting systems, such as bracings and shear walls are installed. The buildings are located in seismic zone-V and soil is medium. Response spectrum Analysis is used for both RCC and Composite Structures. Displacement, Storey Drift, Base shear and Time Period are considered as parameters. When compared to RCC, composite structures performed better.*

Key Words: Composite Structures, ETABS, Response Spectrum Analysis, Bracings, Shear Wall

1. INTRODUCTION

The seismic performance of structures is a crucial factor in structural engineering, especially in earthquake-prone areas. The choice of building materials and construction techniques has a big impact on how resilient a structure is to seismic pressures. Seismic resilience of structures is a major challenge in earthquake-prone areas. Because of their various characteristics and engineering properties, reinforced concrete (RCC) and composite structures have emerged as two key competitors for withstanding seismic loads.

Composite constructions combine the advantages of many materials to improve performance. They often involve the combination of concrete with steel or other high-strength elements. This combination improves structural efficiency by allowing the structure to benefit from the strengths of each constituent material. Composite structures have higher rigidity and ductility than typical RCC structures.

1.1 Bracing

A Bracing system is a structural element to resist lateral forces like wind, and other loads that can cause the building to sway or collapse.

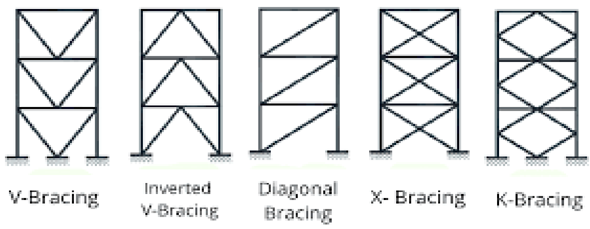

Figure 1. Different types of Bracings

1.2. Shear Wall

Shear wall is a structural element which provide structural support that resists lateral forces such as earthquakes or heavy wind. These walls prevent the building from collapsing or swaying.

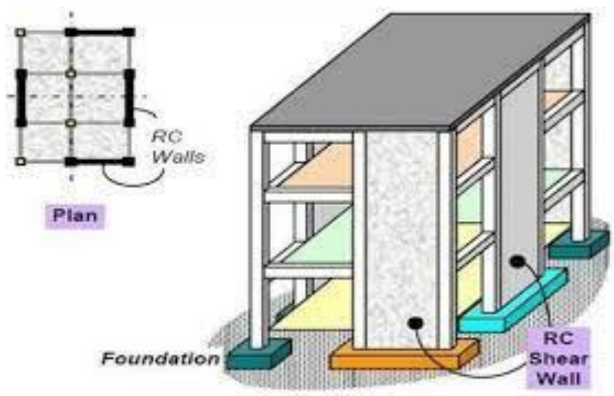

Figure 2.Shearwall

2. OBJECTIVE

1) Modelling of G+25 RCC and Steel-Concrete composite 3-Dimensional Building.

2) To Analyse the G+25 storied RCC and Steel concrete Composite Building byResponse Spectrum Analysis.

3) To study the effect of providing single diagonal bracings and Shear Wall in RC framed building and Composite building.

4) Comparison of seismic behaviour of RCC and Composite building in terms of displacement, drift, base shear, time period.

3. Description of Models

Total 06 models were prepared for seismic study of RC framed building and composite building.

1. Model-01: A RC bare framed building of G+ 25 storeys.
2. Model-02: A RC bare framed building of G+ 25 with bracing.
3. Model-03: A RC bare framed building of G+ 25 with shear wall.
4. Model-04: A Composite building of G+ 25 storey.
5. Model-05: A Composite building of G+ 25 storey with bracing.
6. Model-06: A Composite building of G+ 25 storeys with shear wall.

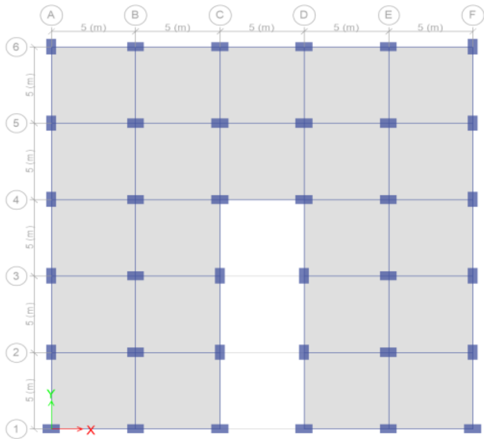

Figure 3. Plan of the Structure

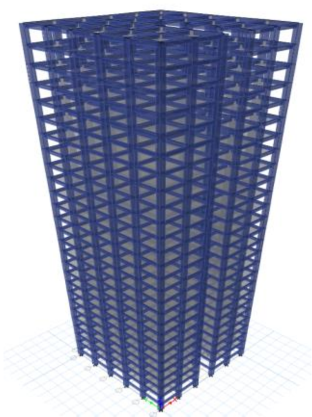

Figure 4. 3D view of Bare Frame Building

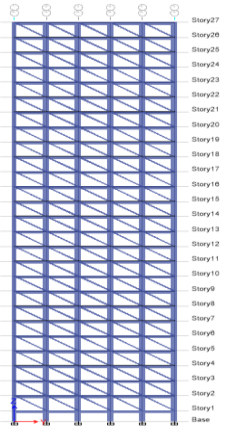

Figure 5: Elevation of Bare Frame Building with Bracing

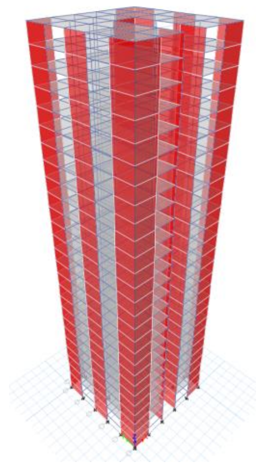

Figure 6: 3D View of Bare Frame Building with Shear Wall

Table -1: Details of Structures

Details	R.C.C	Composite
Plan Dimension	25m x 25m	25m x 25m
No. of Storey	G+25	G+25
Grade of concrete	M30	M30
Grade of Steel	Fe500	Fe345
Storey Height	3.3m	3.3m
Beam Size	300x 600mm	ISWB 600-2
Column Size	600 x 1000mm	900 x 600mm Encased with ISWB 600-2
Bracing Size	300x3oomm	ISHB 350-2

Slab Thickness	150mm	Deck Slab with Concrete 87.5mm
Wall thickness	230mm	230mm
Shear wall Thickness	230mm	230mm
Density of Brick Masonry	20 KN/m^3	20 KN/m^3
Live Load	3 KN/m^2	3 KN/m^2
Floor Finish	1KN/m^2	1KN/m^2
Seismic Zone	5	5
Importance Factor	1.2	1.2
Soil Type	Medium	Medium
Building Type	SMRF	SMRF

4. METHOD OF SEISMIC ANALYSIS

Response spectrum analysis is a widely used method in structural engineering to evaluate the seismic performance of buildings, bridges, and other structures under earthquake loading.

The primary purpose of response spectrum analysis is to determine the maximum displacements, accelerations, and forces that a structure may experience due to ground motion during an earthquake. This analysis provides valuable information for designing structures that can withstand seismic forces and reduce potential damage.

5. COMPARATIVE RESULTS AND DISCUSSIONS

5.1 Story Displacement

Table 2: Comparison of maximum displacements of all models along X- direction

Model Type	RCC Models	Composite Models	Percentage of Decrease
Bare Frame	181.655mm	132.939mm	26.81%
Bare Frame with Bracing	78.274mm	69.543mm	11.15%
Bare Frame with Shearwall	68.737mm	56.016mm	18.50%

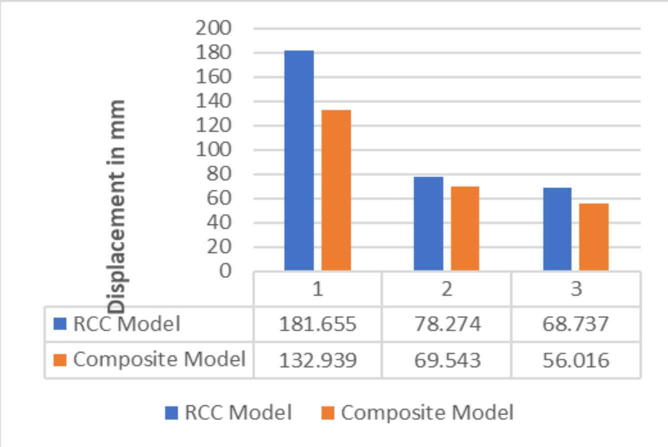

Figure 7: Max Displacement in X-Direction

The above figure and table shows that, storey displacement is maximum in Model 1 which is Bare frame RCC Model i.e 181.655 mm and Minimum in Bare frame composite model with shearwall i.e 56.016mm. All the composite models are having lower displacement values compared to RCC models.

5.2 Storey Drift

Table 3: Comparison of maximum drift of all models along X-direction

Model Type	RCC Models	Composite Models	Percentage of Decrease
Bare Frame	0.002772	0.00195	29.65%
Bare Frame with Bracing	0.001089	0.0009640	11.47%
Bare Frame with Shearwall	0.000977	0.000796	18.52%

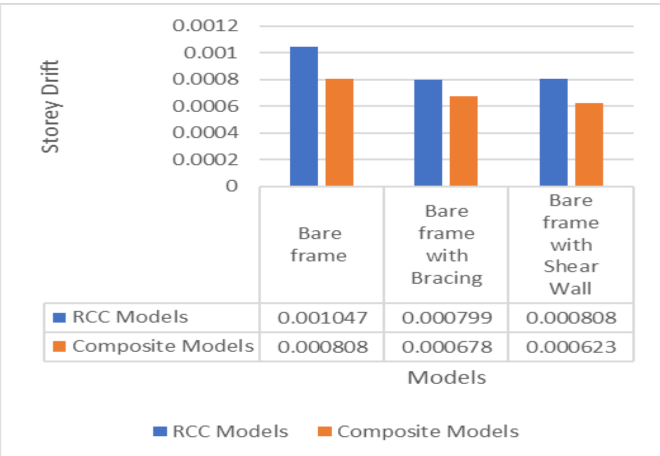

Figure 8: Max. Storey Drift In X-Direction

The above figure and table shows that, storey drift is maximum in Model 1 which is Bare frame RCC model i.e 0.002772 and Minimum in Bare frame composite model with shearwall i.e 0.000796. All the composite models are having lower storey drift values compared to RCC models.

5.3 Time Period

Table 4: Comparision of Time Period of all Models

Model Type	RCC Models	Composite Models	Percentage of Decrease
Bare Frame	6075.56 KN	5312.04 KN	12.56%
Bare Frame with Bracing	6203.80 KN	5359.40 KN	13.61%
Bare Frame with Shearwall	6277.46 KN	5754.50 KN	8.33%

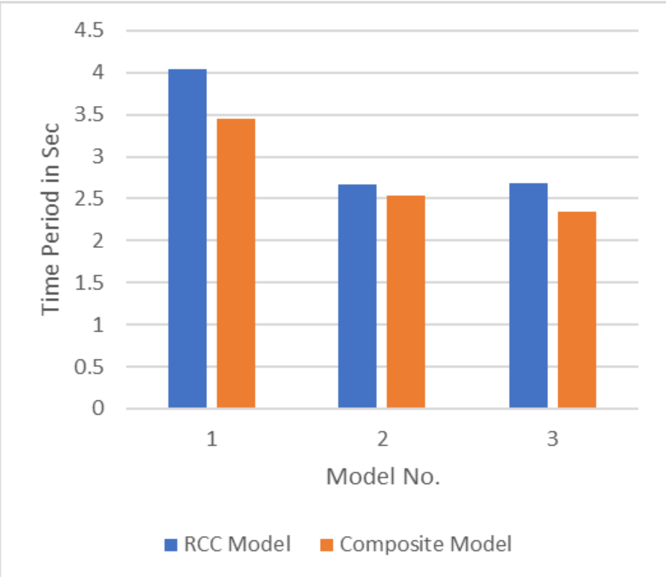

Figure 9: Time Period for all models

From table 4 and figure 9, it shows that Time period is maximum in Bare frame RCC model i.e 4.038 sec and minimum in Bare frame composite model with shearwall 2.350 sec.Time period is decreasing upto 12% to 15% in composite models compared to RCC models as composite models are more rigid than RCC models due to presence of steel.

5.4 Base Shear

Table 5: Comparison of Base Shear of all models along X-direction along X- direction.

Model Type	RCC Models	Composite Models	Percentage of Decrease
Bare Frame	4.038 sec	3.444 sec	14.71%
Bare Frame with Bracing	2.673 sec	2.530 sec	5.34%
Bare Frame with Shear wall	2.685 sec	2.350 sec	12.47 %

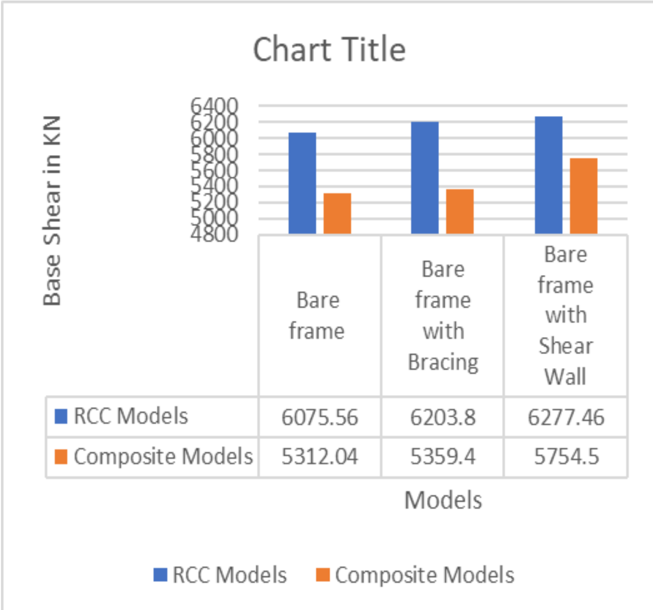

Figure 10: Maximum Base shear for all models in X-Direction

From table 5 and figure 10 Base shear values are presented model vise in X-Direction. Base shear is defined as maximum lateral force that is occurring at the base of the structure. Base shear is maximum in model 3, which is bare frame with shear wall RCC model i.e 6277.46 KN and minimum in bare frame composite model i.e 5312.04 KN .In both RCC and Composite models as the bracing and shear wall is added ,the base shear is increases due to increase in weight of building.

6. OBSERVATION

1. Storey drift is reduces in Composite structures as compared to RCC ,Because composite structures have higher stiffness than that of RCC.

2. In both RCC and composite structures, storey drift is within permissible limit, i.e., 0.004 times the height of storey.

3. Composite structures have a lower base shear than RCC structures by 8% to 13%.

4. The self-weight of Composite Structures is found to be less than RCC Structures.

5. Displacement in composite structures is lesser compared to RCC by 18% to 27%.

6. It is noticed that in case of RCC or Composite models as the bracing and shear wall is added the base shear is increases due to increase in weight of building.

7. CONCLUSION

Composite structures offer a clear advantage over RCC structures, combining the strength of steel with the concrete to create more efficient and resilient buildings. Overall, composite-structures perform better than RCC-structures, and composite-structures are well-suited for high-rise buildings, resulting in faster construction.

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