Performance Based Evaluation of RCC, Steel And Composite Building By Pushover Analysis

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Abstract- *The most of the multistory building are constructed in RCC which mainly depends upon the locally available material and the level of workmanship and skilled required in construction, nowadays RCC is no longer economical because of its increase in dead load, span restriction and hazardous formwork. However composite frame construction is a new technique for multistory building. Which gives economical designs. Both steel and steel concrete composite construction has gained wide acceptance worldwide as an alternative to pure steel and pure concrete construction. Composite construction combines the best of both steel and concrete along with economic cost, fast construction, protection against fire etc.*

In this thesis, the comparison of RCC frame structure with steel and composite frames structure subjected to similar lateral loading by nonlinear static pushover analysis using ETABS Software is carried out, G+11 storey building is considered for analysis, The non-linear analysis has been carried out for different parameters like displacement, storey drift, Performance point, base shear is plotted, and compared. By the results it is found that Composite structure is economical.

Keywords- RCC, Steel and Composite building, ETABS, Pushover analysis, Base shear, Storey displacement, Storey drift, Time period, Performance point.

I. INTRODUCTION

In India, most building structures fall into the category with a low level of construction. Therefore, reinforced concrete components are widely used for the design, because the design is basically quite convenient and economical. However, when population of the city grows exponentially and the land is limited, the buildings of the city should grow vertically. Many high-rise buildings are being built today to achieve this goal. For these high-rise buildings, we found that using composite elements for construction is more efficient and economical than using reinforced concrete elements. The popularity of urban reinforced concrete structures outperforms conventional reinforced concrete structures. Reinforced concrete frames are used in low-rise buildings, since the loads are nominal. However, in the case of buildings of medium height it is impossible to place existing reinforced concrete structures due to the limited distance, lower rigidity and increased vulnerability of the frame. In India, use of steel in the construction industry is much lower than in other developing countries, such as China, Brazil and other countries. Considering the development situation in India, further research is needed in the area of developing new technologies and construction in order to use steel as a building material applicable to the economic sector. Combined composite frames use more steel and are an economical approach to solving the problems facing high-rise buildings.
There are many techniques to meet the needs of the construction industry. Some of them are very popular due to the presence of men, material and money, some of them are popular due to the practicality of the design. Three types of construction techniques are mainly used for the construction of high rise buildings, they are:

- RCC construction
- Steel construction
- Composite construction

In this study we are considering all these constructions (i.e. RCC, Steel and Composite) and carrying out pushover analysis and comparing the results obtained from these buildings.

II. OBJECTIVE OF THE STUDY

The objective of the present study, “Performance based evaluation of RCC, Steel and Composite building by Pushover analysis.” is as mentioned below

- ➢ To study the comparative analysis of G+11 multistory building of RCC, Steel and Composite framed structure by non linear static pushover analysis method using ETABS software.

III. METHODOLOGY

Following methodology is adopted :

- Modeling of RCC, Steel and Composite building using ETABS software tool.
- Non linear static pushover analysis is carried out.
- Key results extraction and presenting in the form of graphs.
- Comparing the results and graphs of all three structures.

IV. DESIGN OF MODEL

The edifice which is considered for the modelling and analysis is a multistory edifice of G+11 story in which frame structures are of RCC, Steel and Composite materials which is having the following data with respect to the structural elements, materials and design of the edifice:

Table 1: Specifications of RCC, Steel and Composite building

PARAMETERS	DIMENSIONS		
	RCC	STEEL	COMPOSITE
No. of Bays	6 X 4	6 X 4	6 X 4
Bay Width	4m	4m	4m
No. of stories	G+11	G+11	G+11
Storey Height	3m	3m	3m
Column size[2]	450X750	ISHB300	0.35m x0.35 m with ISHB 250 steel section
Beam size[2]	300X400	ISMB200	ISMB 250 with 125 mm thick concrete slab on top without shear connectors.
Slab Thickness	150mm	150mm	150mm
Support condition	Fixed at base	Fixed at base	Fixed at base
Grade of cement	M20	–	M20
Grade of steel	HYSD 415 bars	Fe250	HYSD 415 bars, Fe250

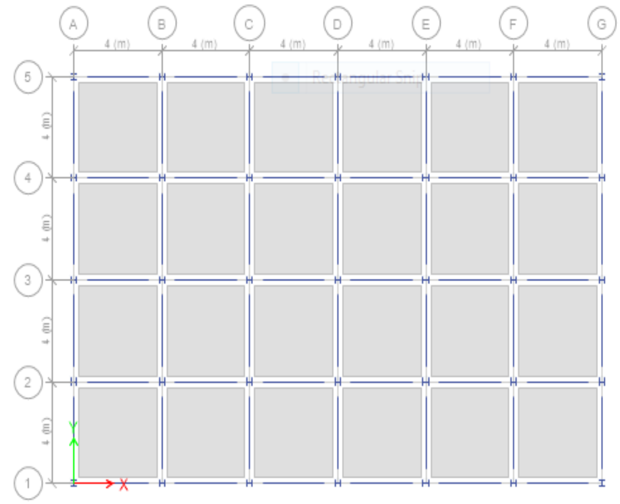

Fig 1: Plan

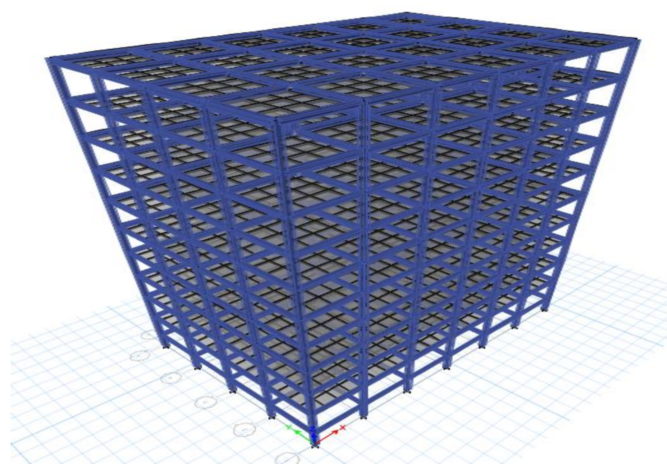

Fig 2: Elevation

CALCULATION OF LOADS: The loads considered for the analysis are Dead load, Live load, Super dead load for floor and roof finish, Wind load, Earthquake loads and Pushover loads.

The brief details of seismic zone factors and the loads considered for the analysis of the structure is as mentioned in the table:

Table 2: Seismic zone factors and loads

Zone	II
Soil	Medium soil
Importance factor	1(IS 1893 table 6)
Response reduction factor	5(IS 1893 graph from fig.2)
Dead load, DL	2 KN per sq.m
Live load, LL	2 KN per sq.m
Super dead load, SDL	13.8 KN per m

LOAD COMBINATIONS:

- 0.9(DL+SD)+1.5EX
- 0.9(DL+SD)+1.5EY
- 0.9(DL+SD)+1.5WX
- 0.9(DL+SD)+1.5WY
- 1.2(DL+LL+SD+EX)
- 1.2(DL+LL+SD+EY)
- 1.2(DL+LL+SD+WX)
- 1.2(DL+LL+SD+WY)
- 1.5(DL+LL)
- 1.5(DL+LL+SD)
- 1.5(DL+SD+EX)
- 1.5(DL+SD+EY)
- 1.5(DL+SD+WX)
- 1.5(DL+SD+WY)

V. RESULTS AND COMPARISION

Following results are observed after the analysis of a modelled structures. The results such as Base shear, storey displacement, storey drift, time period and performance point are compared between RCC, Steel and Composite structure and are represented graphically.

BASE SHEAR:

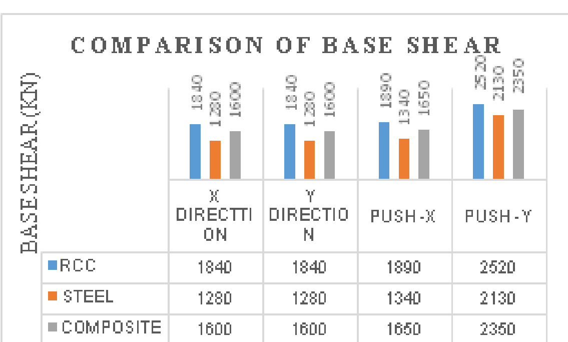

Fig 3: Comparison of Base Shear

MAXIMUM STOREY DISPLACEMENT:

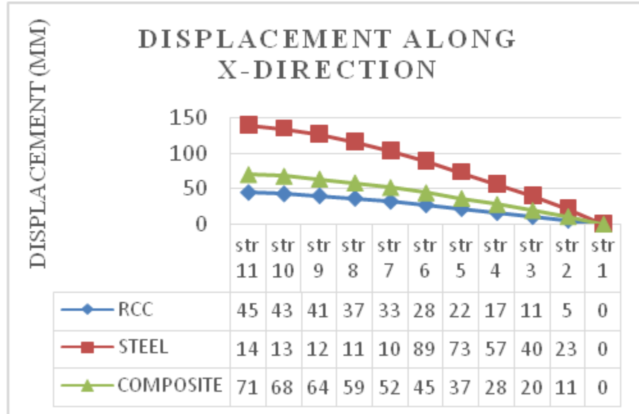

Fig 4: Comparison of Displacement due to seismic load along X- direction

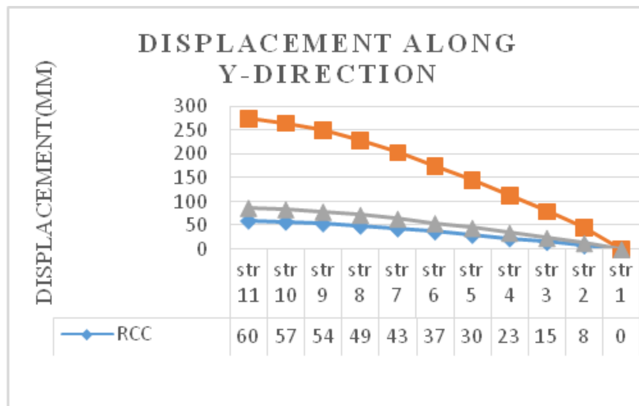

Fig5: Comparison of Displacement due to seismic load along Y- direction

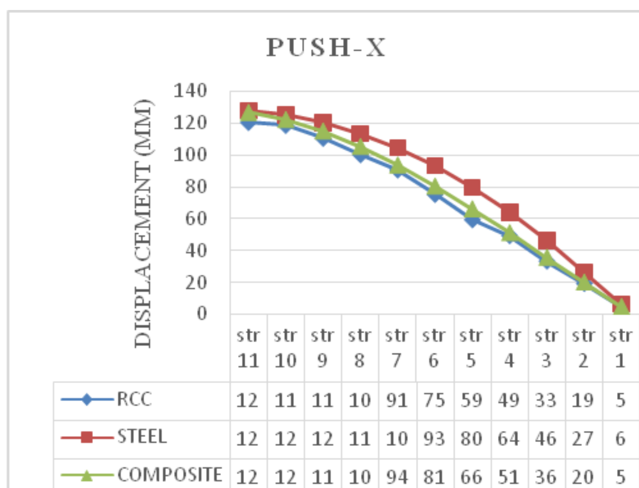

Fig 6:Comparison of Displacement due Pushover analysis along x-direction

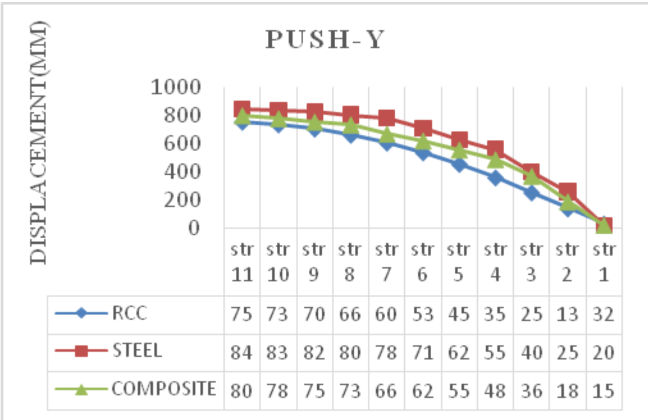

Fig 7: Comparison of Displacement due Pushover analysis along y- direction

MAXIMUM STOREY DRIFTS:

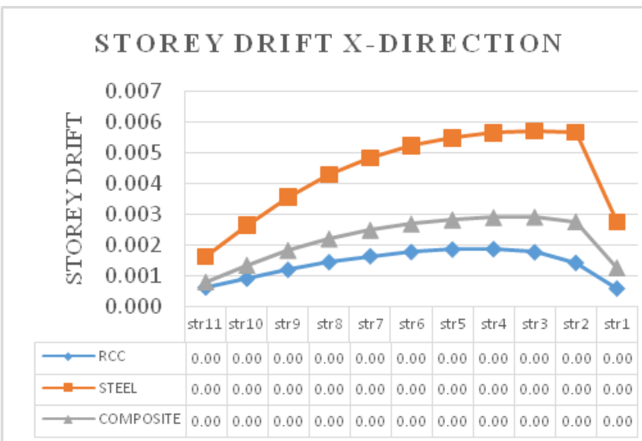

Fig 8: Comparison of Storey Drift along X- direction

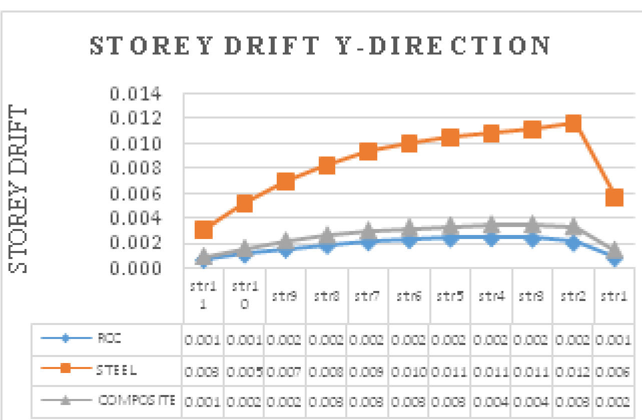

Fig 9: Comparison of Storey Drift along Y- direction

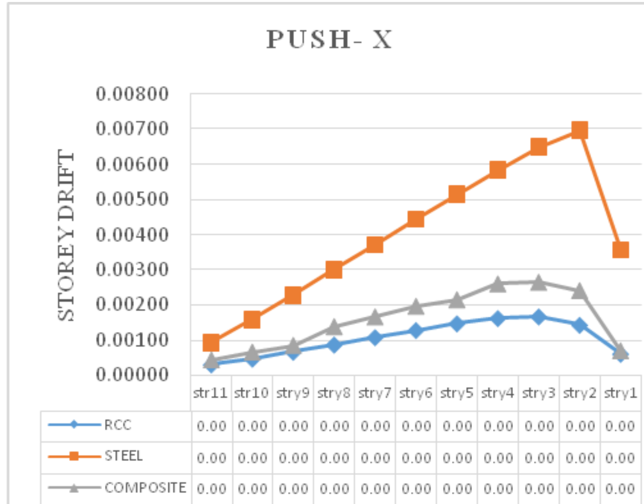

Fig 10: Comparison of Storey Drift due to Pushover analysis along X- direction

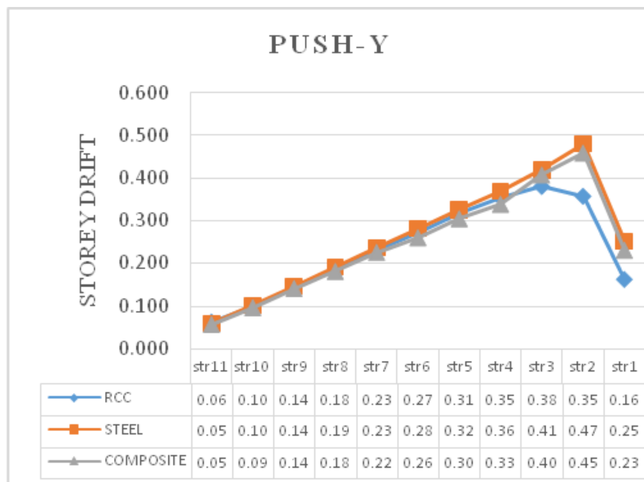

Fig 11:Comparison of Storey Drift due to Pushover analysis along Y- direction

TIME PERIOD :

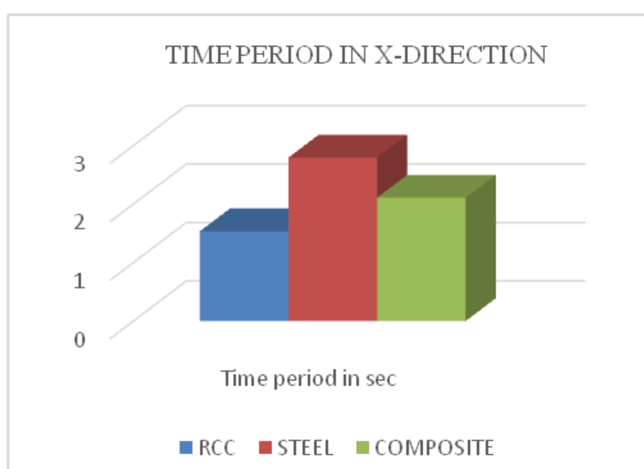

Fig 12: Comparison of time period in x direction

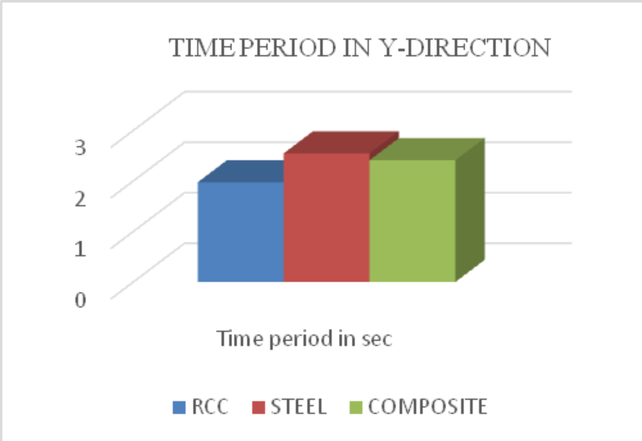

Fig 13: Comparison of time period in y direction

PERFORMANCE POINT AND DISPLACEMENT:

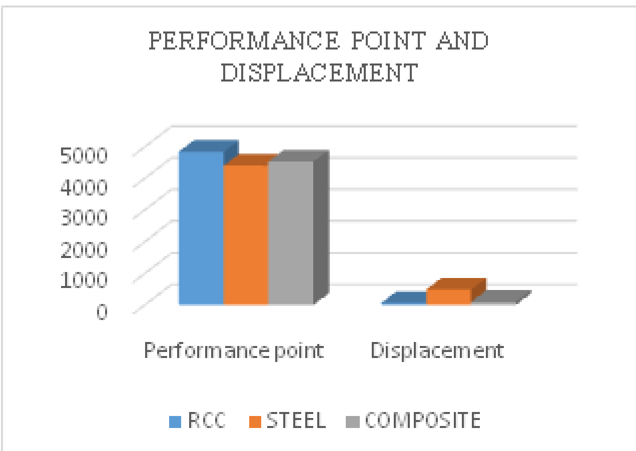

Fig 14: Comparison of Rcc, steel and composite for performance point and displacement

VI. CONCLUSION

1. Base Shear value for RCC frame is more than steel and composite structure because the weight of the RCC frame is more than the composite frame which results in maximizing earthquake forces in RCC as compared to Steel and Composite structure. Base shear gets reduced by 16% for Composite structure, where as 30% for Steel structure as compared with RCC structure.
2. The lateral displacement due to seismic load and pushover analysis on both X and Y direction of RCC structure is reduced as compared with composite by 25% and steel structure by 45% respectively.
3. The differences in story drift for different stories are observed and it is found that RCC structure has lowest values of storey drift because of its high stiffness as compared to steel and composite structure for both seismic and push over analysis.
4. Time period for Steel structure is more as compared to RCC and Composite structure in both X and Y direction. This shows that more time is taken by the steel structure to start oscillating back and forth after lateral forces are applied due to higher flexibility as compared to Composite and RCC structure.
5. Performance point indicates the stiffness or flexibility of the structure. Performance point for RCC is more than Steel structure by 10% and Composite structure by 7%. Structure with high performance point results in minimum displacements.

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