

SEISMIC ANALYSIS COMPARISON OF A RESIDENTIAL COMPOSITE AND RCC STRUCTURES

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Abstract - In India, the Majority of the structures being built are Reinforced Concrete structures or Steel structures. In high rise Reinforced Concrete structures, the size of structural individuals (column, beam, and slab) increments. Because of this, the self-weight of the structure likewise increments. Steel structures then again, are ductile in nature and parameters like displacements, deselection, drifts are more compared to RCC structures. To take care of these issues, composite structures may be reasonable. A geometrically irregular structure (G+18 stories) is designed and analyzed for the two instances of RCC and composite structures (considering seismic tremor zone IV) utilizing ETABS software. The structure is analyzed by using linear static and non-linear dynamic methods, such as equivalent static method, response spectrum method, and time history method. In this investigation, a comparison of an RCC structure and a composite structure is acquired for boundaries like time period, storey displacement and storey drift, base shear, bending moment and shear forces of the structure. From the watched outcomes, it might be induced that a steel composite, performs well in terms of structural integrity when compared to RCC structure

Key Words: RCC structure¹, Composite structure², Storey displacement³, Time period⁴, Storey drift⁵, Base shear⁶.

1. INTRODUCTION

Reinforced Concrete systems are usual in India due to their adaptability to demand, accessibility of materials, and availability of skilled labor. This makes RCC steadily mild, in contrast with its steel. Specifically, metallic structures don't require an association of considerable measurements than the RCC systems because metallic sections have high satisfactory, Then once more, steel systems face thermal improvement and erosion which causes a lower within the existence expectancy of the shape while contrasted with an RCC structure[1]. Subsequently, to eliminate such drawbacks of a decrease in existence variety, composite systems assume a massive task.

For a composite structure, columns are forged in this type of manner that popular metallic I-sections are encased with concrete. Reinforcement bars located with clear measurement to surround the I-phase which gets rid of the possibility of shear failure inside the columns and additionally avoids corrosion[2].

By encasing the concrete around the metal segment it gains extra power and higher fireplace resistance than a conventional metallic structure section. A composite floor system includes a metal beam connected to the steel deck and urban layer. The concrete slab should be nicely related over the metal beam to make it a composite beam, failure of which results in a relative slip on the interface. Composite nature enhances the stiffness and load-sporting capability of the shape, in composite systems, the self-weight of the structure decreases comparing an RCC shape because of the elements as mentioned below. The tale displacement, tale drifts, story shears, axial forces, bending moments, and shear forces will vary due to the varying nature of different parameters as taken into consideration. From this, it could be inferred that with the use of composite[3].

1.1 Objective

Geometrically irregular shape with the version of sectional houses in the transverse route and longitudinal direction belongs to seismic region-IV, soil conditions are considered medium for the evaluation. A comparison in various parameters is achieved for an RCC shape with a Composite structure thinking about residential construction (G+18 storeyed) using the ETAB software program. Equivalent static evaluation, response spectrum analysis, and time history evaluation are done to examine the seismic nature of the building[4].

1.2 Composite Structure

The composite structure is being constructed with a combination of concrete members and metallic members a good way to lead them to act as one unit. This shape can give economic credibility with high

durability, rapid erection, and higher seismic overall performance characteristics. Co-green of thermal expansion of both metal and concrete is nearly the same, with this it inferences that due to better percent of the metal in the composite segment, the shape behavior for thermal expansion is comparatively higher to that of an RCC structure or a metal structure. Composite structure due to its bonding nature and composition result for better electricity, sturdiness, and overall performance[5]. Composite deck slab, composite beam, composite column, shear connector are primary structural elements in a composite structure. The composite floor gadget is nothing but a composite deck slab which consists of a metal deck this is linked to a metallic beam with the help of shear studs, wherein a concrete slab is laid on the metal deck. The metallic deck is located between two metallic beams in which it enables them to withstand the concrete work; it could produce a rigid horizontal diaphragm whilst distributing wind and seismic shear to the lateral Load-resisting structures[6, 7]. The composite deck slab and composite beam are proven in Fig-1.

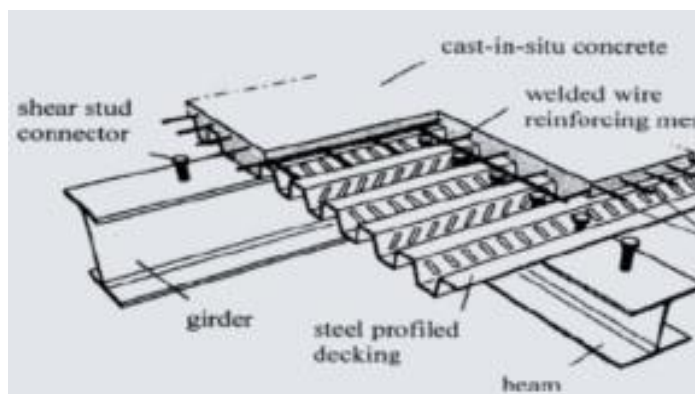


Fig -1: Composite floor system

The composite beam consists of setting a concrete slab on a metal beam with shear connectors which act much like T-beam. In architectural design, the long span beam structures are the present-day trend; this phase has hearth resistance, corrosion resistance, reduced buckling, and in turn, reduces the overall weight of the structure. Besides, it can withstand repeated earthquake loading's and also have excessive stiffness and low deflection values compared to the metallic sections. Composite columns are constructed with hot-rolled metal sections encased with concrete. These composite columns are of three kinds; they're concrete-encased section, concrete stuffed and battered phase as proven in Fig. 2. Due to the decreased size of columns in composite systems, usable floor location increases, basis value decreases, stiffness

increases, buckling resistance will increase, main to the reduction in slenderness ratio[8].

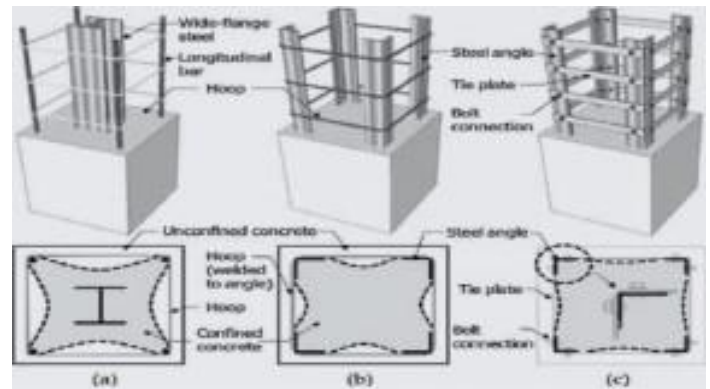


Fig -2: Composite column

Shear Connector is the principle component in the composite floor gadget which transfers the shear among the concrete slab and the metal beam to the steel beam. Shear connectors are integrated to enhance the compressive ability of concrete slab and steel beam and in flip it improves load sporting capacity as well as pressure of shear connector[9, 10]. Based on their suitability many styles of shear connectors are to be had as shown in Fig. 3.

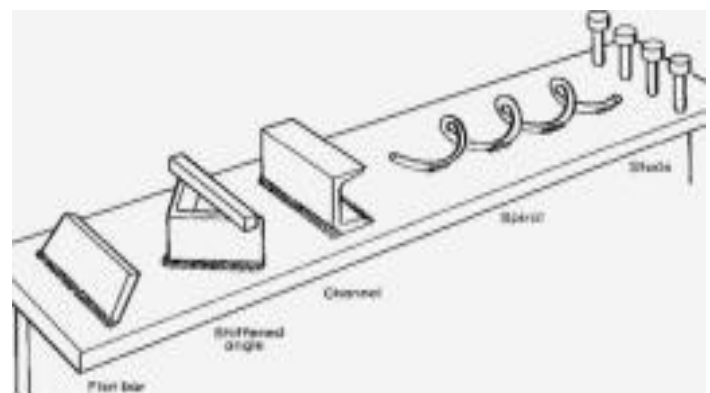


Fig. 3 Shear connectors

2. Modelling & Analysis:

2.1 Description of the model:

In this study, residential building is considered. The structure has geometric irregularities along with various spacing among columns in X & Y instructions. The AutoCAD plan of the shape is shown in Fig. 4. The same constructing plan is used to model and design an RCC structure and a composite structure. The floor to ground peak, useless loads, stay loads and seismic evaluation facts stays equal for both the systems. The shape consists of G+18 storeys. The Equivalent static analysis, Response spectrum analysis and Non-linear

time history analysis are done using ETAB software program.

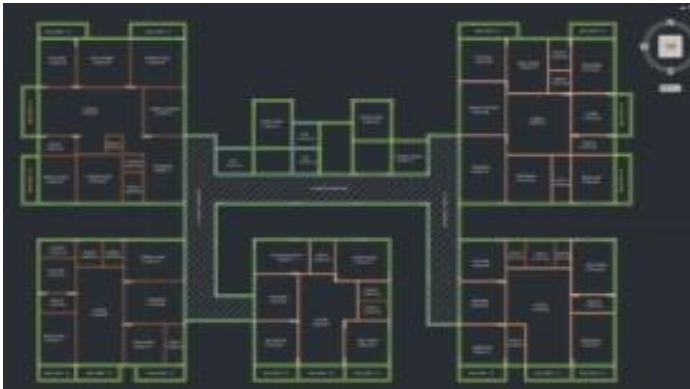


Fig -4: Auto CAD plan of the structure

2.2 Details of the structure:

G+18 storey building plan constructing is taken into consideration, the grade of concrete and metal are M30 and Fe500 respectively. The standard duration, width, depth of the construction is 53m X 33m X 62m respectively. The peak of the plinth and every floor is 2m, 3m respectively. The thicknesses of the slab, shear wall, deck slab are 0.125m, 0.23m, and 0.15m respectively. The sizes of RCC beams are 0.23m X 0.50m, zero.30m X 0.50m. Sizes of RCC columns are 0.23m X 0.90m, 0.23m X 0.75m X zero.75m (L-Column), 0.30m X 1.0m, zero.30m X 1.20m, 0.40m X 1.20m. Composite beam dimensions are ISWB four hundred, 500. Composite column dimensions are ISHB 350 (0.40m X 0.60m), ISHB 450 (zero.45m X 0.65m). The useless loads, live masses, wind masses are taken from IS code (IS: 875:2015) part I, II, III respectively. zone kind IV is taken into consideration. The seismic area is taken from IS: 1893:2016. Equivalent Static analysis, Response spectrum analysis, Non-linear time history analysis are achieved at the structure. The structure is designed for both RCC and composite according to IS: 456:2000, IS: 11384:1985, and AISC 360-10 respectively. The modeled Composite and RCC systems are shown in Fig. 5 and Fig. 6 respectively.

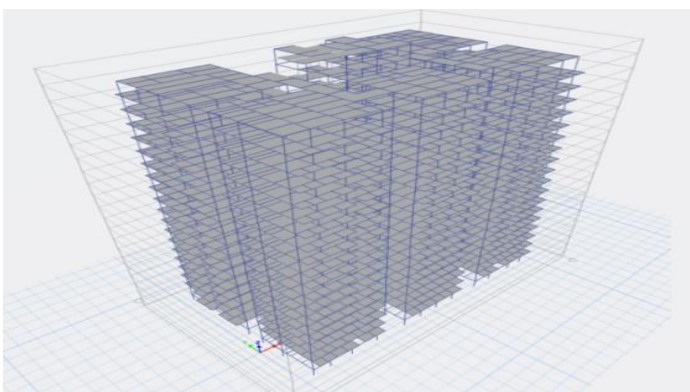


Fig -5: Modeled Composite Structure

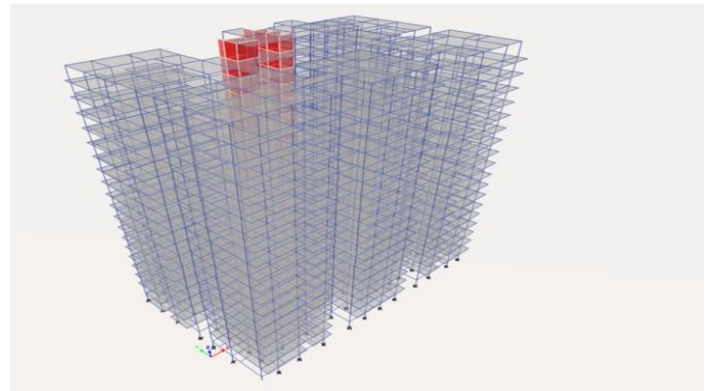


Fig -6: Modeled RCC Structure

3. Results & DISCUSSIONS:

1. The storey displacement in X-direction in composite structure is higher than the RCC structure as shown in chart. 1 but in Y-direction it is mostly similar to RCC structure as shown in chart. 2.
2. The storey drift in X-Direction is lesser for RCC than the Composite structure as shown in chart. 3.
3. The storey drift in Y-Direction is similar for both RCC and Composite structures as shown in chart.4.
4. When compared to the RCC Structure the storey shears are lesser than the Composite Structure as shown in chart. 5, 6.
5. The storey forces in Composite structure are less when compared to RCC structure as shown in chart.7.
6. When compared to Composite Structure, the maximum axial forces, shear forces, bending moments are less than the RCC structure as shown in chart. 8, 9, 10.
7. Maximum shear force in beams varied to each storey but is mostly similar up to storey 7 and from storey 8 to storey 17 RCC structure have more shear forces than the Composite structure and for remaining storeys shear forces are similar for both RCC and Composite structures as shown in chart. 11.
8. The composite structure have maximum bending moments in beams up to storey 12 than the RCC structure and for remaining storeys both structure have same moments as shown in chart.12.
9. For different damping ratios in response spectrum curves of Time history analysis, the Pseudo spectral acceleration in RCC structure is less than Composite structure as shown in chart. 13, 14, 15, 16, 17, 18.
10. The time history curve represents base reactions varying with time in both directions; RCC structure has less well defined time history curve than the Composite structure as shown in chart.19,20.

11. The self-weight, time period, base shears of RCC structure are greater than the Composite structure as shown in chart. 21, 22, 23, 24.

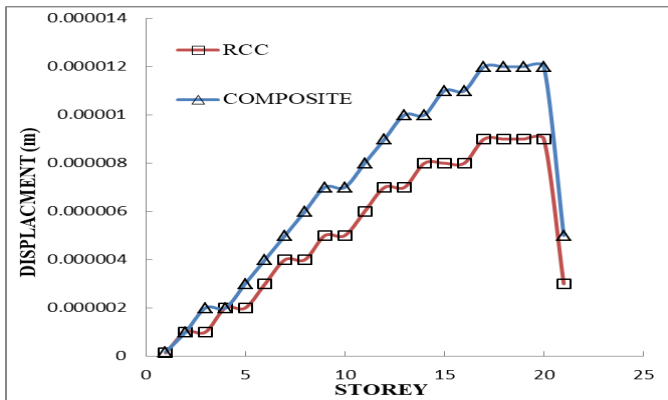


Chart -1: Displacements in X Direction

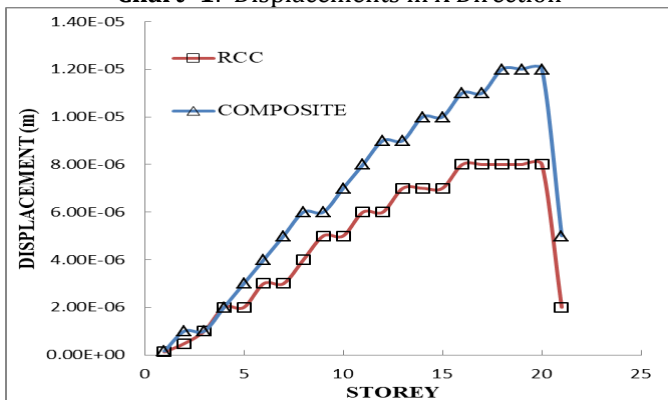


Chart -2: Displacement in Y Direction

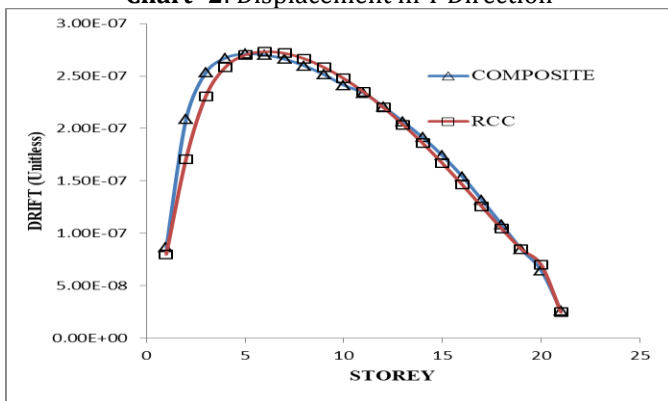


Chart -3: Storey Drift in X Direction

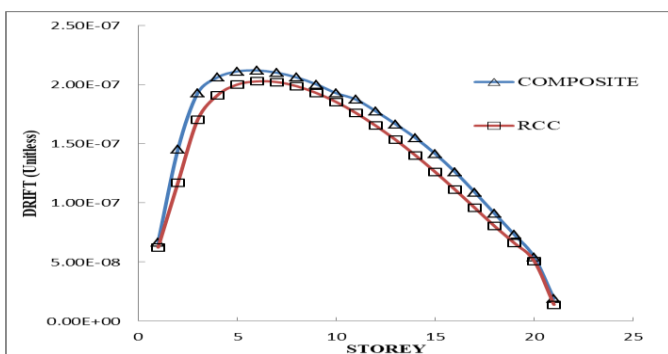


Chart -4: Storey Drift in Y Direction

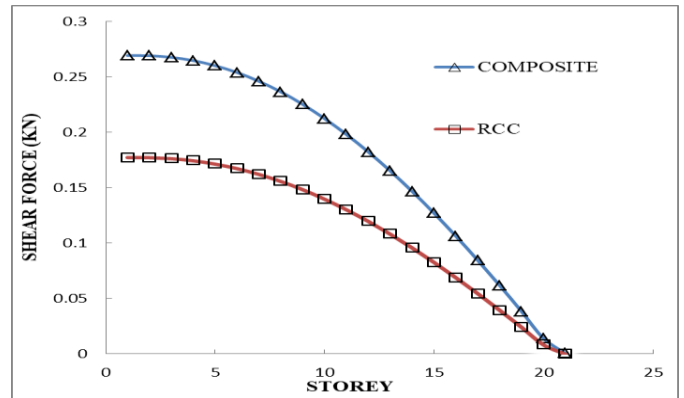


Chart -5: Storey Shear in X Direction

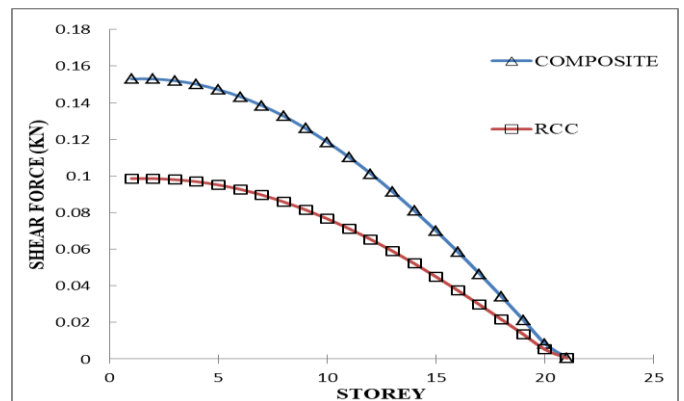


Chart -6: Storey Shear in y Direction

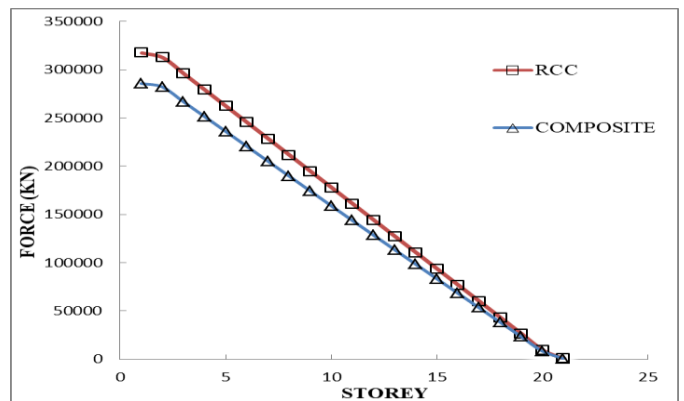


Chart -7: Storey Forces

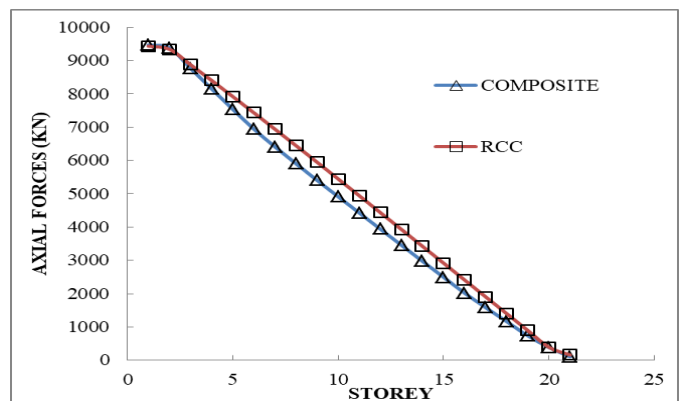


Chart -8: Column Axial Forces

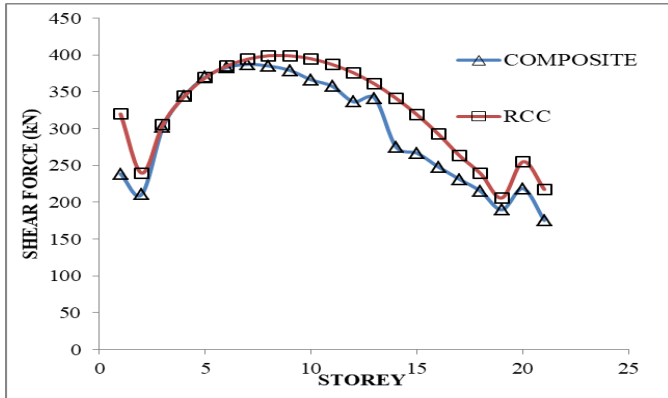


Chart -9: Column Shear Forces

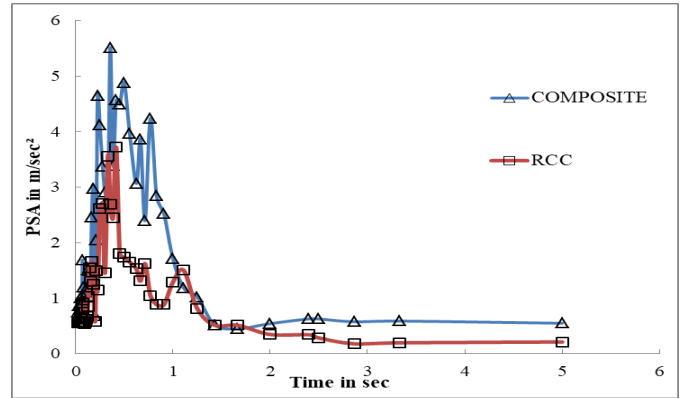


Chart -13: Damping Ratio 0% in X Direction

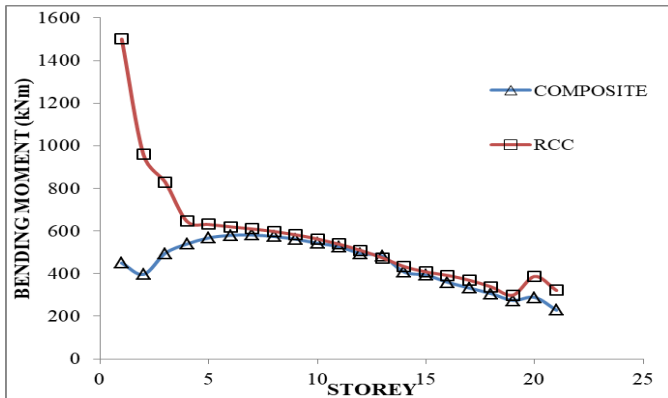


Chart -10: Column Bending Moments

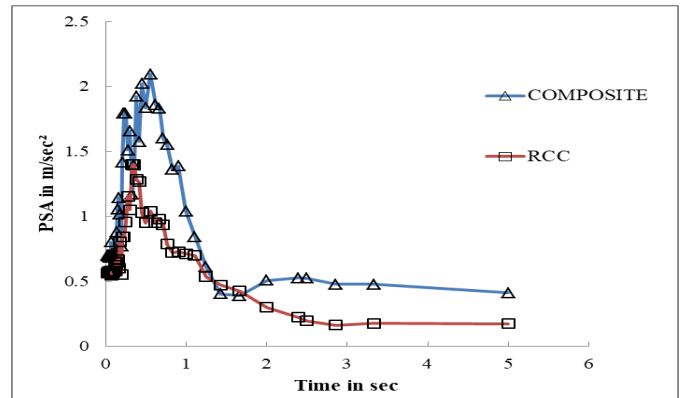


Chart -14: Damping Ratio 5% in X Direction

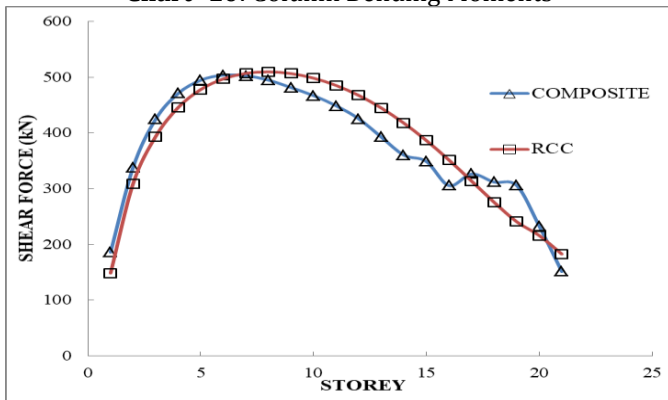


Chart -11: Beam Shear Forces

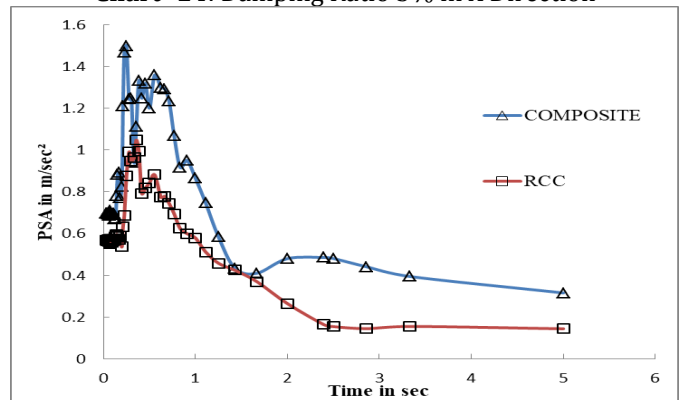


Chart -15: Damping Ratio 10% in X Direction

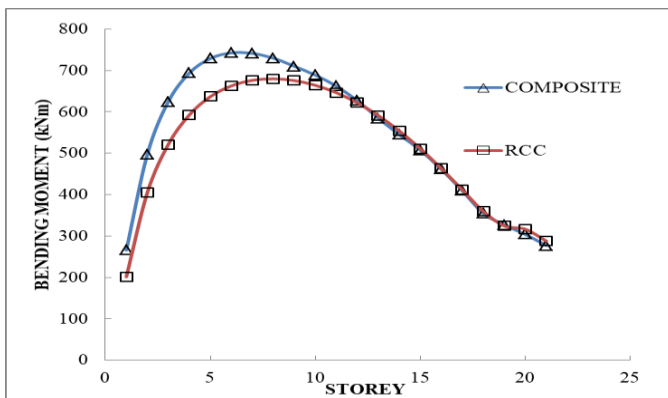


Chart -12: Beam Bending Moments

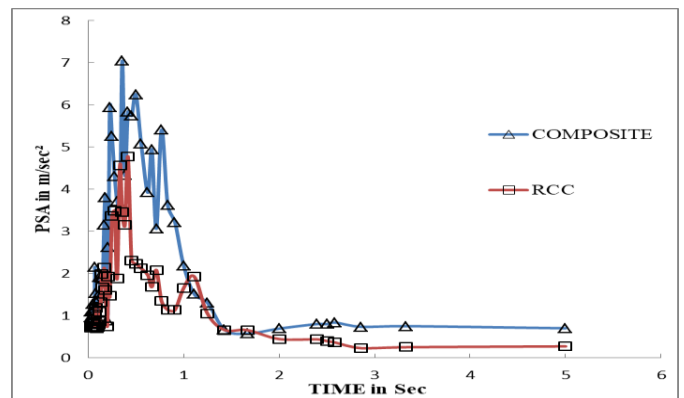


Chart -16: Damping Ratio 0% in Y Direction

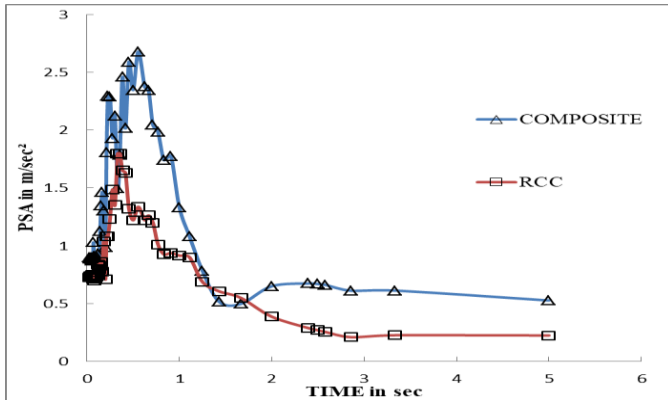


Chart -17: Damping Ratio 5% in X Direction

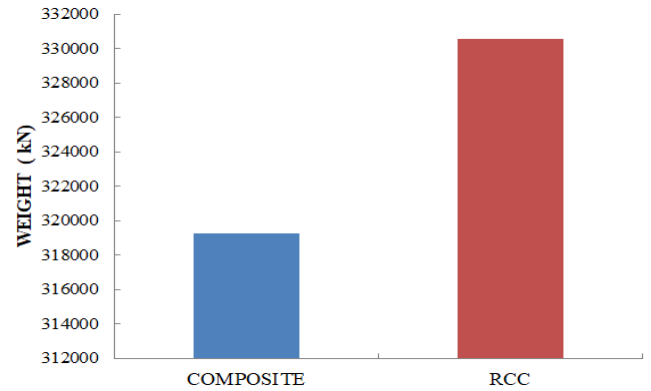


Chart -21: Self-Weight of the structure

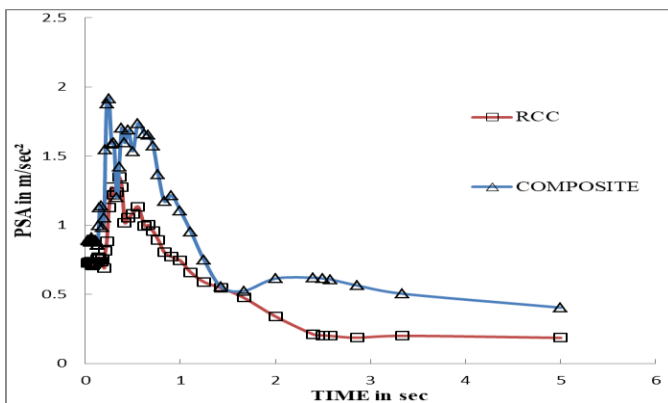


Chart -18: Damping Ratio 10% in Y Direction

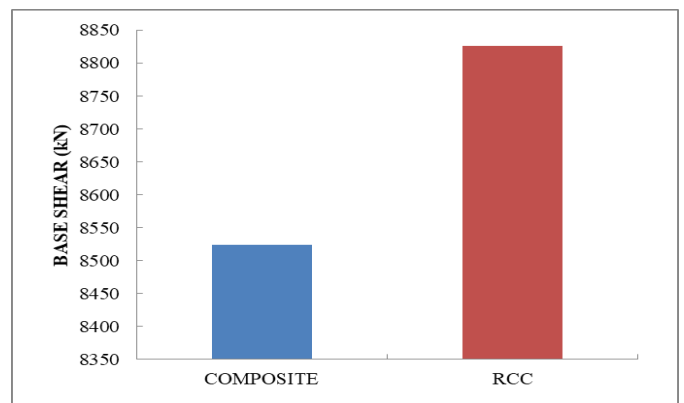


Chart -22: Base Shear in X Direction

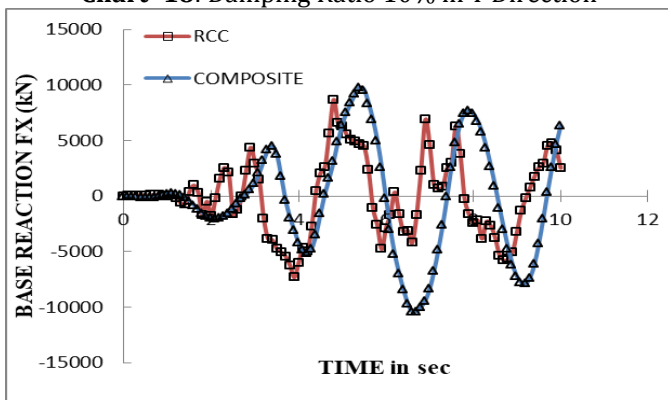


Chart -19: Time History Curve in X Direction

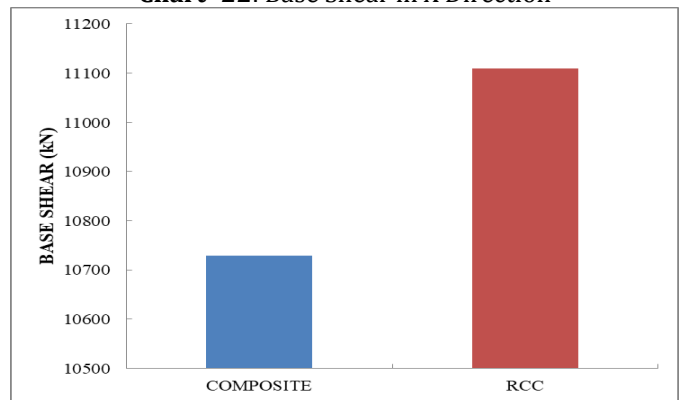


Chart -22: Base Shear in Y Direction

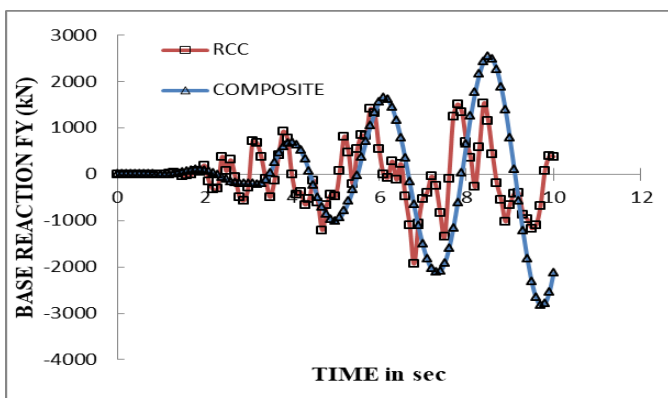


Chart -20: Time History Curve in Y Direction

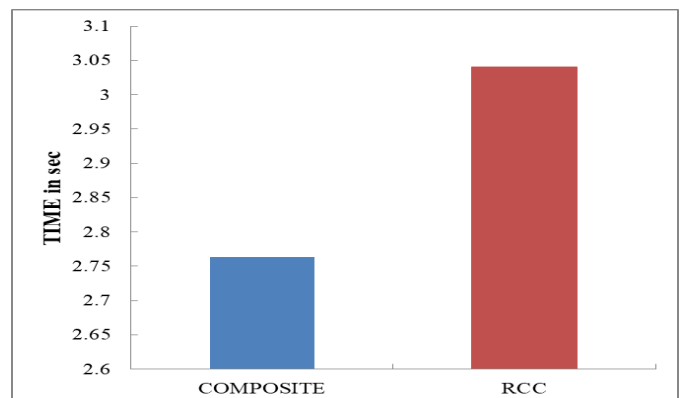


Chart -22: Time Period of the Structure

4. CONCLUSIONS

1. The displacements in RCC structure are less than the Composite structure, but it is safe as per in permissible limits and storey drifts are similar
2. Storey forces in RCC structure are more than the Composite structure. Therefore composite structure can give better performance than RCC structure.
3. The axial forces, shear forces, bending moments of RCC structure in columns are greater when compared to Composite structure and it can give more strength and stability to the structure.
4. The beam shear forces are lower in Composite structure with increase in height compared to RCC structure. Whereas, the beam bending moments are similar in both RCC and Composite structure.
5. The base reaction obtained from time history analysis is lesser in RCC structure compared to Composite structure and The pseudo-spectral acceleration (PSA) obtained from response spectrum analysis establishes that Composite structure has more PSA compared to RCC structure.
6. The self-weight of the structure is less in Composite structure than the RCC structure, due to this; base shear is more in RCC structure than the Composite structure.
7. The time period of the RCC structure is more than the Composite structure.
8. Taking all the above cases in consideration, it can be concluded that composite structures have better performance in terms of structural integrity compared to RCC structure.

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