
“A REVIEW ON COMPARATIVE STUDY OF COMPOSITE RCC AND STEEL STRUCTURE”

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ABSTRACT: Composite structure is gaining more popularity now days in construction area. Composite column like concrete filled steel tube is component with good performance resulting from the confinement effect of steel with concrete and design versatility. Composite structure has more advantage over RCC and steel frame structure. The study about the behavior and the characteristics of composite over RCC and steel is the prime need. In India concrete is very popular material of construction especially in case of medium and low rise buildings. And in case of high rise buildings steel is generally used and the composite construction is not that much popular but it is possible that composite construction can be more beneficial in case of medium and high rise buildings. Steel concrete composite construction can be built in place of RCC structures to get maximum advantage of steel and concrete and to produce efficient and economic structures. It is the decision of contractor or owner that which type of properties they require in the field and according to those properties the type of material can be chosen. This paper shows comparison of various aspects of building construction for steel, RCC as well as composite buildings considering various researches involve in this topic.

Keyword: Composite structure, RCC, Steel structure, Story Drift, Base Shear

1. INTRODUCTION

Reinforced concrete structures have been satisfying greater demands in civil & structural engineering sector for more than 3-4 decades. The applications and usages of R.C.C in large numbers in structural as well as architectural view, stands as a witness and demonstrated its versatility very well. Composite construction is formed when two heterogenous materials are binded together effectively so that they act together as a single element from a structural point of view¹. When this occurs, it is called composite action. In developing countries like India, most of the building structures fall under the category of low rise buildings². So, these conventional Reinforced cement concrete and pure sectional Steel constructions proves to be convenient and economical in nature hence widely used all around. But when it comes to the need for vertical growth of buildings due to lack of land-space area and rapid growth of population, medium to high-rise buildings emerges as a solution to full-fill this need. In recent trend, the composite mode of construction has gained several advantages in comparison with the conventional system construction³. Composite construction marries both steel and concrete (i.e.) it clubs the dynamic properties of both the material (concrete in compression and steel in tension) and also has same thermal expansion which ends up in fast-track construction. Experiences of other countries indicate that this is not due to the lack of economy of Steel as a construction material⁴. Increasing the volume of Steel in construction of building structures is what developing countries like India need at this decade^[1].

Thus composite structure is made to take the benefit of both of the materials. It is shown that the performance of building during an earthquake depends upon several factors like stiffness, ductility, lateral strength and simple and regular configuration.

2. LITERATURE REVIEW

There is a considerable research work has been done in the direction of comparative study of steel, RCC and composite structures. It can be seen from the studied research work that to judge the suitability of construction material, it is very necessary to compare the steel, RCC, and composite buildings for the following aspects. After this comparison, one can be able to come to a decision that which structure should be constructed under various respective conditions.

A. Sattainathan Sharma et.al had compared a framed structure made by Reinforced cement concrete and Composite material located in earthquake zone of IV (G+20 storey) with the plan dimension is 30m x 24m. Various aspects like story displacement, story drift, deflection and stiffness were studied and compared. Methods/Statistical analysis: The method of Equivalent Static analysis has been preferred in the current scenario of analysis. For the seismic analysis (IS-1893-2002), SAP2000 software has been used. By using Extended-three dimensional Analysis of Building Structure (E-TABS) software. Findings: The wind force effect and seismic response of steel-concrete composite frames are in the desired limit in comparison with R.C.C structures. On comparison of the framed structures, the

R.C.C structure imposes more dead load and carries higher bending moment. From the analysis results, it clearly shows that the inter storey drift for composite structure is comparatively more than RCC structure in both transverse and longitudinal direction but are accepted to be in desired (permissible) limits. It has been found from the study that use of composite members in construction is more effective and economic than using reinforced concrete members. The overall performance of manufacturing and construction techniques is improved to higher extent by the usage of composite materials in construction. Applications/Improvements: Composite structures are found to be the best mode of construction for high-rise building while comparing with the conventional R.C.C structures as they serve well for various parameters like deflection, stiffness, story drift and lesser dead weight.

They had concluded that:

- 1) The displacement(deflection) and storey drift in R.C.C. Structure is merely less than composite structure but are in permissible limit as prescribed by the code provisions. It is due to the flexibility of composite structure when compared to RCC structures.
- 2) The dead weight of composite structure varies from 20% to 25% which is less than RCC structure thus resulting in reduction of seismic forces from 15% to 20%.
- 3) It was found also that bending moment in columns of Composite structure is reduced from 12% to 24 %.
- 4) The Stiffness of the composite structure is found greater when compared with RCC structure.

Renavikar Aniket V et.al performed analysis on residential building with steel-concrete composite and R.C.C. construction. The proposed structure is a four multistoried buildings of G+9, G+12, G+15, G+18, with 3.0m as the height of each floor. The overall plan dimension of the building is 15m x 9m. The analysis involves the load calculation, analyzing it by 2D modeling using software STAAD-Pro 2007. Analysis has been done for various load combinations as per the Indian Standard Code of Practice. The project also involves analysis of an equivalent R.C.C. structure so that a cost comparison can be made between a steel-concrete composite structure and an equivalent R.C.C. structure.

They concluded that:

- 1) Though the cost comparison reveals that steel-concrete composite design structure is more costly, reduction in direct cost of steel-composite structure resulting from speedy erection will make steel-composite structure economically viable. Further, under earthquake consideration because of the inherent ductility characteristics, steel-concrete structure will perform better than conventional R.C.C. structure.

- 2) The axial forces, bending moment and deflections in R.C.C. are somewhat more as compared to the Steel composite structure.
- 3) The seismic forces are also not very harmful to the Steel composite structure as compared to the R.C.C. structure, due to low dead weight.
- 4) There is the reduction in cost of steel structure as compared to R.C.C. structure due to reduction in dimensions of elements.

Shweta A. Wagh et.al they had studied and analysed Four various multistoried commercial buildings i.e. G+12, G+16, G+20, G+24 are analysed by using STAAD-Pro software. Where design and cost estimation is carried out using MS-Excel programming and from obtained result comparison can be made between R.C.C and composite structure.

They had concluded that:

- 1) In case of a composite structural system because of the lesser magnitude of the beam end forces and moments compared to an R.C.C system, one can use lighter section in a composite structure. Thus, it reduces the self-weight and cost of the structural components.
- 2) It is seen that the downward reaction (F_y) and bending moment in other two directions for composite structural system is less. Thus one can use smaller size foundation in case of composite construction compared to an R.C.C construction.
- 3) Under earthquake consideration because of inherent ductility characteristics, steel-concrete composite structure performs better than a R.C.C structure.
- 4) In the cost estimation for building structure no savings in the construction time for the erection of the composite structure is included. As compared to RCC structures, composite structures require less construction time due to the quick erection of the steel frame and ease of formwork for concrete. Including the construction period as a function of total cost in the cost estimation will certainly result in increased economy for the composite structure.

D. R. Panchal et.al had worked on steel-concrete composite, steel and R.C.C. options are considered for comparative study of G+30 storey commercial building which is situated in earthquake zone IV. Equivalent Static Method of Analysis is used. For modeling of Composite, Steel and R.C.C. structures, ETABS software is used and the results are compared; and it is found that composite structure is found to be more economical.

They had concluded that:

- 1) As the results show the Steel option is better than R.C.C. But the Composite option for high rise building is best suited among all three options.

2) The reduction in the dead weight of the Steel framed structure is 32 % with respect to R.C.C. frame Structure and Composite framed structure is 30 % with respect to R.C.C. framed structure.

3) Steel and composite structure gives more ductility to the structure as compared to the R.C.C. which is best suited under the effect of lateral forces.

4) Total saving in the composite option as compared to the R.C.C. results in 10 % so as with Steel it will be 6-7%.

Shashikala. Koppad et.al had work on steel concrete composite with RCC options are considered for comparative study of B+G+15 storey of residential building which is situated in earthquake zone 3 and for earthquake loading, the provisions of IS:1893(Part1)-2002 is considered. For modeling of composite and RCC structures, STAAD-pro V8i software is used. The results of this work show that, the cost of composite beam is less by 27% as compared to RCC beam. The maximum shear force and maximum bending moment are less in composite beam as compared to RCC beam. The node displacement is on higher side in composite structure as compared to RCC structure. The weight of composite structure is also less compared to RCC structure. Composite structures are the best solution for high rise structure as compared to RCC structure.

They had concluded that:

1) The cost of composite beams is 27% less than the RCC beams. This is because, the composite beam does not require formwork, and thus no stripping time.

2) The cost of composite structure related RCC column is 20.45% less than the RCC structure related RCC column. This is because; in composite structure related RCC column having less axial forces so less reinforcement steel is required.

3) The axial forces in RCC columns for composite structure is less compared to RCC columns for RCC structure. This is because, RCC sections are bulky in size thus their self-weight as compared to thin steel sections is more. This results in the higher axial force on the columns in case of RCC frame structure.

Deepak M Jirage et.al had work on steel concrete composite with RCC options are considered for comparative study of G+20 story building which is situated in earthquake zone-IV and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. A three dimensional modelling and analysis of the structure are carried out with the help of ETAB software. The results are compared and found that composite structure more economical.

They had concluded that:

1) The wt. of Composite structure is reduced by 23% as compared with RCC structure.

2) The base shear of Composite structure is reduced by 20% as compared with RCC structure.

3) The axial force in Composite structure is less as compared with RCC by 18%, because the self wt. of the RCC structure is more.

4) The time period of Composite is more as compared to RCC.

Mr. Nitish A. Mohite et.al studied and work, options of construction of (B+G+11 storey) commercial building, situated in Kolhapur, with steel-concrete-composite and RCC are studied and compared with each other. Equivalent linear Static Method of Analysis explained in ETABS version 15 software is used and results are compared for different parameters. Comparative parameter includes roof deflections, base shear, storey drifts, for the building and axial forces and bending moments for column's and beams at different level. It is observed that steel-concrete-composite building is found to be more safe and economical and better option.

They had concluded that:

1) The reduction in the self-weight of the Steel-Concrete Composite structure is reduced by 9.48 % as compared to R.C.C. frame Structure.

2) Shear forces in main beams in composite structure are increased by average 39.43% as compared to R.C.C. framed structure while in secondary beams in composite structure are reduced by average 14.39 % as compared to RCC framed structure.

3) Bending moments in main beams in composite structure are increased 52.57% as compared to R.C.C. framed structure while in secondary beams in composite structure are reduced by average 28.93 % as compared to RCC framed structure.

4) Axial forces in column in Composite framed structure have been reduced by average reduced by average 9.08 % as compared to RCC framed structure.

Faizulla Z Shariff et.al study E-Tabs nonlinear software is used for simulation of steel concrete composite (CFT) with steel reinforced concrete structures (RCC) of G+14, G+19 and G+24 stories each are considered for comparative study. Comparison of parameters like base shear, axial force and bending moment is done.

They had concluded that:

1) The base shear for bare frame is less compared to bracings and shear wall in both RCC and CFT buildings.

2) Response spectrum analysis shows lesser value of storey shear when compared with equivalent static analysis.

3) Axial force in internal columns is greater than external columns in case of both RCC and CFT buildings

4) Shear force in columns of RCC buildings has lesser values compared to CFT buildings in both longitudinal and transverse direction.

3. SCOPE OF WORK

In this review paper it is shown that Steel, RCC and Composite structures can be compared in various aspects under various conditions. But soil conditions can be changed other than hard soil and can be compared for worst conditions. And in India generally these aspects are not considered fully. But practical applications of these comparison can make structure more safe and more economical. And more accurate comparison processes and aspects can be developed

4. CONCLUSION

From the above literature discuss and the previous research done the following concluding remark can be made:

- The response of composite structure is better than RCC structure composite structure produces less displacement and resists more structural forces.
- Composite Structure are more economical than RCC and Steel structure incase of high rise building.
- Composite structure are better option for high rise structure as compared to RCC and Steel structure.
- Composite structures are resulted into lighter construction than traditional concrete construction as well as speedy construction. So completion period of composite building is less than RCC building.

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