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A Review on Comparative Study on the Seismic Behaviour of RCC and Composite Structures

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ABSTRACT: *In India most of the structure buildings are low rise buildings. The population in cities is growing exponentially and the land is limited, there is a need of vertical rise of buildings. Reinforced concrete frames are used for low rise buildings, because loading is nominal. But in medium and high rise buildings, the steel concrete composite construction is preferred, because of their light weight over the RCC construction. Composite steel concrete system can provide extremely economical structural systems with high durability, rapid erection and superior seismic performance characteristics. In Composite construction the two different materials are tied together by the use of shear connectors at their interface having lesser depth which saves material cost. In the building construction sector as the utilization of materials is excessive there is a big scope of reducing the harmful effect caused by such heavy utilization, thereby contributing to the sustainable performance of the building. The seismic performance of composite building is better than the RCC building. The parameters like bending moment and maximum shear force is coming more for RCC structure than the composite structure. The comparative study included size, deflections, material consumption of members in RCC sections as compared to composite sections will be studied closely.*

Keywords: Composite structures; Storey drift; Base shear; Displacement; Shear Force; Cost Analysis

1. Introduction

In India the use of steel is low as compared to other developing countries. Experiences of other countries indicate that this is not due to the lack of the economy of steel as a construction material. Reinforced concrete structures have been used in civil engineering sector for 3-4 decads. But in present time composite construction is adopted over the RCC construction. Composite construction is formed when the two hetrogious material are binded together so that they act as a single unit. The entire process is called composite action. Composite construction have essentially different materials complementary to each other; they have almost the same thermal expansion; they have an ideal combination of strengths with the steel efficient in tension and concrete in compression and concrete also protect the steel to corrosion. This paper include the comparative study of RCC and composite structure

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comparative study includes story drift, displacement, base shear, shear force in column, bending moments in composite with respect to RCC sections. Composite structures are most effective and economical with the RCC for medium to high rise buildings.

2. Literature Review

B. Hoffmeister and G. Sedlacek (2000) - In this paper the experiments and numerical investigations performed over the composite structures with high strength materials. Tests on composite beams and columns made of high strength Steel in combination with normal strength or high strength concrete. They found that the modification in the euro code 4 according to the numerical investigations over the composite structures.

Josef Hegger and Peter Doinghaus (2000) – Structural steel and concrete to form composite structures. The high strength steel and concrete is generally used for the composite structure. The Institute for Structural Concrete has carried out experiments and performed FE calculations for composite beams. The tests that were performed at the Institute for Structural Concrete at the Technical University of Aachen confirmed the necessity of a reduction factor for a plastic design where High Performance Concrete (HPC) is being used. The application of a proposed factor depending on the concrete grade has shown good results.

Wendel M. Sebastian and Richard E. McConnel (2000) – In the paper the advanced nonlinear finite-element program is developed for the analysis of composite structures of steel and reinforced concrete. The elements used for the analysis are concrete slab and steel beam. Concrete is nonlinear isotropic material before cracking and nonlinear orthotropic material thereafter, while steel is a linear elastic material. This program provides the help in the behaviour of steel concrete composite structure, at the level of failure. With the help of program crack patterns, internal deformations and shear connector actions have all been determined with high accuracy.

Jörg Lange and Wolfgang Kurz – In the starting of 1980s multi-storey industrial buildings were built with composite decks, beams, and columns. Basic research and the development of design procedures on fire-resistant composite members supported this development. The paper presents some of the most important composite buildings that were built in Germany recently. The real life example of composite buildings in Germany was

Highlight Munich Business Towers, Junghof, Frankfurt, Main Railway Station Berlin.

Tai- Kuang Lee, Austin D. E. Pan (2001) – The author studied that a reliable and computationally efficient beam-column finite element model for the analysis of composite members of fully encased sections under cyclic loading conditions that include uniaxial bending and axial force. They found that the shear studs added to fully encased composite beam-column do not significantly affect the lateral ultimate strength and ductility of the member.

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D. R. Panchal (2011) – The author compared steel concrete composite structure and RCC structure having G+30 multistory commercial building situated in earthquake zone four. The modeling of composite and RCC structure is done with the help of ETABS software. They found that reduction in the seismic weight up to 30% with respect to RCC structure, and the size of the main beam is reduces about 25% and the size of secondary beam is reduces up to 60%. Composite structure is more ductile so it can resist more lateral force as compare to RCC structure, and the displacements are within permissible limit as per code.

Mahesh Suresh Kumawat (2014) – The author modeled and compared the composite structures and RCC structures having G+9 story building which is situated in earthquake zone three and for the seismic loading, according to IS-code. A three dimensional modeling and analysis is done with the help of SAP 2000 software. They found that the total dead weight of the composite structure is less than the RCC structure, Hence seismic forces are reduced up to 15% to 20% in composite structures. The stiffness in composite structure is increased by 12% to 15% in transverse direction and about 6% to 10% in longitudinal direction as compared to RCC structures and the composite structure is more ductile so it can resist more seismic forces as compare to the RCC structures.

Rahul Pandey (2014) - The author compared the seismic performance of a 3D (G+7) storey RCC and Composite building frame situated in earthquake zone V. All frames are designed for same gravity loadings. The RCC slab is used in all three cases. Beam and column sections are made of either RCC or Steel concrete composite sections. Equivalent static method and Response Spectrum method are used for seismic analysis. Base Shear for RCC frame is maximum because the weight of the RCC frame is more than the composite frame. Base shear gets reduced by 40% for Composite frame in comparison to the RCC frame. Reduction in cost of Composite frame is 33% with cost of RCC frame.

Prakarsh Sangave , Nikhil Madur (2015) – The author compared the bare and infill frame of four models of G+6 and G+10 RCC and steel concrete composite structures situated in earthquake zone five. They found that the base shear is less in steel composite structure as compared to the RCC structure, because of the less seismic weight. The story drift and displacement is high in steel concrete composite structure with the RCC structure. Shear force in RCC structures are more as compared to steel composite structures and bending moment in beams and columns of RCC structure is more as compared to composite structure.

Umesh P. Patil, Suryanarayan M (2015) - The author compared the seismic performance of G+15 story's building made up of composite structure and RCC structure using ETABS 2013 software and the structure situated in earthquake zone three on a medium soil. Response spectrum and static method is used for the analysis of the building. They found that story drift in composite structure is less as compared to the RCC structure. Composite structure have less dead weight as compare to RCC structure, so it reduces the total cost of the structure. Composite structures are more ductile and resist more lateral load as compare to the RCC structures.

Zafar Mujawar, Prakarsh Sangave (2015) - The author proposed the comparison of reinforced concrete and composite structures under the effect of static and dynamic loads. The results of this work show that composite structures are best suited for high rise buildings compared to that of reinforced concrete structures. Response spectrum method is used for comparison of three structures with the help of ETABS software. The displacement of composite structure has increased by 48% that of the RCC structure. Also time required for construction of composite structures is less compared to that of R.C structures as no formwork is required.

Mr. Nitish A. Mohite, Mr. P.K.Joshi, Dr. W. N. Deulkar (2015) - The author said that Steel-concrete-composite structures are formed by connecting the steel beams with concrete slab or profiled deck slab with the help of mechanical shear connectors so that slab and beam act as a single unit called as monolithic construction. They presented in work, options of construction of (B+G+11storey) commercial building, situated in Kolhapur, with steel-concrete-composite and RCC are studied and compared with each other. 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 conclude that overall response of composite structure is better than RCC structure.

A.Sattainathan Sharma, R. Anjighap Priya (2016) – The author compared the framed structures made by RCC and composite structure located in earthquake zone four having G+20 story building with the plan dimension is 30m *24m. The equivalent static method has been preferred for the seismic analysis, and SAP2000 software has been used. They found that the displacement and story drift is more in case of composite structure as compared to the RCC structure, but it should be within the permissible limit as per codal provision and the dead weight of the composite structure is reduced up to 20% to 25% as compared to the RCC structure, so that the cost of construction is less in composite structure. The stiffness of the composite structure is more as RCC structure, so that the composite structures are found to be the best mode of construction

Vinay Sanjeev kumar Daman (2016) – The author is compared G+15 multistory building for the steel concrete composite structure with the RCC structure situated in earthquake zone four and for various earthquake loading according to IS:1893-2002. They found that deflection and story drift in composite structure is more than that of the RCC structure, but the deflection is within the permissible limit. The axial force and shear force is more in RCC structure as compared to composite structure. Maximum Bending moment in composite structure is slightly high in some story is than RCC structure.

Renavikar Aniket V. Suryawanshi Yogesh (2016) – The author modeled four multistory buildings G+9,G+12,G+15,G+18, with 3.0m floor height with plan dimension 15m*9m. The analysis is done for the various Load combinations as per IS-code by using STAAD Pro software. They found that the total dead weight of the steel composite structure is less as compare to RCC, so that the seismic force is not very harmful for steel composite structures. The reduction in the section of steel element, cost is reduced as compare to RCC structures.

.**Avani Mandlik, S K Sharma, Shahjad Mohammad (2016) –** The author studied by modeling the multistoried building under the effect of seismic forces and comparing various parameters like the displacements in the building, column forces and moments generated in the building and find out the changes in the various structural parameters of these different

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types of construction techniques on symmetrical G+10, G+15 and G+20 multi-storied buildings under the effect of seismic forces. They conclude on the node displacement in Steel composite structure is less than that in RCC structure in the seismic loading.

3. Conclusion

- The dead weight of the composite structure is less as compared to the RCC structure, so that the seismic forces are not very harmful for the composite structures.
- The displacements and story drift in RCC structure is less than the composite structure but are in permissible limit. It is due to the flexibility of the composite structure when compared to RCC structure.
- The composite structure gives lateral stiffness and more ductility.
- The RCC structure have more weight as compared to the composite structure, so that the base shear and shear force in RCC structure is more than the composite structure.
- Maximum bending moment in beams of composite structure is slightly on higher side in some story's than RCC structure.
- Maximum bending moment in columns of composite structure is reduced from 12% to 24%.
- Dead weight of the composite structure is low, when compared to the RCC structure, resulting in reduction of foundation cost.
- For high rise structures, composite structure are found to be the best mode of construction.
- There is reduction in cost of steel structures as compared to RCC structure due to the reduction in dimensions of the elements.
- The program is developed for the analysis of composite structures and numerically investigated and with the help of this the modification factor is used in Euro code.

4. References

1. B. Hoffmeister and G. Sedlacek (2000). " High Strength Materials In Composite Structures". Institute of Steel Construction, RWTH Aachen D-52056 Aachen, Germany

2. Josef Hegger and Peter Doinghaus (2000). **"**High Performance Steel And High Performance Concrete In Composite Structures". Institute for Structural Concrete, Aachen Technical University

3. Wendel M. Sebastian and Richard E. McConnel (2000). "Nonlinear FE Analysis Of Steel Concrete Composite Structure". Journal of Structural Engineering / June – 2000

4. Tai- Kuang Lee, Austin D. E. Pan (2001). " Analysis Of Composite Beam Columns Under Lateral Cyclic Loading". Journal Of Structural Engineering.

5. Jörg Lange And Wolfgang Kurz (2008). "Composite Buildings In Germany". International Conference On Composite Construction In Steel And Concrete 2008

6. D. R. Panchal (2011). "Comparative Study Of RCC And Composite (G+30 Storey) Building". Institute of Technology, Nirma University, Ahmedabad December-2011.

7. Mahesh Suresh Kumawat (2014). "Analysis And Design Of Multistory Building Using Composite Structure". International Journal of Structural and Civil Engineering and Research Volume 3, No. 2, May- 2014.

8. Rahul Pandey (2014). "Comparative Seismic Analysis Of RCC, Steel And Steel Concrete Composite Frame". National Institute Of Technology, Rourkela , 42.
9. Prakarsh Sangave , Nikhil Madur (2015). "Comparative Study Of Analysis And Design Of RC And Steel Concrete Composite Structures". International Journal of Scientific and Engineering Research, Volume 6, Issue 2, February-2015.

10. Umesh P. Patil, Suryanarayan M (2015). "Analysis Of G+15 RCC And Composite Structure Having A Soft Storey At Ground Level By Response Spectrum Method And Equivalent Ststic Methods Using ETABS 2013". International Research Journal of Engineering and Technology Volume 2, June-2015.

11. Zafar Mujawar, P.S. (2015). " Comparative Evaluation Of Reinforced Concrete, Steel And Composite Structures Under The Effect Of Static And Dynamic Loads". Int. Journal Of Engineering Research And Applications , 4.

12. Mr. Nitish A. Mohite, Mr. P.K.Joshi, Dr. W. N. Deulkar (2015)."Comparative Analysis Of RCC And Steel Concrete Composite Building". International Journal Of Scientific And Research Publication , 6.

13. A.Sattainathan Sharma, R. Anjighap Priya (2016). "Comparative Study On Multi-Story Structure Of RCC And Composite Material".Indian Journal Of Science And Technology, Vol 9(2), January 2016

14. Vinay Sanjeev kumar Daman (2016). " Design Of Steel Concrete Composite Structure As Comparative With Reinforced Concrete Structure By Adopting STAAD. PRO". International Journal of Engineering Sciences and Management Research, January-2016.

15. Renavikar Aniket V. Suryawanshi Yogesh (2016). " Comparative Study On Analysis And Cost Of RCC And Steel Composite Structure". International Journal of Science and Research, Volume 5 Issue 7, July-2016.
16. Avani Mandlik, S K Sharma, Shahjad Mohammad (2016). "Behaviour Of Symmatric RCC And Steel Frame Structures Under Seismic And Wind Loading". International Journal Of Research And Scientific Innovation, 6.