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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. As the land is limited and there is an exponential growth in population, there is a need of vertical rise of buildings. For the low rise buildings Reinforced concrete frames are used for, because loading is nominal. The steel concrete composite construction is preferred in medium and high rise buildings, because of their light weight over the RCC construction. Composite steel concrete system can provide highly economical structural systems that gives high durability, rapid erection and superior seismic performance characteristics. When two different materials are tied together in the composite construction with the help of shear connectors at their interface having lesser depth, it 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 value of bending moment and maximum shear force is higher 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 structure, storey drift, Base shear, Displacement, Shear force, Cost analysis.

1. INTRODUCTION

As compared to other developing countries, the use of steel in India is quite low which is not due to lack of economy of steel as a construction material but due to the fact that, the reinforced concrete structures have been used in civil engineering sector for 3-4 decades. But in present time composite construction is adopted over the RCC construction. Composite construction is formed when the two heterogious 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 high degree of similarity in thermal expansion and also have an ideal combination of strengths with the steel efficient in tension and concrete in compression, along with this the concrete also protect the steel from corrosion. This paper include the comparative study of RCC and composite structure comparative study includes story drift, displacement.

2. LITERATURE REVIEW

2.1 B. Hoffmeister and G. Sedlacek (2000)

In this paper [1] the experiments and numerical investigations performed over the composite- structures with high strength materials. Tests have been conducted on composite beams and columns made of high strength Steel combined with normal or high strength concrete. They found that the modification in the euro code 4 according to the numerical investigations over the composite structures.

2.2 Josef Hegger and Peter Doinghaus (2000)

In this work the researcher have studied Composite structures made of structural steel and concrete which maximize the advantages of the two components. The use of high-performance materials composite construction becomes popular. The European Coal and Steel Community has therefore supported the research project 'Use of High Strength Steel $460'. From past many years European research institutes worked on developing design and execution guidelines to overcome the limitations associated with using these high-strength materials. The Institute for Structural Concrete has carried out experiments and performed FE calculations for composite beams made of High Performance Steel $460 (HPS) and High Performance Concrete

C 70/85 (HPC). The experiments they performed 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 factors they proposed depending on the concrete grade has proven good results.

2.3 Wendel M. Sebastian and Richard E. McConnel (2000)

They developed a highly advanced nonlinear finite-element (FE) program to analyze the general composite structures of steel and reinforced concrete, including composite space trusses. In their program they have used concrete slab and steel beam as the elements for the analysis. Also they have used the layering technique in determining local stress redistributions associated with progressive through-depth cracking and yielding in the slab and steel beam elements. Concrete shows nonlinear elastic isotropic behaviour before cracking and nonlinear orthotropic thereafter, whereas steel is taken to be initially elastic with strain-hardening capabilities after yielding. This program helps in study the behaviour of steel concrete composite structure, at the level of failure and also it determined the actions such as crack patterns, internal deformations and shear connector with high accuracy.

2.4 Jörg Lange and Wolfgang Kurz

They people have studied about the multi-storeyed buildings that were built with composite deck slabs, beams, and columns. Basic research and the development of design procedures was on fire-resistant composite members supported this development. Some of the most important composite buildings that were built in Germany recently. From last some decades (1950 to 1980) many important high-rise buildings were built using steel and composite members. Starting with the 16 storey building for the Continental Gummiwerke in Hannover in 1952 followed by the Thyssen building in Düsseldorf. The research on fire-safe steel and composite structures that started in the late 1970s helped in designing new industrial buildings using partly encased composite beams and columns that was advantageous to users in many aspects. These are easy retrofitting and refurbishment, fast erection, good fire resistance. There are some real life examples such as Highlight Munich Business Towers, Junghof, Frankfurt, Main Railway Station, Berlin.

2.5 Tai- Kuang Lee, Austin D. E. Pan (2001)

In this paper[4], 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. Based on the comparison with the empirical data, stiffness reduction is suggested for the fiber model analysis. They investigate that the main cause of stiffness decay of fully encased composite beam-columns was buckling of longitudinal.

2.6 D. R. Panchal (2011)

In this research [6], the author compared steel concrete composite structure and RCC structure having G+30 multistory commercial building situated in earthquake zone four. The ETABS software was used in this research for the modelling of composite and RCC structure. 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%. The research shows [6] that the Composite structure is more ductile in nature so it can resist more lateral force as compare to RCC structure, and the displacements are within permissible limit as per code.

2.7 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 [7]. 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 increment in the stiffness in composite structure has been shown by researcher about 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.

2.8 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 storey drift and displacement is high in steel concrete composite structure with the RCC structure. Results of this study [9] shows that the Shear force in RCC structures are more as compared to steel comp-osite structures and bending moment in beams and columns of RCC structure is more as compared to composite structure.

2.9 Umesh P. Patil, Suryanarayan M (2015)

The author compared the seismic performance of G+15 story's building made up of RCC structure and compostite structure using ETAB 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. The work proposed that [10] storey drift in composite structure is less as compared to the RCC structure. Result of this work proves that the Composite structure have less dead weight as compare to RCC structure, so it reduces the total cost of the structure. This work [10] also supports that the Composite structures are more ductile and resist more lateral load as compare to the RCC structures.

2.10 Zafar Mujawar, Prakarsh Sangave (2015)

They have compared the Reinforced concrete, Steel and Composite structures under the effect of static and dynamic loads. Response spectrum method were used for comparison of three structures with the help of ETABS software. This work results in that the 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.

2.11 Mr. Nitish A. Mohite, Mr. P.K.Joshi, Dr. W. N. Deulkar (2015)

They analysed the steel concrete composite structures are formed by connecting the steel beams with concrete slab or profiled deck slab with the help of shear connectors so that the structure act as a single unit. They modelled and analysed B+G+11 storey commercial building situated in Kolhapur with steel concrete composite structure and RCC structure and the results of both structures are compared. Equivalent linear Static Method is used for the analysis with ETABS software. Comparative factors 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 was observed that steel-concrete composite building is found to be more safe and economical and proved as a better option. Overall they conclude that the response of composite structure is better than RCC structure.

2.12 *A*.Sattainathan Sharma, R. Anjighap Priya (2016)

In this paper [13], 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, it reduces the

construction cost of composite structure. The stiffness of the composite structure is more as RCC structure, therefore composite structures are found to be the best mode of construction.

2.13 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 [14], but the deflection is within the permissible limit. The axial force and shear force is more in RCC structure as compared to composite structure. Research shows that the Maximum Bending moment in composite structure is slightly high in some story is than RCC structure.

2.14 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. The work proposed [15] 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.

2.15 Avani Mandlik, S K Sharma, Shahjad Mohammad (2016)

They Modelled the multi-storied building under the effect of seismic and wind forces respectively and they also compare the various parameters like the displacements in the building, column forces and moments generated in the building. The various structural parameters of these different types of construction techniques on symmetrical G+10, G+15 and G+20 multi-storied buildings under the effect of seismic and wind forces respectively. It discusses the analysis & design procedure adopted for the evaluation of symmetrical high rise multi-storied buildings G+10, G+15 and G+20 under effect of Wind and Earthquake 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.

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