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A Review of Steel Concrete Composite Beam

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ABSTRACT:
The majority of residential buildings are designed and constructed in reinforced concrete, which largely depends on the existence of the constituent materials as well as the quality of building skills needed, and also the usefulness of the design standards. R.C.C. is no longer economical because of its expanded dead weight, hazardous formwork. Composite construction, however, is a recent development for the construction industry. steel concrete composite structures are currently very popular due to several advantages over conventional concrete and steel structures. Concrete structures are heavy compared to composite building, giving greater seismic weight as well as more deflection, composite structure incorporates their best properties between both steel and concrete to reduced costs, rapid construction, fire protection, etc. Through use of new modern composite structures can find it economically prohibitive the slow construction of every storey while casting RCC columns, allows the erection of high rise structural frameworks to continue at speed. However, the excellent earthquake resistant performance of composite beam columns has long been known in Japan and have been commonly used for construction in that region. It was also necessary to develop seismic design criteria for typically used Indian structural systems to promote the use of such a successful type of composite construction.

KEYWORDS: Steel Composite, Shear-connectors, RCC,Sandwich construction ,Composite Structures.

I. INTRODUCTION

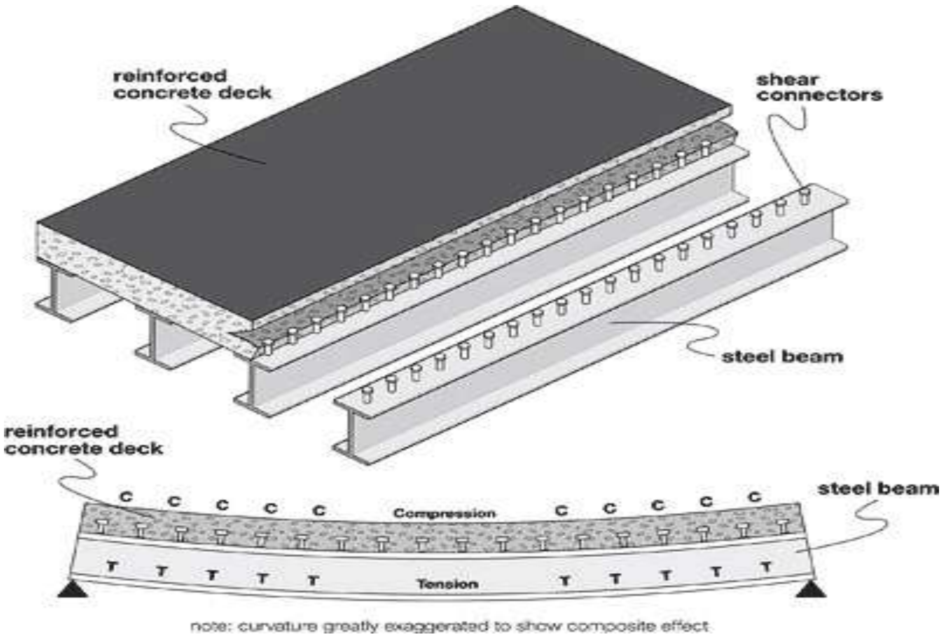
In India most of the building structures fall under the category of low rise buildings. So, for these structures reinforced concrete members are used widely because the construction becomes quite convenient and economical in nature. But since the population in cities is growing exponentially and the land is limited, there is a need of vertical growth of buildings in these cities. So, for the fulfillment of this purpose a large number of medium to high rise buildings are coming up these days. For these high rise buildings. it has been found out that use of composite members in construction is more effective and economic than using reinforced concrete members. The popularity of steel-concrete composite construction in cities can be owed to its advantage over the conventional reinforced concrete construction. Reinforced concretes frames are used in low rise buildings because loading is nominal. But in medium and high rise buildings, the conventional reinforced concrete construction cannot be adopted as there is increased dead load along with span restrictions, less stiffness and framework which is quite vulnerable to hazards.In construction industry in India use of steel is very less as compared to other developing nations like China, Brazil etc. Seeing the development in India, there is a dire need to explore more in the field of construction and devise new improved techniques to use Steel as a construction material wherever it is economical to use it. Steel concrete composite frames use more steel and prove to be an economic approach to solving the problems faced in medium to high rise building structures.

COMPOSITE STRUCTURES

When a steel component, like an I-section beam, is attached to a concrete component such that there is a transfer of forces and moments between them, such as a bridge or a floor slab, then a composite member is formed. In such a composite T-beam, the comparatively high strength of the concrete in compression complements the high strength of the steel in tension. Here it is very important to note that both the materials are used to fullest of their capabilities and give an efficient and economical construction which is an added advantage.

COMPOSITE STEEL-CONCRETE BEAM

A concrete beam is formed when a concrete slab which is casted in-situ conditions is placed over an I-section or steel beam. Under the influence of loading both these elements tend to behave in an independent way and there is a relative slippage between them. If there is a proper connection such that there is no relative slip between them, then an I-section steel beam with a concrete slab will behave like a monolithic beam. The beam is composite of concrete and steel and behaves like a monolithic beam. Concrete is very weak in tension and relatively stronger in tension whereas steel is prone to buckling under the influence of compression. Hence, both of them are provided in a composite such they use their attributes to their maximum advantage. A composite beam can also be made by making connections between a steel I-section with a precast reinforced concrete slab. Keeping the load and the span of the beam constant, we get a more economic cross section for the composite beam than for the non-composite tradition beam. Composite beams have lesser values of deflection than the steel beams owing to its larger value of stiffness. Moreover, steel beam sections are also used in buildings prone to fire as they increase resistance to fire and corrosion.



II. LITERATURE REVIEW

Varsha Patil et al., (2015) made a research work on response of structures made of RCC, Steel and Composite when subjected to various static and dynamic loads which is mainly due to earthquake. This was a review journal about the composite structure when subjected to the seismic loads. They are both theoretical and software analysis of the structure. Were due to the reduction of self load they withstand the seismic loads well compared to the RC structure. As the structures are more than G+3, Storey stiffness can be observed that the transverse and longitudinal storey stiffness for composite structure is large as compared to RCC structure. The structures are design by STAAD-PRO using Eurocode and Equivalent Static Method of Analysis is used. For modeling of Composite & R.C.C. structures, staad-pro software is used and the results are compared; design of slab. beam, column and foundation for both composite and RCC have carried out and cost comparison is done and concluded that Steel-Concrete composite design structure is more costly, reduction in direct costs of steel-composite structure resulting from speedy erection will make Steel-concrete Composite structure economically viable.

Parag P. Limbare et al., (2016) made a paper work for RCC structure with steel concrete composite options are considered for comparative study of G+20 story building which is situated in earthquake zone-II and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. The design and analysis of the structure are carried out with the help of STAAD-PRO software. The results are compared and found that composite structure more economical. This paper also states that composite structure is suitable for all horizontal and vertical members in a structure and the construction time also reduces. The 3D building model is analyzed using Equivalent Static Method and Response spectrum method. The building models are then analysed by the software Staad Pro. Different parameters such as deflection, story drift, shear force & bending moment are studied for the models.I-section is carried out for whole structure with results that, this type of section is more effective than the other type of sections in steel-concrete composites.

Panchal et al., (2014) done a paper of the Indian context, composite steel concrete section is a relatively recent design concept and no suitable updated codes are available for the design of the same A simpler approach discussed in the current work not only avoids costly experimentation needed for design purposes, but also facilitates the design of several options for steel sections and shear connectors with shear connectors VB.NET is fully object oriented and offers execution of controlled code that runs under Common Language Runtime (CLR), resulting in applications that are robust, stable and secure. It also makes it possible to conveniently connect to the Microsoft Access database that has been found to be very helpful in providing quick access to the properties needed for design of different steel sections. As part of the pre- and postprocessor, a number of forms designed to allow the design of various types of composite slabs, beams and columns not only make the software quite user friendly and flexible, but also make the implementation of the software very appealing. For composite columns with a number of steel sections embedded in concrete and numerous concrete filled sections, the proposed computational approach is found to provide detailed performance.

Mandlik, Sharma et al., (2016) made this paper to explain improvements in the different structural parameters of all these different types of building techniques on symmetrical multi-storey structures 11, 16 and 21 storey buildings respectively, under the influence of seismic and wind forces. R.C.C. and Steel are deemed to withstand lateral forces resisting the system in these buildings. This research explores 11, 16 and 21 storied buildings with using STAAD.ProV8ii the comparison of results shows that: In such loading situations, the node displacement in steel systems is smaller than that in the RCC structure wind load and seismic load. In the case of seismic loading, the column forces in the R.C.C. structure are greater than those of the steel structure. Column forces in 16 storey and 21 storey RCC and steel systems are almost the same under the impact of wind load due to the ductile behavior of the steel that withstands the wind force more than that in concrete, but 11 storey RCC construction has less column forces than that in steel. The moment in the RCC structure in both seismic and wind load is very high relative to Steel. For steel buildings, there are very low bending moments.

Patil and Kumbhar et al., (2013) done a research on Nonlinear dynamic study of ten storied RCC buildings is conducted and seismic responses of the Modell are analyzed, taking into account different seismic intensities. Using SAP2000-15 program, the building under consideration is modelled. So the seismic responses, notably base shear, storey displacements and storey drifts for both axes, are observed to differ in comparable trends of intensities for all time histories and all models used in the study (V to X). As well as the parameters of seismic responses, base shear, storey displacement and storey drifts alike, are known to be among the enhanced order ofseismic intensities differing from V to X for any and all Time Histories, as well as all models. The seismic magnitude of VI, VII, VIII, IX and X has been more than 1.85, 3.56, 7.86, 15.1 and 17.15 times compared to the earthquake magnitude of V for all models (i.e. either with or without soft story) and for all the time history. And for the seismic different intensities of VI, VII, VIII, IX and X, the attributes of base shear, storey displacements and storey drifts (X and Y directions) are measured. Seeing as Time History is a realistic technique used during seismic analysis the reliability of structures evaluated and designed using the process defined by IS code is ideally checked.

Sutar and Kulkarni et al., (2016) made a research cited here has done to understanding the nonlinear composite frame behavior using ETAB 9.7 after examining the author reported that, composite steel concrete has more lateral load capability compared to RCC frame and the lateral displacement of composite steel concrete frame is reduced compared to RCC frame as composite steel concrete has light weight. The composite steel concrete frame follows strong column weak beam behavior as hinges are formed rather than column components in the beam element. From inelastic study for both RCC & composite frames, no unexpected plastic hinges were found. But the composite yield mechanism is superior to RCC since, compared to RCC, in high seismicity, the composite moment resisting frame has better performance.

May et al.. (2017) carried the study on Dynamic analysis of 13 storey RCC multi storey

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framed structure the Bhuj and Koyna earthquakes are considered in the study through time history and response spectrum analysis, with the aid of SAP2000 software, responses of such building are analyzed comparatively. By using time history analysis, the seismic response such as base shear for Bhuj earthquake is found to be more than 45.44 percent for Koyna earthquake. By response spectrum method, the base shear of the Koyna and Bhuj earthquake is found to be 37.01 percent and 41.30 percent higher than the time history method. The top storey displacement by response spectrum method of the Koyna and Bhuj earthquakes were found to be 33.15 percent and 34.26 percent higher than the time history method. For all the effects, the values of the storey drifts for all the stories are found to be within the allowable limits defined as per IS: 18932002 (Part I). The research recommends that time history analysis be conducted as it more reliably determines the structural response than the analysis of the response spectrum, It is concluded that the building used for pushover analysis is seismically stable since the base shear of the performance point is greater for both koyna and Bhuj earthquakes than the base shear designed.

Achari et al., (2018) done a study on simplified 30story composite structure approach is modelled and evaluated in this study, where columns and slabs are of composite form and steel section beam. Equivalent static analysis and dynamic time history analysis was carried out using ETABS Ver.15 software in conformity with IS 1893 (Part 1): 2016 requirements. It can be concluded from modal analysis that, due to larger time periods, composite structures are more stable in design and the presence of vertical irregularities raises the time period. The composite structure is subject to greater deformation and drifts compared to all other structural systems, with vertical irregularities at two positions, i.e. at the foundation and at mid height. Composite structure drifts and displacements with vertical irregularities are found to be within the allowable limits as defined by the code (H/300 = 300 mm and h/250 = 12 mm). These designs can also be suggested in the high seismic zone, up to 30 stories. Vertical irregularities lower the composite structure's overall stability, so it is possible to adopt such external bracing structures at these places. It can be concluded from the dynamic time history study that the vertical irregular steel structure does not induce additional acceleration, although it does see a slight increase in displacement.

Jagadale et al. (2019) provides a comparative analysis of the seismic performance of eight Storey frames for Steel, R.C.C. and Composite RCC, Steel and Composite Building Frame situated in Earthquake Zone V. The ETAB 2015 software is being used and the observations are evaluated and recorded. For seismic analysis, the equivalent dynamic method is used. Composite structures are ideally suited to high rise buildings and help in rapid construction. Lateral displacement of the Composite frame top story is 17 percent less than the steel frame and 15 percent more than the RCC frame in X Direction the Composite frame base shear is 84 percent less than the RCC frame and16 percent more than the steel frame. For RCC frames, axial forces in columns are greater than composite frames and steel frames, which equate to 24 percent and 81 percent respectively. The composite frame weight is 15% higher than the steel frame and 34% lower than the RCC frame for the (G+7) building frame.

Agarwal et al., (2020) provides a comparative analysis of the seismic performance of (G+7) Storey frames for Steel, R.C.C. and Composite RCC, Steel and Composite Building Frame situated in Earthquake Zone V. The ETAB 2015 software is used and the results are compared and reported. For seismic analysis, the equivalent dynamic method is used. Composite structures are ideally suited to high rise buildings and help in rapid construction. Lateral displacement of the Composite frame top story is 17 percent less than the steel frame and 15 percent more than the RCC frame in X direction The Composite frame base shear is 84 percent less than the RCC frame and16 percent more than the steel frame. For RCC frames, axial forces in columns are greater than composite frames and steel frames, which equate to 24 percent and 81 percent respectively. The composite frame weight is 15% higher than the steel frame and 34% lower than the RCC frame for the (G+7) building frame.

Abdul Qahir Darwish et al., (2020) made a review journal about the steel concrete compositestructures, where this journal firstly explains about the needs of this type of construction method and explains about the components of the composite construction like, composites slab, composites beams, composites column and shear connectors. The study indicates that the use of concrete filling steel tube columns had been consistently used for the construction of tall buildings as they have substantial economy compared to conventional steel construction. Compared to RCC and Steel construction, performance wise results are also good. Saying that by using SAP2000-15 program, the building under consideration is modelled. So the seismic

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responses, notably base shear, storey displacements and storey drifts for both axes, were observed to differ in comparable trends of intensities for all time histories and all models used in the study (V to X). This also explains, the bracing system is a good method of retrofitting the high-rise RCC structure to improve the seismic excitation system. It can also be said that the bracing system is a safe practice for high-rise RCC structure implementation to control and reduce the damage to the RCC structure during dynamic loading by increasing the structure's lateral load resistance capability due to strengthening characteristics. The cost analysis shows that the composite design structure of Steel Concrete is costlier, it will make the composite construction of steel concrete commercially feasible and minimize the direct expense of the steel composite structure arising from accelerated erection.Low-rise building comparisons are analyzed in this study work, in which the same seismic parameters are applied to all structures and the results of the analysis were compared to verify the suitability under seismic conditions of RCC, steel and composite low-rise buildings. Compared to RCC or SS (Steel Structures), the authors have concluded that the CS is stiffer and thus seismically resistant.

Shreyas K.N et al., (2018) done a journal investigation, A moment resisting frame of steel composite material structure are compared in terms of storey displacement, storey drift, and storey shear, deflection of the beam, axial load, and Base shear.It says that, Moment frames have been widely used for seismic resisting systems due to their superior deformation and energy dissipation capacities. A moment frame consists of beams and columns, which are rigidly connected.This journal explains the selection of the type of moment frame that should be selected according to levels of seismic risk or seismic design category. Seismic risk levels can be classified into low, moderate and high according to seismic zones concrete moment frames into two types: Ordinary Moment Resisting Concrete Frame (OMRCF) and Special Moment Resisting Concrete Frame (SMRCF).

The main objective of this journal is to estimate the seismic demands developed and to facilitate the conceptual design process and investigation is specifically towards the improving the seismic behavior of Steel composite moment resisting frame structures, & also intended to be for the development and implementation performance-based seismic engineering.

The analysis part of this journal is by using Extended-three dimensional Analysis of Building Structure (E-TABS) software 2016 V16.2.0, the models of structures were analyzed. The study parameters of this analysis is Maximum storey displacement, storey drift, storey shear, overturning moment, bending moment, shear force, axial force and cost of the structure. Since the design is related to India, for calculation of seismic loads and parameters, Indian standard of code for earthquake resistant design of structures IS 1893 (PART-1): 2002 and wind loads of IS-875 (PART-3) were referred for values.The result of the investigation shows that by using Steel composite design of tall buildings provides good results when compared to R.C.C and conventional steel building and also economically serve as a better solution for tall buildings by reducing cost up to 1.26% to 2%. Weight of composite structure is low when compared to R.C.C. structure resulting in reduction of foundation cost.

III. CONCLUSIONS

The foregoing conclusions are drawn from the aforementioned literature.

•In terms of the construction time factor, due to faster erection and placement, composite structure rather than RCC models can be suggested. However, for better structural behavior, appropriate workmanship needs to be followed.

•The composite structure is light weight thus the base shear and base moments are very lees as compared to conventional RCC frame structure beside this shear force in RCC structure is also considerably more than the composite structure due to heavy weight.

•When comparing the two composite structures, it was found that the structure's response parameters with concrete filled steel tubular columns and with concrete enclosed I section columns did not change significantly.

•For RCC, the time period is lower than for composite structures.Besides being moreductile, composites resist lateral load better than RCC structures.

•In the RCC structure, the displacements and storey drift are greater than the composite structure, but are within allowable limits. In contrast to the RCC structure, this is

due to the flexibility of the composite structure. The composite structure gives lateral stability and more ductility.

•The research recommends that time history analysis be conducted as it more reliably determines the structural response than the analysis of the response spectrum.

•Equivalent static analysis shows relatively higher values than the response spectrum method of analysis and the response spectrum method of

analysis findings display the structure's behavior more reliably than static
analysis

•The choice of steel frames is better than RCC, but the choice of composite frames for high-rise construction is best.

•The ultimate behavior of the composite structure is higher than the structure of RCC and Steel.

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