A REVIEW PAPER ON DESIGN AND COMPARISON OF MULTI-STORIED BUILDING OF R.C.C SECTION AND COMPOSITE SECTION BY STAAD.PRO V8i AND MANUAL

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Abstract: The purpose of this research paper is to determine the composite framing system consisting of steel girder acting monolithically with concrete has been as viable alternative to the conventional steel a reinforced concrete system in the high rise construction. The tall building and super tall building has been a common building type Mumbai, Kolkata, with multiple functions and complex geometry. Composite construction is broadly used in tall building structures and constitutes the mix structure together with concrete and steel construction. The mixture of the construction is purposely design for specific area based on the analysis results to achieve the best cost effectiveness. New types of composite construction are conceived of by engineers for columns and walls. Material distribution is more flexible and innovative in the structural level and member level. However the reliability of computer model analysis should be verified carefully. Further researches in the design and build of composite constructions are necessary to insure the success of its application.

Index Terms: **Composite beam, column, RCC column, RCC beam, Shear Connector, STAAD.Pro V8i Software.**

I. INTRODUCTION

With the rapid development of society, a variety of structural forms of new buildings springing up the structure of the twenty first century has gradually entered the area of composite structure:'' high performance steel + high – performance steel of high performance concrete''. The composite section of structural member as is known usually is composed of standard steel sections with concrete- usually of richer grade. It requires lesser area compared to concrete sections. For a high rise building in India, the composite sections of structural members are in things as it sustains lateral load to a great extent without collapse. This happens as the beam-column joints are quite ductile because of the extensive use of Fe- 250 grade of standard sections as against Fe- 415 & Fe- 500 grade of steel. With rapid growth in population along with the development of industrial and commercial activities rapid urbanization has taken place which has resulted in to continuous influx of rural people to metro cities in India. So obviously the horizontal space constraint is reaching an alarming situation for Metros. To scope with the situation maximum utilisation of space vertically calls for the construction of multi-storeyed buildings in large numbers but the question of affordability of the large customers mainly the middle income group of our country necessitates efficient and cost effective design of such buildings. While the concept of cost comparison considering time value of money is popularly advocated and practised all over the world particularly in the South East Asia the same has not been given due consideration till date in India. Use of reinforcement cement concrete as a material of construction is well- known in India mostly due to its lesser direct construction cost with respect to the alternatives. INSDAG has been trying to convince the architects, designers, builders and Government bodies about the importance of Life Cycle Cost (LCC) of structure and selection of construction materials for their projects. However, studies are required to be done for reducing the direct construction cost with alternative option following advanced technologies already prevalent in developed countries. One such technology is fast-track composite construction which is very popular method of construction of buildings abroad. With view to finding out cost effectiveness of steel-concrete composite option vis-à-vis RCC alternative, INSDAG has carried out this study to compare direct construction cost and real initial cost of composite construction having varied combination to cladding material and floor to floor height using a typical floor plan with that of RCC alternative involving brick façade and 3.15 m floor to floor height. For designing the structural framing system with steel-concrete composite option, Limit State Method of Designing following BS 5950 (Part 1,3&4) have been used. When we look at the scenario of composite construction in India, efforts are underway for making beams in composite construction as evidence by Bureau of Indian Standards introducing a separate code. IS: 11384:1985. There are organisations, which have taken interest in producing metal decking sheet suitable for composite construction. Government on their part have gone a head approving a few bridges in Kolkata & Delhi making use of this methodology. However one should be honest to report that we have not exploited the potential of composite system fully, be it in building industry or in infrastructure projects.

II. LITERATURE REVIEW

Dr. MD. Subhan (2017), studied the currently, Composite sections of the steel and concrete have been employed and deliberated around the world, yet filled tubular columns require more reflection. A substantially nonlinear model is proposed using ANSYS software with proper boundary conditions. This paper presents nonlinear finite element analysis of concrete enclosed steel column subjected to reverse cyclic, buckling and monotonic loading condition and to understand maximum deformation, load it can withstand, and stress distribution.

Anamika Tedia1(2017), tried to use Steel-concrete composite construction means steel section encased in concrete for columns & the concrete slab or profiled deck slab is connected to the steel beam with the help of mechanical shear connectors so that they act as a single unit. Steel-concrete composite with R.C.C. options are considered for comparative study of G+5 storey office building with 3.658 m height, which is situated in earthquake zone III(Indore)& wind speed 50 m/s. The overall plan dimension of the building is 56.3 m x 31.94 m. Equivalent Static Method of Analysis is used. For modelling of Composite & R.C.C. structures, Staad-pro software is used and the results are compared; and it is found that composite structure more economical.

Zhenwen Gong, Bin Zeng,(2017),The research results show that the node displacement response power spectrum under the load of wind is obtained, which provides the basis for rationally optimizing the structure. Based on the above findings, it is concluded that the optimization design based on finite element model has a wide significance, which is a useful attempt to reduce the blindness of design and has great engineering significance and application value.

Tariq M. Nahhas(2017), The study used software package ETABS in this study for modeling and analysis. The results are dissimilar from the comparisons reported for test places of USA. It is concluded that at most places SBC base shear is higher for both ELFP and MRSA. However, the results cannot be generalized and considered always right. The same is factual for overturning moments. Consequently, we cannot report that SBC is more conservative than UBC for all scenarios.

Shenzhen Foreign Languages School, Shenzhen, China(2017),In this research, by applying Finite Element Analysis (FEA) method, we simulated a cantilever beam composed of a sandwich structure in Abaqus, to find out the preferred design principles that help decrease the stress and displacement in the beam when applied a uniform load. We also determined the effect of the core geometry on decreasing the displacement and the stress in the beam.

DR. Chaterjee (2016): An experimental investigation of the ultimate strength and behaviour of a new type of composite beam called CSCC beam (Confined Steel Concrete Composite Beam) is a concrete beam shuttered with cold formed steel sheet which acts as a composite beam by means of shear connectors and bracings. Stud shear connectors are used to take up the bond between sheet and concrete. The passive confinement by the cold formed sheet in the sides and bottom influences the strength and ductility of the system. These beams are provides very good confinement of concrete. Totally eight CSCC beams are tested and the entire behaviour of the beams are monitored to predict the physical response of the beams under three different types loading such as pure bending, pure torsion and combined bending and torsion. Two point loading was obtained for pure bending. The deformation criteria (deflection, moment and flexural rigidity) are also included in the investigation throughout the entire load history experimentally. The results obtained by the experimental values which are found to be in good agreement.

R Prabhakara (2016), The grade of concrete was M30 and the grade of steel was kept Fe415. Composite action is predominant over the fundamental mechanism of load slip, load transfer and shear transfer. Sound bond between the two materials under flexure-shear is to be achieved during the design and construction of composite structures. The connection between the steel and the concrete section of this work was established using T-shear connectors. T-shear connectors were used in three different configurations. The beam specimens were tested by subjecting them to two points loading. The experimental results have also indicated that, the span to depth ratio and shear span to depth ratio have an influence on the increase in the load carrying capacity of the composite beams.

K.Sathish Kumar,(2016) a simple computation procedure is developed to predict the general behaviour of composite beam with shear connector under bending. Different spacing of shear connector should be change cold form sheet considered. The experiments include four series of composite beams tested. The tests reported were used to ascertain the flexural strength of the beams and to validate the theoretical predictions. Companion specimens of concrete cylinders and cubes were tested for compressive strength and elastic modulus properties. The section was then exposed to bending, and the change in the behaviour was noticed. The effect of a wide range of important parameters was studied on composite beams accompanied by bending.

Abhishek Sanjay Mahajan (2016), The paper presents the effect of FEC (Fully Encased Composite) on a G+ 20 storey special moment frame .In this paper two different structures are considered for the comparison under seismic analysis. The linear static analysis and nonlinear static analysis i.e. “Pushover analysis” are done for G+20 storey structure. The building is analyzed and design for seismic loading by using ETAB software. The unique method of pushover analysis is followed with the help of FEMA 36 specifications and for hinge formation ATC40 is considered. Results are compared for the Base shear, Modal time period, Storey displacement and storey drift for both structures. As the composite is having more lateral stiffness, the results of time period and storey displacement shows the significant variation. While analyzing for “Non-linear static analysis the performance point for the FEC is significantly much more as compared to the RCC model.

Y.P.Pawar, S.S.Kadam,(2016), The composite bridge gives the maximum strength in comparison to other bridges. The design and analysis of various girders for steel and concrete by using various software’s, in that paper for composite bridge calculate the bending moment for T girder and finding which is more effective. The efforts will make to carry out to check the analysis of bridge by using SAP 2000 software. To determine the static analysis of T girder by using manual method as well as software. The results obtained from the software in structural analysis are compare the results obtained from manual calculations.

Vinay N, Harish M L.(2015), Composite action is predominant over the fundamental mechanism of load slip, load transfer and shear transfer. Sound bond between the two materials under flexure-shear is to be achieved during the design and construction of composite structures. The cracking load, load-deflection behaviour, ultimate load and failure pattern of the beam specimens were studied. The experimental results indicate that, the load carrying capacity of the composite beams was increased by 38.09% to 214.28%. The experimental results have also indicated that, the span to depth ratio and shear span to depth ratio have an influence on the increase in the load carrying capacity of the composite beams. The mid-span deflection at ultimate load for the composite beams was reduced by 50% when compared to control beams. It was observed that, the steel-concrete composite beams failed due to shear-compression failure in the shear span.

Smitha. K .K (2015),Composite structures consisting of concrete slab and rolled up steel sections are widely used structural members in bridges and high rise buildings. The composite action is established by connecting the concrete slab and the steel section by using shear connectors. In this paper, four different types of shear connectors have been analyzed and the best connector for a particular composite beam has been evaluated based on its performance under static load keeping the loading and the amount of steel in the connector as a common aspect.

K.Shanmuga Priya (2015) ,The passive confinement by the cold formed sheet in the sides and bottom influences the strength and ductility of the system. These beams are provides very good confinement of concrete. Totally eight CSCC beams are tested and the entire behaviour of the beams are monitored to predict the physical response of the beams under three different types loading such as pure bending, pure torsion and combined bending and torsion. Two point loading was obtained for pure bending. The deformation criteria (deflection, moment and flexural rigidity) are also included in the investigation throughout the entire load history experimentally. The results obtained by the experimental values which are found to be in good agreement.

Jeeva K (2015) In this project an attempt is being made to compare the structural behaviour of steel and steel-concrete composite structures for four different storey levels ranging from G+7 (21.35m) to G+10 (30.05m) structures under response spectrum and pushover analyses. Pushover analysis which is a non-linear static analysis is a popular tool for predicting seismic forces and deformation demands for performance evaluation of existing and new structures. The results indicate that SRC structures are more flexible and they have high displacement values along longitudinal direction; however along the lateral direction the composite structures have lower displacement and drift values compared to steel structures. G+10 storey steel structures are found to suffer maximum displacement and bases shear.

G.Augustine Maniraj Pandian2(2015), The above parameters obtainable under pushover analysis are compared with that of linear response spectrum analysis. The results indicate that SRC structures are more flexible and they have high displacement values along longitudinal direction; however along the lateral direction the composite structures have lower displacement and drift values compared to steel structures. G+10 storey steel structures are found to suffer maximum displacement and bases shear.

Zhou Wangbao,1 Li Shu-jin,1(2015), The results from the proposed method are found to be in good agreement with those from ANSYS through numerical studies. Its validity is thus verified and meaningful conclusions for engineering design can be drawn as follows. There are obvious shear lag effects in the top concrete slab and bottom plate of steel beams under dynamic excitation. This shear lag increases with the increasing degree of shear connections. However, it has little impact on the period and deflection amplitude of vibration of composite box beams. The amplitude of deflection and strains in concrete slab reduce as the degree of shear connections increases. Nevertheless, the influence of shear connections on the period of vibration is not distinct.

Dr.SavitaMaru (2014), Steel-concrete composite construction means steel section encased in concrete for columns & the concrete slab or profiled deck slab is connected to the steel beam with the help of mechanical shear connectors so that they act as a single unit..Steel-concrete composite with R.C.C. options are considered for comparative study of G+5 storey office building with 3.658 m height, which is situated in earthquake zone III(indore)& wind speed 50 m/s. The overall plan dimension of the building is 56.3 m x 31.94 m. Equivalent Static Method of Analysis is used. For modelling of Composite & R.C.C. structures, staad-pro software is used and the results are compared; and it is found that composite structure more economical.

Francesco Trentadue1, Erika Mastromarino2, (2014),This system works in two distinct phases with two different resisting mechanisms: during the construction phase, the truss structure bears the precast floor system and the resisting system is that of a simply supported steel truss; once the concrete has hardened, the truss structure becomes the reinforcing element of a steel-concrete composite beam, where it is also in a pre-stressed condition due to the loads carried before the hardening of concrete. Within this framework, the effects of the diagonal bars on the bending stiffness of this composite beam are investigated. First, a closed-form solution for the evaluation of the equivalent bending stiffness is derived. Subsequently, the influence of geometrical and mechanical characteristics of shear reinforcement is studied. Finally, results obtained from parametric and numerical analyses are discussed.

Hiroshi Mutsuyoshi,(2014),The test results showed that all of the composite beams exhibited significant improvements in stiffness and strength properties, above those of single HFRP I-beams without a UHPFRC slab. A fibber model was developed to predict the strength and stiffness of the composite beam, and the model accuracy was verified. Good agreement was found between the experimental and analytical results. The high tensile strength of a carbon FRP in an HFRP tensile flange could be used effectively, and the delaminating failure of an HFRP compressive flange could be prevented through the addition of a UHPFRC slab on the top flange of the HFRP I-beam. The study revealed that HFRP–UHPFRC beams were efficient and could provide a competitive, cost-effective, and sustainable solution to bridge structures.

Dr. MD KAusik(2014), substantially nonlinear model is proposed using ANSYS software with proper boundary conditions. This paper presents nonlinear finite element analysis of concrete enclosed steel column subjected to reverse cyclic, buckling and monotonic loading condition and to understand maximum deformation, load it can withstand, and stress distribution.

Balaji A Raju, A Praveen 2013 described the pre-engineered steel buildings are widely used in the construction of industrial buildings. Very short erection time and higher strength to weight ratio are the major advantages of these systems. Some of the components like slabs and walls in PEB construction are still done on-site. This paper addresses this limitation through development of a composite panel using cold form steel section. The panel is experimentally analysed for flexure and the results hence obtained are also simulated using finite element method.

Mohammad S. Qatu1,(2012), This paper reviews most of the research done in recent years (2000-2010) on the static and buckling behaviour (including post buckling) of composite shells. This review is conducted with an emphasis on the analysis performed (static, buckling, post buckling, and others), complicating effects in both material (e.g. piezoelectric) and structure (e.g. stiffened shells), and the various shell geometries (cylindrical, conical, spherical and others). Attention is also given to the theory being applied (thin, thick, 3D, nonlinear…). However, more details regarding the theories have been described in previous work.

D.Datta(2011), Mostly the metros with better living opportunities are densely populated because people from less privileged areas throng en mass to these metros. So, it is an arduous task to accommodate such a large volume of migrating people considering all the constraints of expansion possibility of the metros, which necessitates construction of tall buildings. For high-rise buildings Steel-Concrete composite construction is cost-effective. Further, cost is a concept, which varies according to its purpose and Direct Construction Cost is an investment only. The durability, resistance to wind / earthquake tremors, Life Expectancy, better functionality are considered in assessing the Net Construction Cost and Life Cycle Cost of the structures.

D. Datta (2010), In this paper for high-rise buildings Steel-Concrete composite construction is cost-effective. Further, cost is a concept, which varies according to its purpose and Direct Construction Cost is an investment only. The durability, resistance to wind / earthquake tremors, Life Expectancy, better functionality are considered in assessing the Net Construction Cost and Life Cycle Cost of the structures.

Avinash Ramsaroop, KrishnanKanny(2010), The inputs of the program are the material properties, material limits and loading conditions. Equations based on Hooke's Law for two-dimensional composites were used to determine the global and local stresses and strains on each layer. Failure analysis of the structure was performed via the Tsai-Wu failure theory. The output of the program is the optimal number of fibre layers required for the composite laminate, as well as the orientation of each layer.

Rajneesh &Mamta (2005) ,In this paper two different structures are considered for the comparison under seismic analysis. The linear static analysis and nonlinear static analysis i.e. "Pushover analysis" are done for G+20 storey structure. The building is analysed and design for seismic loading by using ETAB software. The unique method of pushover analysis is followed with the help of FEMA 36 specifications and for hinge formation ATC40 is considered. Results are compared for the Base shear, Modal time period, Storey displacement and storey drift for both structures. As the composite is having more lateral stiffness, the results of time period and storey displacement shows the significant variation. While analysing for "Non-linear static analysis the performance point for the FEC is significantly much more as compared to the RCC model.

Dharti D. Soni1, Nirav K. Patel2(1996),A G+ 5 Storied frame system of R.C.C.,Steel and steel-concrete composite building is taken under consideration for seismic performance for earthquake zone III with medium soil. Total 3 Models are analysed using Equivalent static method of analysis (IS : 1983 2002). Section is selected by optimization technique for efficient and economical design.

III. CONCLUSION

This review paper provides information on various factors that help in understanding of factors affecting design, and analysis of composite structure. Factors such as material selection have been studied along with the scope of composites in developing more ductility. In composite structure due to high ductile nature of steel it leads to increased seismic resistance of the composite section. Steel component can be deformed in a ductile manner without premature failure and can withstand numerous loading cycles before fracture. The simplified plasticity theory can be adopted to calculate the flexural capacity, the cross-sectional form of thick steel plate at the bottom has good flexural capacity and ductility, and the stress factor alpha can be appropriately improved in the review. The maximum vertical displacements in the short and long term can also be evaluated for simply supported and continuous composite beams using accurate finite element model. The effect of slip and moisture transfer on the behaviour of steel concrete composite beam was also reported. On the other hand researcher reported the natural networks can be applied successfully on the composite construction models. Conventionally headed shear connectors are mostly used for the steel concrete composite beams and bridges. However recently new types of shear connectors are being increasingly used and studies have been carried out such shear connectors. Studies showed that epoxy adhesive can also be successfully used at alternate of connector in composite construction.

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REFRENCES

[1] D. Datta and S. Ghorai, "Multistoreyed Residential Building (B+G+20) Storied with Steel-Concrete Composite construction", Institute for Steel Development & Growth
[2] T.K. Bandyopadhyay, "Basic Concepts in Composite Structures", Refresher Course on Composite Construction using Structural Steel, organized by Institute for Steel Development & Growth (INSDAG.
[3] R. Narayanan, "Composite Steel Structures", Advances, Design and Construction, Elsevier, Applied Science,
[4] Study Report, "Steel Framed Multi-storeyed Buildings", The Economics of Construction in the UK,
[5] R Narayanan, "Structural Steel Design", Teaching Resource: Volume I, II & III : INSDAG Publication prepared by IIT Madras, Anna University and Structural Engineering Research Centre (SERC), Chennai.
[6] D. Datta and A. Guha, "Guidebook for Design of Embossed Profiled Sheets acting as Composite Deck", Institute for Steel Development & Growth.
[7] D. Datta and S. Ghorai, "Multi-storeyed Buildings with Steel-Concrete Composite Construction – (G+3) & (G+6)", Institute for Steel Development & Growth .
[8] T.K. Bandyopadhyay, "Life-Cycle-Analysis of Steel-Intensive Green Buildings", Green Engineering.
[9] D. Datta & S. Chanda, "Life Cycle Cost Analysis of Buildings", Institute for Steel Development & Growth
[10] Balakrishnan S., Chapman J.C. (1964), "Experiments on Composite Beams," Struct. Eng.,
[11] Yam.L.C.P., Chapman J.C. (1968), "The inelastic behaviour of simply supported composite beams of steel and concrete.
[12] Dennis Lam and Ehab Lobody (2005), "Strength analysis of steel concrete composite beams in combined bending and shear" 2005,.
[13] George Abdul Sayed (1982), "Composite Cold Formed Steel Concrete Beams," Journal of Structural Division,.
[14] Cai C.S., Jianguo Nie (2009), "Performance of Steel-Concrete Composite Beams under Combined Bending and Torsion," Structural Engineering,
[15] Johnson, R.P. (1975), "Composite Structures of Steel and Concrete," Volume-I-Blackwell Scientific Publication, London.
[16] Ray M.B. and Mallik, S.K. (1980), "Interaction of Flexure and Torsion in Steel Concrete Composite Beams," The Indian Concrete Journal.
[17] Richard, P. Nguyen (1991), "Thin Walled Cold Formed Steel Composite Beams," Journal Structure Engg.