ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 1, January 2018

Use of Composite Structure in Multistoried Building

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Abstract: **-- The design of buildings is basically done with concrete and masonry. Reinforced concrete and steel materials are mostly used in framing structure of the building. Reinforced Concrete Structures are mostly used in low rise building but for medium, to high rise building as it is no longer economical & efficient design concept. Thus, this created the challenge for structural designers for making the economical construction for multi-storey buildings. Hence the use of composite structures in a multistory building has gained the attention of structural engineers to improve the overall performance of the building. Thus, composite construction has gained importance over simple RCC and Steel construction of buildings.**

I. INTRODUCTION

Steel–Concrete construction has been widely used in the fields of bridge & building construction. Composite Structures are defined as structures which consist of composite sections which are made up of two different types of materials such as structural steel and concrete which acts together to form single unit. Composite Structures combines the dynamic properties of Structural Steel (Tension) & concrete (Compression) which provides greater stability to multistory buildings & also have same thermal expansion. Structural steel members are generally fabricated as component consisting of thin plate & shell elements, so on loading they are subjected to lateral buckling while concrete are thick enough and are less prone to buckle but they are subjected to creep and shrinkage. Hence composite structures are used as it binds both the properties of steel and concrete.

II. LITERATURE REVIEW

The literature review focuses on current structural systems commonly available to designers for residential and commercial buildings.
The scope for literature is limited to composite structural systems. Composite structures are widely accepted over the world as an alternative & additional method of construction over pure steel and RCC.
Literature says that if composite structures are properly configured then they are highly durable and can give best performance in building construction.

Johnson R.P "Composite Structures of Steel & Concrete" Vol.1, Blackwell Scientific Publications 1994 took initiative for composite construction started by extensive research by Dr Chapman & Prof. Johnson R.P led to publish a book with a review of behavior of composite structure of steel and concrete .In his book, he drafted design methods for composite structures for both buildings and bridges.

Bhavin H. Zaveri, Jasmin A. Gadhiya, Hitesh K. Dhameliya "A Review on the Comparative Study of Steel, RCC and Composite Building ". International Journal of Innovative Research in Science, Engineering and Technology. Vol. 5, Issue 1, January 2016
They proved that the overall response of composite structure produce less displacement & resists more structural forces.

- Composite structures are best solution for high rise buildings and are resulted in speedy construction.
- Steel has excellent resistance to tensile loading but prone to buckling & concrete gives more resistance to compressive force. Hence steel can be used to induce ductility & concrete can be used for corrosion and fire performance.

D.R Panchal & P.M Marathe "Comparative Study RCC Steel & Composite Buildings" Institute of Technology, Nirma University, Ahmedabad 382-481,December 2011

- They suggested that in beams, shear forces are increased in steel structure and reduced in

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composite structures up to large extent as compared to RCC structure .

- Further, they stated that Steel & Composite structures gives more ductility to buildings as compared to RCC which is best suited under effect of lateral forces.
- In main beams, shear forces are increased in steel structure & reduced in composite structure upto large extent as compared to RCC structure.

Anamika Tedia & Dr Savita Maru "Cost , Analysis & Design of Steel Concrete Composite Structure & RCC structure"

- They stated that under earthquake considerations because of inherent ductility characteristics steel concrete composite structures will perform better than RCC.
- The cost comparison reveals 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 structures economically viable.

Thus, summary of literature review are:

- There is no need for formwork because steel beams sustain the self weight of steel & concrete by itself or with assistance of few temporary props.
- The material cost of composite structure is less & hence it results in speedy construction takes because of no formwork.
- The nodal displacement in composite structure is more as compared to RCC structure. This is because the composite structures is more flexible as compared to RCC structure.
- As composite structures are more ductile hence they will perform better under the effect of lateral forces and in major earthquake zones.
- Due to light weight, small sections & good load carrying capacity use of composite structures in multistory buildings has increased.

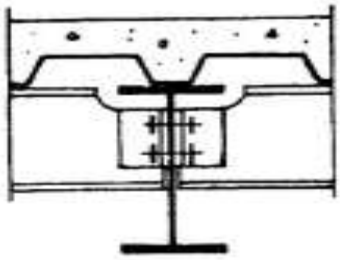
STUDY OF ELEMENTS OF COMPOSITE STRUCTURE

A composite member is consists of rolled or built up structural steel that is either filled with concrete; encased by reinforced concrete or structurally connected to reinforced concrete slab. Composite members are designed such that the structural steel and concrete acts together to resist axial compression and bending.

1.Composite Beams
2.Composite Slabs
3.Composite Columns
4.Shear Connectors

Composite Beams

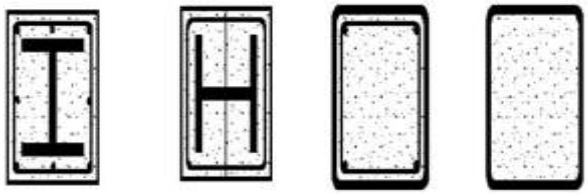
A steel concrete composite beam consists of steel beam either fully encased in concrete or un-encased steel beam made to act integrally with a concrete or composite slab using shear connectors. Composite beams are often designed under the assumption that the steel beam supports weight of the structural steel. This approach results in use of less number of connectors then they are required to enable the maximum bending resistance. Composite beams reduces beam depth & hence can be constructed with profiled sheeting with concrete topping or with cast in place or precast reinforced concrete slab.



Composite Beam

Composite Column

A steel concrete composite column is compression member comprising of either concrete encased hot rolled steel section or concrete filled hollow section of hot rolled steel. A steel column fabricated from rolled or built-up steel shapes and encased in structural concrete or fabricated from steel pipe or tubing and filled with structural concrete where structural steel portion accounts for at least 4% of gross column area. It is generally used as load bearing member in a composite framed structure. There are three types of composite columns used in practice , which are concrete encased, concrete filled & battered sections.



Composite Column

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
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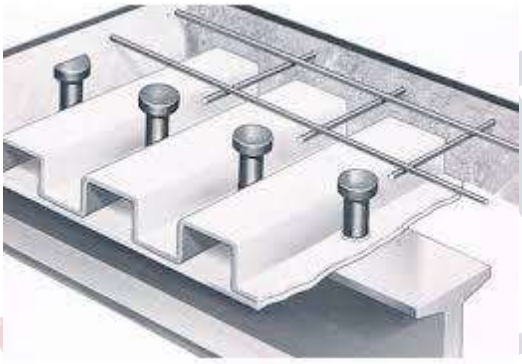
Composite Slab

A composite slab consists of steel beam, metal deck & concrete slab, in which steel sheets are connected to the composite beam with the help of shear connectors. Initially steel sheets act as permanent shuttering & also act as bottom reinforcement for steel deck slab & later it is combined with hardened concrete. Slab System consisting of a concrete slab and deformed metal deck where the two act compositely in flexure and shear. The most common arrangement found in composite floor is a rolled or built up steel beam connected to formed steel deck & concrete slab. The composite floor produces rigid horizontal diaphragm providing stability to overall building distributing wind and seismic shears to lateral load resisting systems. Composite slab are usually designed as simply supported members in the normal condition.



Composite Slab

Shear Connectors

Shear connectors are used to connect the concrete & structural steel & are essential for steel concrete construction as they integrate the compression capacity of supported concrete slab with supporting steel beams to improve load carrying capacity and overall rigidity . Commonly used types of shear connectors as per IS 11384-1985 are :

- Rigid type
- Flexible type
- Anchorage type

Rigid type shear connectors are very stiff & sustain only small deformation while resisting the shear force. They derive their resistance from bearing pressure on concrete & fail due to crushing of concrete. Short bars, T-sections are common examples of rigid type.

Flexible type shear connectors derive their stress resistance through bending & undergo large deformation before failure. Headed studs channels come under this category.

Anchorage type shear connectors are used to resist horizontal shear and prevent separation of girder from concrete slab at the interface through bond. These connectors derived from resistance through bond & anchorage action.

SHEAR CONNECTOR

ADVANTAGES OF COMPOSITE STRUCTURES

- Most effective use of materials i.e. concrete in compression and steel in tension can be achieved.
- Composite constructions are amenable to "fast track" construction because of rolled steel & pre-fabricated components rather than cast in situ concrete.
- Flexible in design & ease of fabrication
- Cost of formwork is lower as compared to RCC construction.
- Easy structural repair /maintenance / modification.
- Reduction in overall cost of structure & foundation cost.
- Composite structures have higher stiffness then corresponding steel structures & thus bending stress & deflection are lesser.
- Composite structures have better seismic resistance due to high amount of ductility & hysteretic energy of material / structural frame.
- Ability to cover large column free area which leads to more usable space. Thus, area occupied by composite column is less than area occupied by RCC column.

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