

# Experimental Behaviour of Load Carrying Capacity of Steel Concrete Composite Beam

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**ABSTRACT:** Plain cement concrete has high compressive strength; its tensile strength is relatively low. Normally, the tensile strength of concrete is about 10% to 15% of its compressive strength. Hence, if a beam is made of plain cement concrete, it has a very low load carrying capacity since its low tensile strength limits its overall strength. Composite structures aims to make each material perform the function it is best at, or to strengthen a given cross section of a weaker material. Composite structure is a structural member composed of two materials, here steel and reinforced concrete structure. Therefore in this study, the load carrying capacity, stiffness, energy absorption capacity of conventional reinforced concrete beam is comparatively tested with the composite beam.

**KEYWORDS:** Composite beam, steel concrete, beam strength.

## I. INTRODUCTION

Structures refer to any members composed of more than one material is called composite structures. The parts of these composite members are rigidly connected such that no relative movement can occur. Composite structures aims to make each material perform the function it is best at, or to strengthen a given cross section of a weaker material. In steel construction the composite structure is a composite beam and composite column. Composite beam consist of reinforced concrete slab with steel beam and connected with shear connector. Composite column is a steel column cased in reinforced concrete column or steel column encase reinforced concrete column. Savings in steel weight are typically 30% to 50% over non-composite beams. The other advantages of composite structures are smaller construction depths, the greater stiffness of the system means that beams can be shallower for the same span, leading to lower storey heights and savings in cladding, etc. It also shares the advantage of rapid construction, effective utilisation of steel and concrete. More economical steel section (in terms of depth and weight) is adequate in composite construction when compared with conventional non-composite construction. Hence in this study the load carrying capacity, stiffness and energy absorption capacity of the composite beam was compared with the conventional concrete beams.

## II. MATERIALS AND METHOD

An experimental investigation on the behaviour of reinforced concrete beam and composite beams were carried out and the parameters like strength and durability properties were assessed. The materials used and its properties are as follows.

**Cement:** Cement is the most important constituent of concrete, in that it forms the binding medium for the discrete ingredients made out of naturally occurring raw materials and sometimes blended with industrial wastes. Cement comes in various types and chemical compositions. 53 grade Ordinary Portland Cement conforming to IS 576-1964(10) is used for the study. Specific gravity of cement is 3.15.

**Fine aggregate:** The fine aggregate used in this investigation was clean river sand passing through 4.75mm sieve with specific gravity of 2.62 conforming to zone II.

**Coarse aggregate:** Hard granite broken jelly (20 mm) was used in the experimental work with the specific gravity of 2.76.

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**Water:**The potable water available in college campus was used for mixing and curing of concrete. The specification cast was water cured in curing tank by complete immersion.

**Reinforcement steel:**The main and distribution reinforcement used for the RCC beam specimen is HYSD (Fe 415) bar of diameter 8 mm. The shrinkage and temperature reinforcement of Steel concrete composite slab is HYSD (Fe 415) bar of diameter 8mm.

**Structural steel:**Structural steel in the form of hot rolled sections of rolled beams is used. The standard section (ISMB 125) which available in the market is used as the beam element. The section has Weight of 13 kg/m run and sectional area of 16.6 cm<sup>2</sup>.

**Shear Connectors:** The most common type of shear connector used in composite beams for buildings is a 19 mm diameter by either 100 mm or 125 mm long welded stud. For thru-deck welding, this is the only stud diameter that can be used practically, because it is the only one for which suitable ferules are available. There are a number of other forms of shear connector available, such as angles welded to the top flange. However, most lack a practical application in composite beams, with the exception of shot-fired connectors. M19X100 hexagonal bolt conforming to IS 11384-1985 is used as shear connector which is used in this experiment.

**Mix design:** The mix design was arrived M20 grade of concrete as per IS: 10262-2009. The proportion found from mix design was 1:2.5:3.8:0.55(Cement: Fine Aggregate: Coarse Aggregate: Water) with a cement content of 320 kg/m<sup>3</sup>.

S. No	Materials	Weight in kg/m <sup>3</sup>
1	Cement	350
2	Fine Aggregate	811
3	Coarse Aggregate	1216
4	Water	158
5	Water Cement Ratio	0.5

**Dimensional details:** The dimensional details of RCC beam and Steel & concrete composite beam is given in table-2.

RCC beam	Dimension
Length (m)	1.5
Breadth (cm)	45
Thickness (mm)	70
Area of Reinforcement (Ast) (mm <sup>2</sup> /m)	215
Steel concrete composite Slab	Dimension
Length (m)	1.5
Breadth (cm)	45
Thickness (mm)	70
Area of Reinforcement (Ast) (mm <sup>2</sup> /m)	250

**Casting:** The RCC beam casting is conducted in fully supported conditions on the laboratory floor. The main reinforcement provided is 8mm diameter bars at 150c/c and the distribution reinforcement is 8mm dia bars at 200c/c. The reinforcement grill is properly placed within the side shuttering by allowing adequate cover for the beam. The ingredients of concrete are weighed correctly; concrete is mixed and poured into to beam. The beam is casted and cured for 28days. Similarly, the steel and composite beam without encasing was casted. The steel & composite beam and cold formed steel concrete composite beam were casted with the help of steel encase, i.e. covered by steel. The figures of casting for all the above mentioned is given by the following figures.

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Figure-1: Casting of RCC beam



Figure-2: casting of Steel and concrete composite beam  
without steel encased



Figure-3: casting of Steel and concrete composite beam  
with steel encased

The casted cubes were cured for 28 days. Then the test for the ultimate load carrying capacity, Stiffness and Energy absorption capacity for the RCC beam and steel concrete composite beam were made by following the standard peecedures.

### III.RESULTS AND DISCUSSIONS

From the Test results the important parameters such as Ultimate load carrying capacity, Stiffness and Energy absorption capacity for the RCC beam and steel concrete composite beam has been determined. The load Vs deflection for RCC beam and steel concrete composite beam has been plotted. The figure-4 shows theLoad Vs Deflection curve of RCC beam, the figure-5 showsthe deflection curve of steel concrete composite beam without steel encased, the figure-6 shows the deflection curve of steel concrete composite beam with steel encased and the Load Vs Deflection curve of cold formed steel concrete composite beam with steel encased was given by the figure-7.

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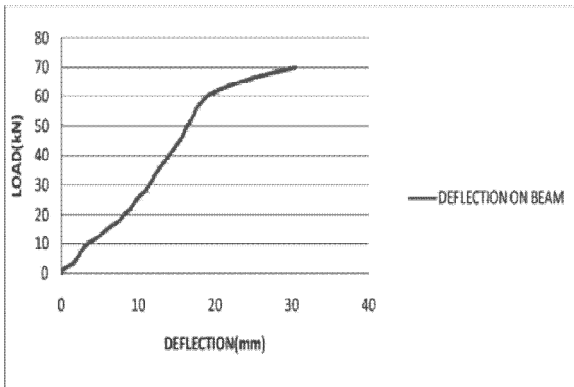


Figure-4: Load Vs Deflection curve of RCC beam

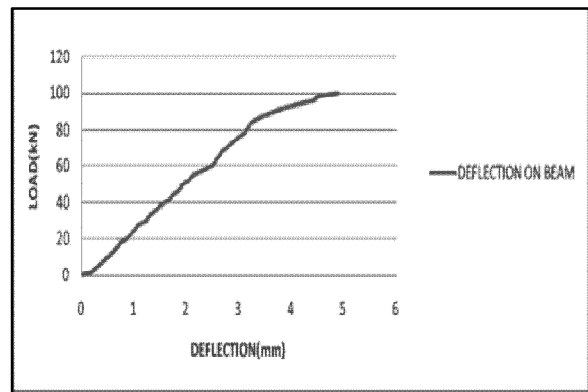


Figure-5: Load Vs Deflection curve of steel concrete composite beam without steel encased

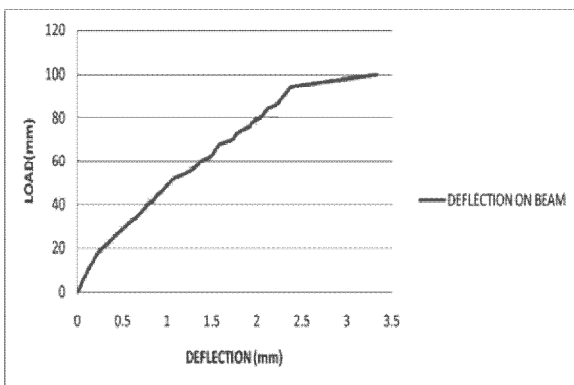


Figure-6: Load Vs Deflection curve of steel concrete composite beam with steel encased

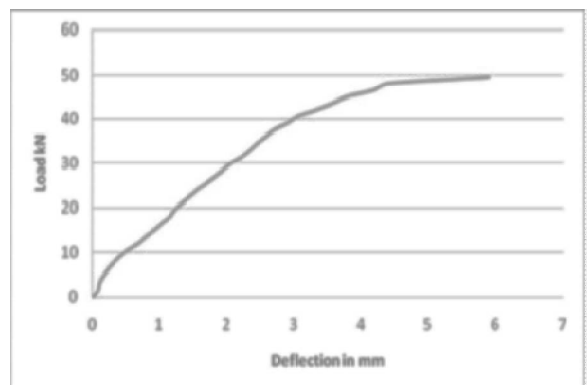


Figure-7: Load Vs Deflection curve of cold formed steel concrete composite beam with

The figure-8 shows the Ultimate load carrying capacity for the (i) RCC beam is 70kN, (ii) composite beam without steel encased is 140kN, (iii) composite beam with steel encased is 150kN and cold formed composite beam without steel encased is 50kN. It denotes that composite beam with steel encased has the best ultimate load carrying capacity. From the figure-9, the stiffness was identified as, (i) the stiffness value of RCC slab is 26 kN/mm, (ii) the stiffness value of composite beams without steel encased is 30kN/mm, (iii) stiffness value of composite beams with steel encased is 40kN/mm and (iv) the stiffness value of cold formed concrete composite beams without steel encased is 20kN/mm. when comparing the stiffness values, the composite beams with steel encased has greater. From the figure-10, the Energy absorption capacity of the RCC and steel and concrete composite beams was identified. The steel and concrete composite beams exhibit considerably large value of energy absorption capacity when compared to the conventional RCC beam. The energy absorption capacity of RCC beam is 400 kNmm, energy absorption capacity of steel concrete composite beams without steel encased is 500kNmm, energy absorption capacity of steel concrete composite beams with steel encased is 560kNmm, and the energy absorption capacity of cold formed concrete composite beams without steel encased is 240kNmm.

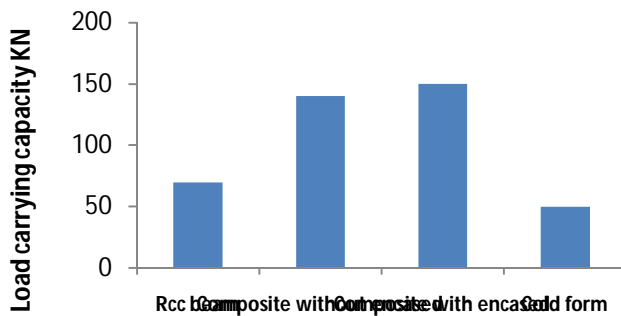


Figure-8: Ultimate load carrying capacity

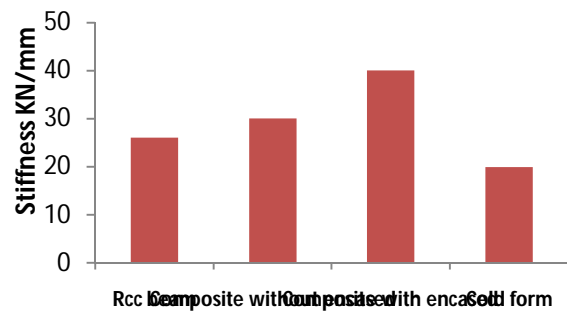


Figure-9: stiffness

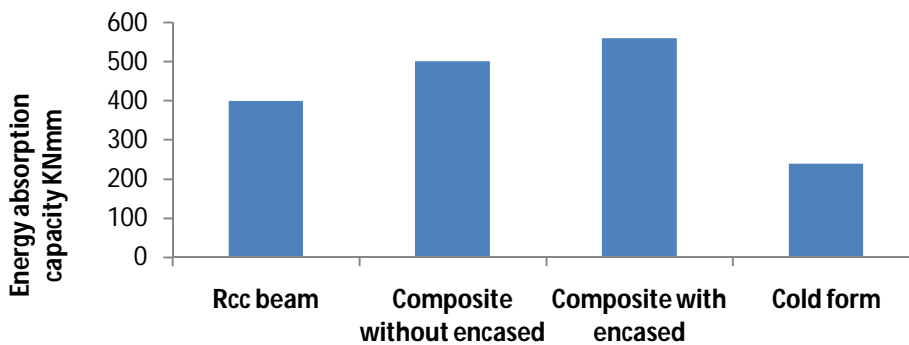


Figure-10: Energy absorption capacity

#### IV. CONCLUSION

Based on the results on the experimental investigation, the following conclusion is arrived. The ultimate load carrying capacity of the steel concrete composite beam with steel encased and steel concrete composite beam without steel encased is found to be 114% and 100% higher than the RCC beam and cold formed concrete composite beam is 40% less than the RCC beam. Hence the strength property of the steel concrete composite beam with steel encased and steel concrete composite beam without steel encased is very much good as compared to the RCC beam. The stiffness of the steel concrete composite beam with steel encased and steel concrete composite beam without steel encased is found to be 1.53 times and 1.15 times respectively higher than the RCC beam. The energy absorption capacity of the steel concrete composite beam with steel encased and steel concrete composite beam without steel encased is found to be 40% and 25% higher than the RCC beam and cold formed concrete composite beam is 40% less than the RCC beam. The structural behaviour and load carrying capacity of the steel concrete composite beam with steel encased and steel concrete composite beam without steel encased is very much good as compared to the RCC beam.

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