Volume 6, Issue 4 (2019) 1-9 ISSN 2347 - 3258
International Journal of Advance Research and Innovation

EXPERIMENTAL STUDY ON COMPOSITE RCC BEAM BY USING COLD FORM STEEL WITH SHEAR CONNECTORS.

A.Ananthakumar[a], T.N.Manju shree[b], J.Preethi[b], R.Soundharya[b], K.Monisha[b]
[a] Assistant professor, Department of Civil Engineering, Vivekanandha College of Technology for women, Namakkal
[b]UG student, Department of Civil Engineering, Vivekanandha College of Technology for women, Namakkal

Article Info
Article history:
Received 25 January 2019
Received in revised form
20 February 2019
Accepted 28 February 2019
Available online 15 March 2019

Keywords
Compression strength,composite material,shear connectors.

ABSTRACT
This paper presents the results of research of the experimental study on the behaviour of cold-formed steel composite beams. The behaviour of composite Beams, which are composed of cold-formed steel sheeting and normal strength concrete, has been studied. Cold-formed steel (CFS) sections are lightweight materials where their high structural performance is very suitable for building construction. Conventionally, they are used as purlins and side rails in the building envelopes of the industrial buildings.The results of various researchers indicated that the robustness of the product (cold-formed steel-concrete) was significantly improved for both the shear resistance and the flexural resistance. The investigation on the behaviour of CFS-normal strength concrete designed as composite is a key issue where the innovative construction method and significant advantages will be highlighted. The review papers have proven that the use of cold-formed steel as composite has enhanced the application of the cold-formed steel as competitive material for construction.

CONTENT

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1. INTRODUCTION

Nowadays reinforced concrete is mostly used in construction work. In rcc structure the reinforcement is not important thing. The cost of the steel is not economical. By economical wise we have to reduce the amount of reinforcement. In order to reduce the reinforcement the only remedy is composite construction. In order to reduce the amount of reinforcement by composite construction. The materials using for this composite construction is reinforced concrete and cold formed steel with shear connectors. A structural member composed of two or more dissimilar materials joined together to act as a unit is called as composite beam. In this reinforced concrete and cold formed sheet combined together and act as a composite beam . The two materials are interconnected by means of mechanical shear connectors. It is current European practice to achieve this connection by means of headed studs, semi-automatically welded to the steel flange. For single span beams, sagging bending moments, due to applied vertical loads, cause tensile forces in the steel section and compression in the concrete deck thereby making optimum use of each material.

Reinforced Cement Concrete:

Reinforced concrete is also called reinforced cement concrete is composite material in which concrete’s relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength or ductility.The reinforcement is usually,though not necessarily,steel reinforcement bars and is usually embedded passively in the concrete before the concrete sets. Reinforcement schemes are generally designed to resist the tensile stresses in particular regions of the concrete that might cause unacceptable cracking or structural failure.Modern reinforced concrete can contain varied reinforced materials made of steel,polymer or alternate composite material. Reinforced concrete may also be permanently stressed,so as to improve the behavior of the final structure under working loads.

Cold form steel:

Cold-formed steel (CFS) is the common term for products made by rolling or pressing thin gauges of sheet steel. Cold formed steel goods are created by the working of sheet steel using stamping, rolling, or presses to deform the sheet into a usable product. Cold worked steel products are commonly used in all areas of manufacturing of durable goods like appliances or automobiles but the phrase cold form steel is most prevalently used to describe construction materials

The use of cold formed sheet construction materials has become more and more popular since the introduction of codified standards in 1946. In the construction industry both structural and non-structural elements are created from thin gauges of sheet steel. These building materials encompass columns, beams, joists, studs, floor decking, built-up sections and other components. Since concrete/CFS composite beams have not been considered before by the engineering community as viable structural elements, current building codes do not provide provisions for the design and construction of such beams. Therefore, research studies were needed to assess the feasibility of developing this novel structural system.

Shear connector:

Shear connectors are mechanical devices that are employed to unite steel beams to concrete slabs, absorbing the shear flow at the beam-slab interface and preventing a vertical separation between the two elements (uplift). Connectors are classified as flexible and stiff. Generally speaking, the flexibility of connectors can be associated with their response in relation to the shear flow generated between the steel beam and the concrete slab when they function as composite beams. This response corresponds to a relation of strength vs. relative displacement (slip), in other words, it corresponds to "ductile" behaviour. This characteristic does not strongly affect the behaviour of the composite beam in a serviceability or "elastic" state, but it conditions the response of the connector in the ultimate state by allowing the shear flow to be redistributed among all the connectors. Thus, under increasing loads, a flexible connector approaching its maximum capacity presents sufficient strain to allow the shear flow to be passed on to the adjacent connectors, which leads to uniformity. This characteristic allows for uniformly spaced connectors along the length of the beam, without reducing the capacity of the connection in the strength. Composite action between the steel and the concrete is achieved by means of shear connectors by the effective transfer of shear at the interface between concrete and sheet elements. These shear connectors are typically studs welded to the steel beams and set into the concrete slab. A composite beam can be made to be considered to have full shear connection or partial shear connection, proportional to the amount of shear connection.

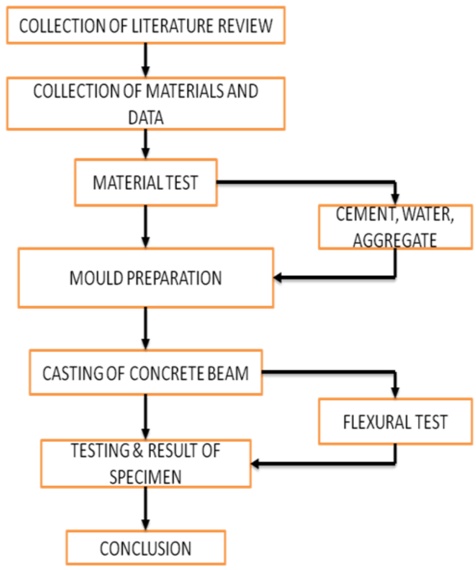
2. OBJECTIVE

- The reinforced concrete structures may be subjected to many types of damage and distress. But, the scope of this study is limited to damage of reinforced concrete beams due overloading alone.
- The damaged structures could be repaired and rehabilitatedto a satisfactory level of performance at a reasonable cost by different methods.
- A comparative study was made on the two techniques based on the performance on reinforced concrete beams.
- This objective was planned to be achieved by an experimental study on reinforced concrete beams.

3. SCOPE

- To study the static behavior of reinforced concrete beams as perfect beams,undamaged laminated beams nd predamaged beams rehabilitated beams experimentally.
- To assess the characteristic of ferrocement as a rehabilitation materials.
- To predict the flexural properties strength,deformation,ductility and energy capacity of the beams based on the regression analysis.
- To study the experimental and nalytical investigation

4. METHODOLOGY



5.MATERIAL COLLECTION

5.1 CEMENT

Ordinary Portland cement of 53 grades available in local market is used in the investigation. The Cement used has been tested for various proportions as per IS 4031-1988 and found to be confirming to various specifications of are 12269-1987.The specific gravity was 3.14.

S.No	Properties	Results
1.	Standard Consistency	31.25
2.	Initial Setting Time	36minutes
3.	Fineness Modulus	2%
4.	Specific gravity	3.225

5.2 COARSE AGGREGATE

Crushed angular granite metal of 6 to 12.5 mm size from a local source was used as coarse aggregate. The specific gravity of 2.77 and fineness modulus 3.702 was used.

S.No	Properties	Results
1.	Specific gravity	2.7
2.	Moisture content	0.233%

5.3 FINE AGGREGATE

River sand of 2.36 mm size sieve passed was used as fine aggregate. The specific gravity of2.64 and fineness modulus3.376 was used in the investigation.

S.No	Properties	Results
1.	Specific gravity	2.624
2.	Moisture content	2.4%
3.	Fineness modulus	3.8%

5.4 COLD FORM STEEL

The material thickness for such thin-walled steel members usually range from 0.0147. The steel plates and bars as thick as 25.4mm can also be cold formed successfully into structural shapes.

Plate thickness (mm)	Youngs modulus (Mpa)	Yield strength (Mpa)	Ultimate strength (MPa)
2.0	2.04 x10^5	248.51	342.94
1.5	1.97 x10^5	242.63	337.25
1.0	1.94 x10^5	240.78	339.49

5.5 SHEARCONNECTOR

Shear connectors can take the form of either headed studs, channels or high strength structural bolts. Cold formed steel sheets are used as partial confinement for the beams. The beams using the profiled sheeting are referred as profiled composite beams. They increase the compressive strength and the deformation of confined concrete by offering resistance to the lateral bulging of concrete.The thickness of steel sheet used in cold formed construction is usually 1 to 3mm.With this least thickness the sheet is used as a formwork and reinforcement.

Size of the shea connectors (mm)	Yield load (KN)	Ultimate load(KN)	Design strength (KN)	Max slip(mm)
6.35 dia and 57 height	12.67	15.67	10.45	3.15
6.35 dia and 54 height	12.67	15.336	10.47	3.22

Fig 5.1 Shear connector

6. EXPERIMENTAL PROCEDURE

6.1 CASTING

Cold formed steel was fabricated as per the requirement in a plate bending machine. Shear connectors were welded on the inner surface of Steel flange area and simultaneously the core reinforcing bars containing minimum tension reinforcement, compression reinforcement and transverse reinforcement tied.

Figure 6.1 Cold form steel with shear connectors

Corrosion treated cold formed steel trough section was placed on a level floor, core reinforcing system was kept above with minimum cover and then concrete was poured within the wooden side planks, which were prepared as per the size of beam

Figure 6.2 reinforcement setup

7. EXPERIMENTAL STUDY ON FRESH AND HARDENED CONCRETE

7.1 TESTS ON FRESH CONCRETE

7.1.1 SLUMP TEST

Slump test is the most commonly used method of measuring consistency of concrete. The apparatus used for doing slump test are Slump cone of bottom diameter 20cm, top diameter 10cm and height 30 cm. In this test, the concrete is filled in four layers, each approximately ¼ of the height of the mould. Each layer is tamped 25 times by the tamping rod of 16 mm dia. After the top layer has been rodded, the concrete is struck off level with a trowel and tamping rod. The mould is removed from the concrete immediately by raising it slowly in a vertical direction. This allows the concrete of subside. The difference in level between the heightofthemould21andthatofthe highest point of the subsided concrete is measured. This difference in height in mm is taken as Slump of concrete. The nominal slump value for different degrees of workability based on IS: 456 is tabulated in the below Table 6.

Table 7.1 Nominal Slump Value for Different Degrees of Workability

Placing Conditions	Degree of Workability	Slump in mm
Shallow sections	Very low	-
Lightly reinforced sections	Low	25-75
Heavily reinforced sections	Medium	50-100
Heavily reinforced Sections Without vibrations	High	100-150

7.1.2 COMPACTING FACTOR TEST

Compacting factor test is more precise and sensitive than the slum ptest and is particularly useful for concrete mixes of very low workability. This test has been developed at the Road Research Laboratory U.K. and it is one of the most efficient tests for measuring the workability ofconcrete.Thistestworks on the principle of determining the degree of compaction achieved by standard amount of work done by allowing the concrete to fall through a standard height. The degree of compaction or compacting factor is measured by the density ratio. i.e., the ratio of the density actually achieved in the test to density of same concrete fully compacted.

Table 7.2

Nominal Compactin Factor for Different degrees of workability

Placing Conditions	Degree of Workability	Compacting Factor
Shallow sections	Very low	0.75 - 0.80
Lightly reinforced sections	Low	0.80 - 0.85
Heavily reinforced sections	Medium	0.85 - 0.92
Heavily reinforced sections without vibrations	High	Above 0.92

7.1.3 TEST RESULTS

Table 6.3 Test results for fresh concrete

MIX	SLUMP IN mm	COMPACTION FACTOR
M_{30}	131	0.998

7.2 TESTS ON HARDENED CONCRETE

7.2.1 COMPRESSIVE STRENGTH

The machine consists of pillars connecting the base and top. A hydraulic jack is packed to the base in the centre of the pillars one of the two loading plates is attached to the adjustable screw with a self aligning spherical setting between the screw passes through the top plate and can be raised or lowered for initial clearance adjustment with the help of the handle. Loading is done with the upward movement of the lower platter. The horizontal pumping unit is housed in an elegant dust proof case. It is double plunger type driven by an elegant motor through a belt driven. This is a separator unit and it is connected to the jack by a suitable connecting tube supplied with the machine. The strain rate central knots provides mean for varying the rate of loading simple by rotating it. There is a provision for hand operation of the machine in case of power failure. A handle that fits in to the jacket of the pump head through the slot is used to fit this and the pump can be separated therefore.

Figure 6.2 testing of cube

7.2.2 FLEXURAL STRENGTH TEST

The machine consists of a loading unit and control unit. The loading unit has one hydraulic cylinder which is attached to the centre of the base and the platen slides within the cylinder. which is attached to the centre of the base and the platen slides within the cylinder. A motor is mounted in the right side of the base. The chain and sprocket driven by the motors rotate the screwed columns mounted in the base with bearings. These screws pass through the main nuts fitted in the lower cross head. The lower table is connected to the upper crosshead by two straight columns. The jaws are inserted in the lower and upper crossheads for holding the specimen.The control units consists of one oil tank contains the hydraulic oil and oil level sight glass for checking the oil level fitted to the oil tanks. Two valves on the control panel one at the right side and the other at the left side are used to control the flow of oil in the hydraulic system.

Table 7.4 Test results

S.No	Tests on Concrete	Test results	
		7 Days	28 Days
1	Compressive test on cube	19.32	29.40
2	Flexural test on prism	12.03	17.33

8.TESTING OF BEAM

Figure 8.1 Testing of beam

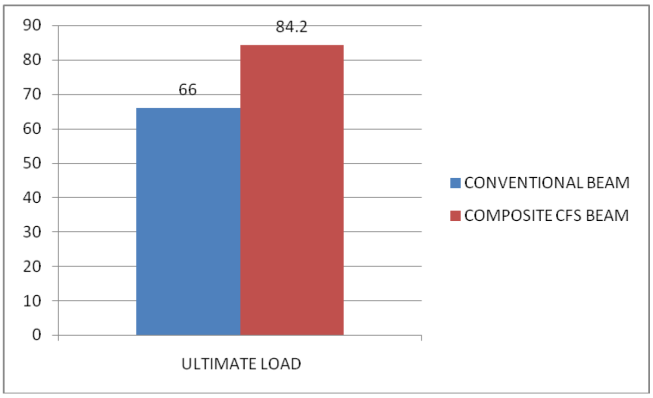
Table 8.1 TEST RESULTS

BEAM DESIGNATION	FIRST CRACK LOAD	ULTIMATE LOAD	DEFLECTION
CC	19.50	66.00	11.66
CCB	26.00	84.20	15.37

9. RESULT

9.1 COMPARISON OF ULTIMATE LOAD

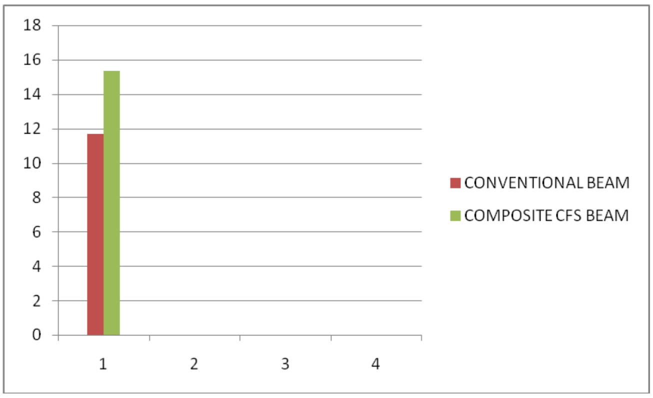
The ultimate load of conventional beam was 66 kN and the ultimate deflection was 11.6mm. The ultimate load of beam with unstiffened channel encased with concrete was 84.50kN and ultimate deflection was 15.37mm..



Graph 8.1 comparison of ultimate load

9.2 COMPARISON OF ULTIMATE DEFLECTION

. The beam with stiffened channel encased with concrete has the maximum value where as the conventional beam has theleast value for the ultimate deflection. Figure 8.2 show the comparison of ultimate deflection of the three different types of beams.



Graph 8.2 Comparison of ultimate deflection

9.3 DISCUSSION OF TEST RESULTS

The total applied load versus mid-span deflection for the test specimens are shown in figure 8.3. Specimens that were subjected the same loading scheme exhibited relatively similar cracking patterns. The initial cracks in the form of pure flexural cracks occurred at locations of maximum bending moment

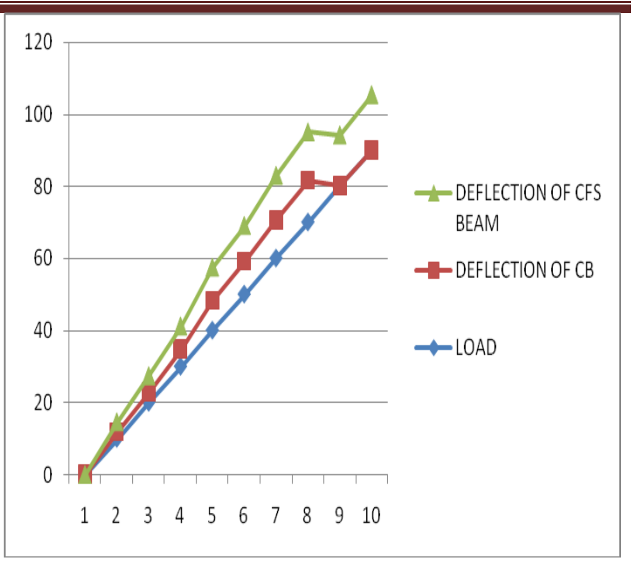


Figure 8.3 Load versus deflection

10. CONCLUSION

Experimental studies were performed on test specimens representing cold form steel concrete composite beams.Continuity at the concrete-CFS interface was provided by shear connectors.The studies were designed to investigate the structural performance of concrete simple beams and concrete/CFS composite beams. Based on the results obtained from this study, the following conclusions are made.Concrete/CFS composite beams can be designed for flexural failure.The use of shear connectors is feasible for providing composite action. When adequate number and spacing of shear connectors are furnished, the CFS track acts as tension reinforcement and the concrete/CFS composite beams can increase their flexural capacity.

The beams with stiffened channel has the highest load carrying capacity than the conventional beams.

Loss of strength due to shear in all composite beams are less, which permits reduction in amount of stirrups to achieve full flexural capacity The study suggested that the stiffened channel is the most suitable section for use in composite beams.

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Emailid:ananthaakumar7410@gmail.com