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EXPERIMENTAL STUDY ON EFFECT OF THICKNESS ON STEEL ENCASED CONCRETE BEAMS

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Abstract- This paper presents an experimental investigation on the effect of the thickness of steel sheets in steel encased concrete structures. This experiment includes two steel encased concrete beams of size 0.3 x 0.3 x 1.2 m with a thickness of 4mm and 2mm steel sheets. They are designed for a shear failure at 50kN without any compression and tension reinforcement which are tested under two point loading on 100 tones loading frame till their failure. Failure of encased beams is primarily due to bond slip failure between steel and concrete, which leads to the yielding of steel where failure occurs. In this study both beams failed at the interface at a similar load, where beam-2 failed at more strength when compared to beam-1.

Keywords: Steel encased concrete beams, beam without reinforcement.

I. INTRODUCTION

Steel encased concrete composite beams are generally prepared by cold formed u shaped steel sheets. It provides confinement to the concrete. As concrete is good in compression due to confinement it performs better than conventional RCC beams. Primary failure of steel encased concrete beams is by failure of bonding between steel sheets and concrete which is a brittle failure. Research is still going on analysis of such failure in steel encased concrete beams. Checkered steel sheets are being used in case of plane steel sheets to increase bonding between steel and concrete, which delays the primary failure of steel encased concrete composite beams.

The composite concrete-coated steel beam was initially inspired by a composite floor. Oehlers [1, 2] and Uy and Bradford [3, 4] used steel profile plates as the permanent formwork and the longitudinal reinforcements of the composite beam; furthermore, the profiled sheet and the internal concrete were integrated by the protruding rib of the profiled steel sheet. These experimental results of [1-4] showed that the cooperative performance between the profiled steel sheet and concrete can increase long-term strength and stiffness, improve ductility and reduce long-term load deviation, while the mode of breakage of the composite material the beam was a combination of adhesion failure and a local slip of the steel sheet.Jiepeng Liu [5] 10 RCUCB were tested with different conditions and three types of failures have been observed. Li-huachen [6] 6 c-shaped beams were tested and with the use of checkered steel bonding between concrete and steel has been increased. Lihuachen [7] performed pullout test on specimens and found that with increase in checkered pattern depth there is significant increase in bond strength of concrete and steel.

Two steel encased concrete beams of size 0.3 x 0.3 x 1.2 m with a thickness of 4mm and 2mm steel sheets are prepared, they are designed for a shear using studs of 10mm diameter without any compression and tension reinforcement which are tested under two point loading on 100 tones loading frame till their failure.

The main objective of this paper is to investigate the failure mechanism of beams with no tension and compression reinforcement and permanent formwork, checking the behavior of beams with increase in thickness of permanent formwork.

II. TESTING PROCEDURE

A. *Preparation of Specimen*

Two cold-formed steel sheets of thickness 2mm and 4mm with the same surface texture(plane) are selected and cut into required sizes(300X1200mm). Shear studs of 10mm diameter are welded to the base plate with required spacing to the moulds, side faces of the moulds are welded to the bottom plate perpendicularly and care to be taken the strength of the weld should be same as the strength of the plate as shown in figure1. A mix proportion of M30 grade concrete is prepared and poured into the mould, cubes have been casted for the compressive strength of concrete. Specimens are cured for 28 day using jute bags. After curing specimen is tested under 100 tonnes loading frame.

Fig.1 Specimens welded with shear studs

B. *Testing*

The experiment was conducted on a 100-ton loading frame. Beams were placed in simply supported condition and loading applied was two point loading as shown in figure2. Load and displacement control methods are included in the test used. At the initial stage, data is recorded for each additional 5tonnes load. After the steel beam, the bottom plate is opened, data is recorded for each increase in 2tonnes load and LVDT are placed under the beam at mid-span for mid-span deflections.

Fig.2. specimen under loading frame

III. EXPERMENTATION

A. *Failure process*

When load is applied on the beams primary failure in steel encased concrete beams is due to interfacial slippage between concrete and steel this failure occurs to de-bonding of concrete and steel sheets which can be noticed by faint sound is heard. Further application of loads will de-attach the side and bottom plates where steel starts yielding and further application of load steel yields and huge deflection occurs indicating failure of beam.

1. Beam-1: load was applied gradually at the load of 30.73 tonnes applications sounds of interfacial bondage failure was heard. At the load of 44.7 tonnes the base plate started yielding by breakage in the weld of base plate and side plates and displacement has been increased and at the load of 60.3 tonnes the specimen got completely detached with concrete and steel has been yielded completely

2. Beam-2: load was applied gradually at the load of 31.07 tonnes applications sounds of interfacial bondage failure was heard. At the load of 59.7 tonnes the base plate started yielding by breakage in the weld of base plate and side plates and displacement has been increased and at the load of 74.7 tonnes the specimen got completely detached with concrete got crushed at the point of application with a less displacement when compared to beam-1.

B. Test results

Test results of the experiment are shown in the table-1 where M_p,F_p indicates moment and displacement at interfacial slip failure, M_y,$F_y$indicates moment and displacement at yield point and M_u,F_u indicates moment and displacement at ultimate failure of beam.

TABLE I

Test results of specimens

S.No	Specimen	Displacement(mm)			Moment(kN-M)		
		F_p	F_y	F_u	M_p	M_y	M_u
1	Beam-1	0.44	0.65	1.81	61.24	89.08	107.28
2	Beam-2	0.19	0.37	0.93	61.92	118.97	132.9

Test results have shown that primary interfacial slip failure in both the specimens have been in similar fashion due to similar design of the shear studs and same texture of cold formed steel sheets. Beam-1 has deflected more for a lesser load when compared to beam-2, This shows that the beam -1 is ductile when compared to beam-2. As the thickness of the steel plates increases the beam deflects less and makes the failure brittle and sudden in nature.

C. Load-deflection curve

Fig. 3 is the measured load-deflection curves of the specimens. As shown in Fig. 3, the whole loading process can be roughly divided into four stages.

1) Linear elastic stage: From the application of load till the interfacial slip failure of concrete occurs inside the steel beam. In this stage, the deflection of composite beams increases linearly with the applied load.

2) Weak nonlinear working stage: From the interfacial slip failure until the bottom plate of the steel beam yields in tension. In this stage, the deflection of composite beams is approximately linear with the applied load.

3) Elastic-plastic working stage: From the bottom plate yielding until the ultimate load is reached. In this stage, deflection rapidly increases and has an obvious nonlinear relationship with the applied load.

4) Failure stage: Deflection increases obviously after reaching the ultimate load, and the applied load drops gradually with the crushing of the concrete slab or rapid development of relative slip.

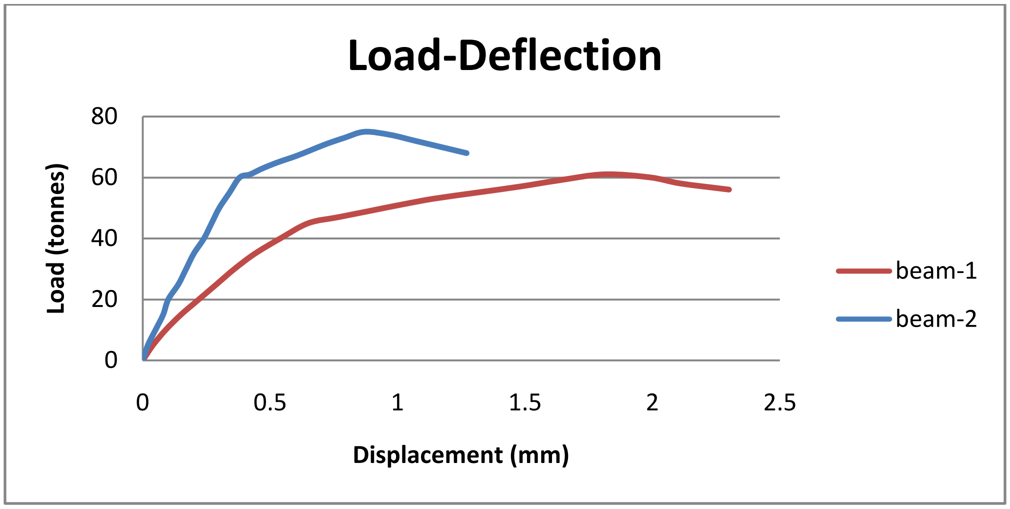

Fig.3 graph showing Load-Deflection of beam-1 and beam-2

IV. CONCLUSIONS

Based on the experiments conducted on the specimen the following results have been obtained.

1. Beams were designed for a shear capacity of 50KN but the primary interfacial slip failure occurred at far better load.
2. The primary interfacial slip failure is very early when compared to ultimate failure of beams.
3. As the thickness of steel sheets increases the deflection of the beam reduces.
4. With the increase in thickness of steel sheets beams failure becomes brittle in nature.

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