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Research Paper

EXPERIMENTAL STUDY ON COMPOSITE DECK WITH DIFFERENT ASPECT RATIO

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Profile steel sheet concrete composite slab are gaining increasing usage in modern construction practice with the greater emphasis on fast tract construction. Composite action between concrete and profile is generally achieved by embossment. For a new pattern of embossment full scale testing is necessary. In this paper, two composite deck specimens with different aspect ratio having one wavelength width and three wavelength width are tested. The slabs are formed by composite interaction between the concrete and steel deck with bolts to improve bond and load carrying capacity. Experiments are performed to estimate the load carrying capacity of composite deck with bolts as shear connector. Comparison of load carrying capacity is made for one wavelength and three wavelength slab with bolts as shear connector.

Keywords: Composite deck slab, Aspect ratio, Shear connector, Deflection, Load carrying capacity

INTRODUCTION

Steel concrete composite floor deck consists of concrete cast on top of cold-formed profiled steel sheets. The steel deck is prepared by cold-forming structural steel sheet of thickness between 0.8 mm to 1.2 mm into a repeating pattern of parallel ribs. Onto the deck sheet lightweight or normal weight concrete is poured to make up the composite system. The deck sheets act as Stay In Place (SIP) formwork and also as a tensile reinforcement to a concrete slab.

Composite floors with profiled decking consist of the profiled decking, shear connectors, reinforcement for shrinkage and temperature stresses. At the ends, the decks are supported generally by steel beam .The connection between floor and beam is made up with welded studs. For the steel deck and concrete to act compositely, a mechanical interlocking is provided by embossments, indentation or holes. If the connection between the concrete and steel sheet is perfect, that is if longitudinal shear deformations are equal in the steel sheet and in the adjacent concrete, the connection provides complete interaction.

The objectives of this paper are:

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1. To examine the strength of slabs with different aspect ratio.
2. To study behavior of deck with bolt type connections.

EXPERIMENTAL STUDY

An experimental investigation was conducted using same length of deck slab but two different width, viz., (1) Three wavelength; and (2) One wavelength composite slab. In both the cases the geometry is set in such a way that one way bending take place Steel bolts have been used instead of embossment to provide bond between the concrete and galvanize steel profile sheet.

Deck Properties

The three wavelength and one wavelength composite slab are made of trapezoidal shape galvanized profile sheet as shown in Figure 1 and 2. The plain steel sheets are with a size measuring 1500 mm length and 51 mm depth. It is built with 6 mm diameter galvanized bolts as shown in Figure 3 which were inserted in the profile as shown in Figure. Yield strength steel sheeting was found as 163.75 N/mm^2 after testing. Average section properties are also presented in Table 1.

Concrete Properties

Concrete used for the specimens is of normal

Figure 1: Section of Three Wave-Length Slab (CS)

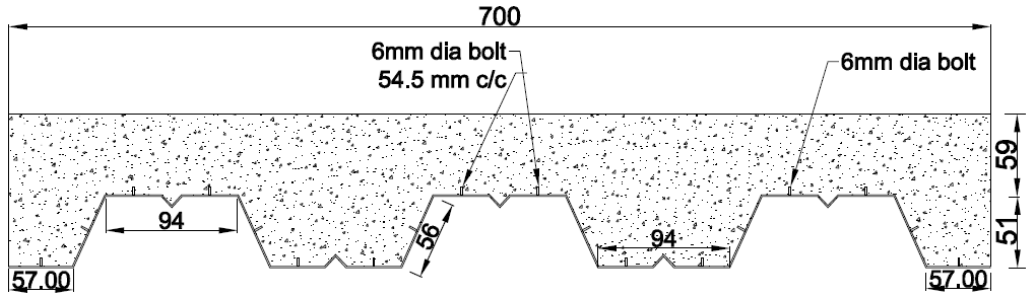

Figure 2: Section of one Wave-Length Slab (CB)

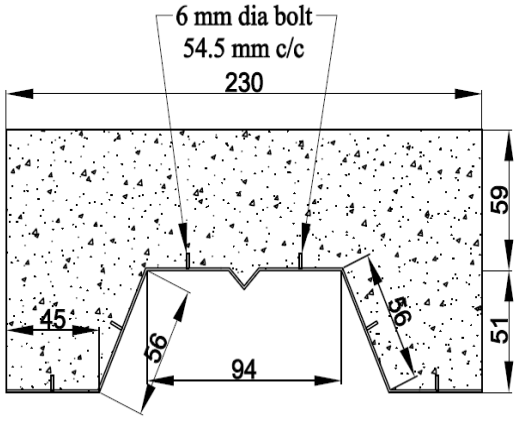

Figure 3: Deck with Bolts

Table 1: Section Properties

	Three wave-length-CS	One wave-length-CB
Length of deck (mm)	1500	1500
Effective Length of deck (mm)	1320	1320
Width of deck (mm)	700	230
Depth of Deck (mm)	51	51
Overall depth (mm)	110	110
Height of concrete above deck (mm)	59	59
Centroid of profile from top (mm)	84.5	84.5
Thickness (mm)	1	1
Area of Deck (mm2)	920	296
Yield Strength of deck (N/mm2)	163.73	163.73
Bolts Diameter and Height (mm)	6 mm , 22mm	6 mm , 22mm
Bolts spacing on sloping Face (mm)	70 mm c/c	70 mm c/c
Bolts spacing on horizontal Face (mm)	140mm c/c	140mm c/c

weight, designed for compressive strength of M25 grade concrete. Concrete compressive strength is determined from concrete cubes 150 mm × 150 mm × 150 mm size according to IS 10262:2009 procedures. Three cubes are tested on the same day as the slab (three or one wave length slab) test. The concrete compressive strength of 27.73 N/mm^2 in three wave length and 31.99 N/mm^2 in one wavelength.

TEST PROCEDURE

In this study, three wave length slab and one wavelength with bolt connectors were casted and tested. The tests were performed on simply supported condition with uniformly distributed load as shown in Figure 4. The

Figure 4: Test Set Up

experimental set up for the composite slab is shown in figure. Load was applied by hydraulic jack via longitudinal spreader beams. Three

deflectometers were placed beneath the bottom edge of the deck, one at midspan and two at quarter span of the slab. The load at first crack, deflections and ultimate load were measured.

Observations and Result

In three wavelengths deck CS, first crack was developed at a load of 31.90 kN ,after that the load is increased and second crack was observed at a load of 92 kN. In one wavelength slab CB first and second crack were observed at load of 46.1 kN and 53.20 kN, respectively. In both the slabs, after initial cracking, deboning noise was arised. Local bucking was not observed in any of the profile sheet .At the time of failure vertical separation and diagonal shear crack was observed in CS as shown in Figure 6. In specimen CB no vertical separation is found, but diagonal shear crack was observed as per Figure 7. The horizontal slip is observed visually and found as 2 to 3 mm in both side surface of specimen. Table 2 shows load and deflection results including the self weight and I girder weight.

Figure 5: Mid Span Deflection Plot for CS & CB with Shear Bolts

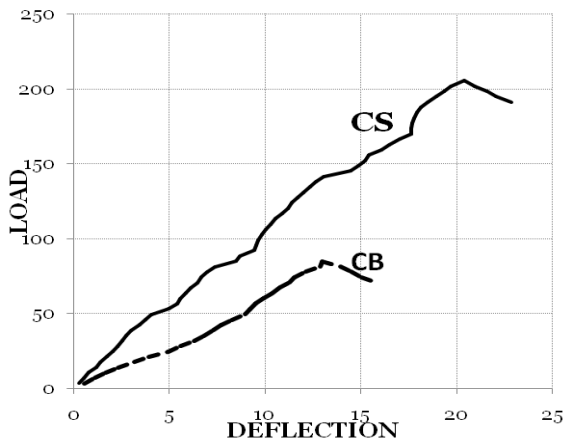

Figure 6: Vertical Separation and Diagonal Crack on CS

Figure 7: Shear Crack on CB

Table 2: Experimental Results

Specimen	Load at First Crack (kN)	Ultimate Load (kN)	Mid Span Deflection (mm)
3-wave length slab(CS)	31.90	206.17	22.85
1-wave length slab(CB)	46.1	85.66	15.83

Calling the deflection at mid-span of the slab δ, the load deflection curve, P-δ is plotted as shown in Figure 5.

THEORETICAL FLEXURAL CAPACITY

Moment of resistance is calculated as per Euro code EN1994-1-1 (2004), section 9. As per Euro code EN1994-1-1, in the analysis full shear connection is assumed.

$$T = A_{pe}\frac{f_{yp}}{\gamma_{ap}} \quad ...(1)$$

$$C = b*x*\frac{0.85\left(f_{ck}\right)_{cy}}{\gamma_c} \quad ...(2)$$

By equating tensile force Eq. (1) and compression force Eq. (2) depth of the neutral axis is calculated

Design resistance moment of the section is Eq. (3)

$$M_{Rd} = T\,z \quad ...(3)$$

Where lever arm 'z' is Eq. (4)

$$z = d_p - 0.5\,x \quad ...(4)$$

For the selected geometry, analytical value of neutral axis and load carrying capacity considering factor of safety is found as per Table 3.

Table 3: Theoretical Load Carrying Capacity

Specimen	Depth of the neutral axis X (mm)	Load Carrying CapacityW (kN)
3-wave length slab(CS)	12.45	97.45
1-wave length slab (CB)	10.56	31.73

CONCLUSION

Two composite slabs having different aspect ratio with bolts are tested and their load carrying capacity is compared. Comparison is also done between experimental and analytical results. Experimental values for load carrying capacity were much higher than analytical value. This may be due to contribution of bolts in load carrying capacity. In experimental work, it is found that the ultimate load carrying capacity of 3 wavelengths slab CS is 2.41 times more than one wavelength slab CB. Analytical result for the load carrying capacity of the 3 wavelength slab CS is 2.96 times more than one wavelength slab CB. Analytical and experimental result shows that, slab with higher aspect ratio CB shows satisfactory tendency to behave as a slab. It shows potential to consider comparatively smaller section for testing composite deck with any new bond pattern.

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