An Experimental Investigation of steel concrete composite deck slab

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Abstract - *Composite steel concrete slabs that have integral steel shuttering at the soffit of a reinforced concrete slab are common in building infrastructure. The composite construction is lighter, stronger and more economical when compared to conventional construction method. The cold form profiled sheet acts as a platform during the construction phase and acts as an external reinforcement after the construction. The concrete of M$_{20}$grade will be used for slab which is placed over the reinforcement. The mild steel profile sheet acts as formwork for concreting. The size of the profile sheet is 1.25m height and 350mm wide and 80mm thickness. The deck slab having steel bottom with galvanized coating does not provide much connection between steel and concrete. Anticorrosive paint is used on the bottom of trapezoidal profile sheet. It is used to avoid the corrosion of profile steel sheet. The main objective of this study is to use the profile sheet along with nominal reinforcement in order to improve the strength and aesthetic appearance. To improve the bonding strength between steel sheet and concrete, shear connectors are provided.*

Keywords: Composite deck slab, profile steel sheet, shear connector, concrete reinforcement.

1. INTRODUCTION

Composite deck slab consist of steel and concrete. In order to ensure suitable connection between two parts of composite plate-steel and concrete, headed studs are used as shear connector. When the concrete has gained sufficient strength, it acts in combination with the tensile strength of the decking to form a 'composite' slab. Slab thickness normally ranges from 100mm to 250mm for shallow decking and from 280mm to 320mm for deep decking. Composite slabs are normally used for spans between 3m and 4.5m supported on beams or walls. If the slab is unpropped during construction, the decking alone resists the self weight of the wet concrete and construction loads. Subsequent loads are applied to the composite section. If the slab is propped, all of the loads have to be resisted by the composite section. This can lead to a reduction in the imposed load that the slab can support, because the applied horizontal shear at the decking-concrete interface increases. However, for both unpropped and propped conditions, load resistances in excess of loading requirements for most buildings can be achieved. Composite slabs are usually designed as simply supported members in the normal condition. Composite slabs and beams are commonly used (with steel columns) in the commercial, industrial, leisure, health and residential building sectors due to the speed of construction and general structural

economy that can be achieved. Although most commonly used on steel framed buildings, composite slabs may also be supported off masonry or concrete components.
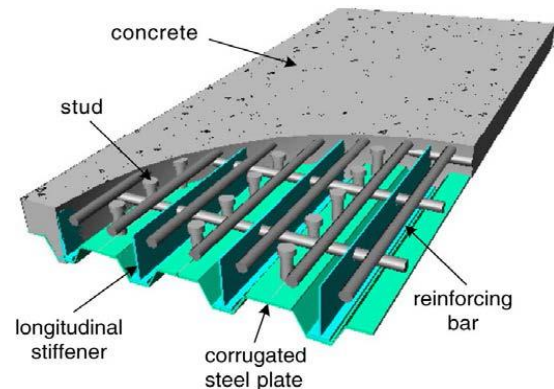

Fig- 1: Steel–concrete composite deck

2. OBJECTIVES

- To use the profile sheet along with nominal reinforcement in order to improve strength and aesthetic appearance etc.
- To improve the bonding strength of steel sheet with concrete by providing shear connector.

3. ADVANTAGES OF TRAPIZOIDAL PROFILE SHEET

- Profile steel sheets act as the form work while concreting. Unpropped span up to 3.5m.
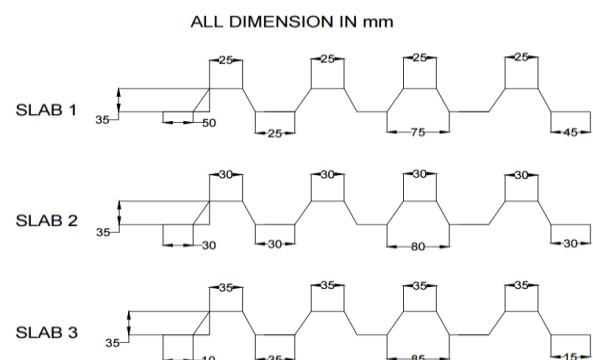- Provide concrete savings up to 65kg/m^3 of floor.

Fig- 2: Trapezoidal Profile Sheet

3.1. DIMENSIONS OF TRAPEZOIDS IN EACH SLAB

Table- 1: Dimensions of Profile Sheet

SLAB	TOP WIDTH(mm)	BOTTOM WIDTH(mm)	HEIGHT(mm)
SLAB 1	25	75	35
SLAB 2	30	80	35
SLAB 3	35	85	35

4. MATERIALS USED

4.1. Cement

The cement used is OPC grade 53. Various tests were performed on the cement. The specific gravity of this cement was found to be 3.15. The initial setting time is 29 minutes. The final setting time was found to be 410 minutes.

4.2. Fine Aggregate

The river sand conforming to zone II as per IS-383-1987 was used and its specific gravity was found to be 2.74. The sand was washed and screened in order to remove delirious materials.

4.3. Coarse Aggregate

The coarse aggregate used is gravel of size 20mm. The specific gravity of the gravel used was found to be 2.74.

4.4. Mild steel sheet

Trapezoidal mild steel sheet for making composite deck slab was used. Three various size of profile sheets are used in this project.

4.5. Reinforcement rods

10mm and 8mm diameter rod for reinforcement details were used. 10mm is provided for shorter direction and 8mm is provided for longer direction.

4.6. Shear connector

Shear connectors were used to increase the bonding strength of steel and concrete.

4.7. Cover block

15 mm cover blocks were used in order to prevent corrosion.

4.8 Anticorrosive paint

Anticorrosive paint is used on the bottom of trapezoidal profile sheet. It is used for to avoid the corrosion of profile steel sheet.

5. MIX DESIGN

Table -2: Mix Design

CEMENT (kg/m³)	FINE AGGREGATE (kg/m³)	COARSE AGGREGATE (kg/m³)	WATER (liters)
394	854.5	1003	197

6. FRESH CONCRETE TEST

6.1. Slump Cone Test

The concrete slump test is an empirical test that measures the workability of fresh concrete. The test is performed to check the consistency of freshly mixed concrete in a specific batch. Consistency refers to the ease and homogeneity with which the concrete can be mixed, placed, compacted and finished.

6.2. Compaction Factor Test

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. This test is used to find the degree of compaction of concrete.

7. HARDENED CONCRETE TEST

Flexural capacity of the composite slab is found. The boundary condition of slab will be, one end is hinged and another end is on roller support. The load will be applied uniformly in the slab. The composite slab will be placed such that the load accurately applied on the specimen. The uniformly distributed load is applied to three various size of composite deck slab. The load is applied gradually to the specimen by using hydraulic jack and the vertical increment of deflection is noted by using dial gauge, relation between the load and deflection, load and strain, and the moment and curvature of the slab. I-section is used in this test set up and ring hydraulic jacks are provided in the top of the deck slab. The uniformly distributed load is applied to the three slabs. The pressure gauges and dial gauges are used for this test. The two dial gauges are used for to determine the deflection of slab.

Fig- 3: Loading frame

Table -3: Deflection values for slab1

Loading (kN)	Deflection readings	Deflection in mm
450	0	0
470	40	0.4
490	60	0.6
500	70	0.7
510	80	0.8
520	100	1.0
530	120	1.2
540	140	1.4
570	160	1.6
580	200	2.0
600	240	2.4
620	260	2.6
650	280	2.8

Table -4: Deflection values for slab 2

Loading (kN)	Deflection readings	Deflection in mm
450	0	0
500	80	0.8
510	100	1.0
520	140	1.4
530	180	1.8
540	210	2.1
550	230	2.3
560	260	2.6
590	280	2.8
610	290	2.9
630	330	3.3
650	360	3.6
660	380	3.8
680	390	3.9
700	420	4.2
710	440	4.4
720	460	4.6
740	480	4.8

Table -5: Deflection values for slab 3

Loading (kN)	Deflection readings	Deflection in mm
460	40	0.4
500	50	0.5
510	60	0.6
520	80	0.8
540	100	1.0
550	120	1.2
570	140	1.4
590	180	1.8
600	200	2.0
620	210	2.1
630	230	2.3
640	250	2.5
670	280	2.8
690	310	3.1
700	330	3.3
730	360	3.6
750	380	3.8
770	400	4.0
780	420	4.2
800	460	4.6
830	480	4.8

Chart -1: Deflection value comparison for slab 1
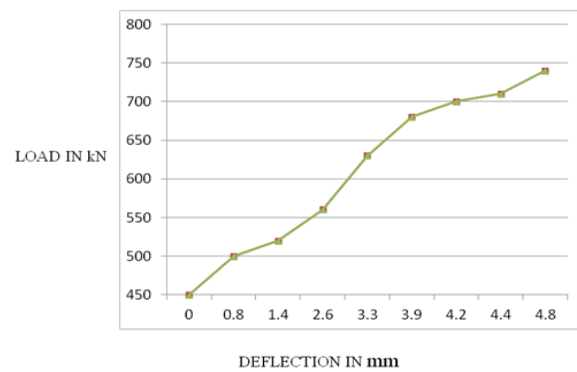
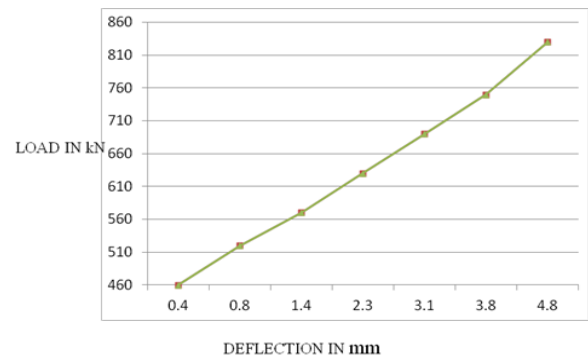**Chart -2**: Deflection value comparison for slab 2

Chart -3: Deflection value comparison for slab 3
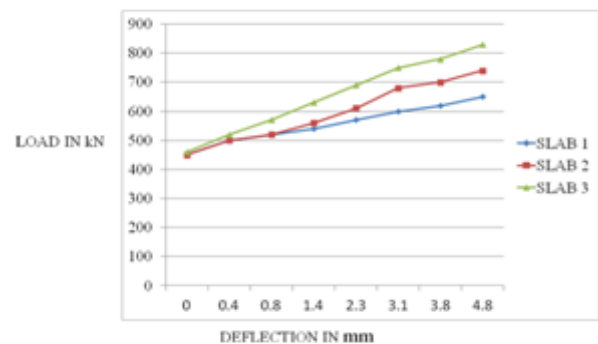

Chart- 4: Comparison of Load vs. Deflection Values

The average deflection value of composite deck slabs are given below.

Table- 6: Average deflection values

SL.NO	DESCRIPTION	LOAD(kN)	DEFLECTION VALUE IN mm
1	Slab 1	650	2.8
2	Slab 2	740	4.8
3	Slab 3	830	4.8

8. CONCLUSIONS

An experimental study on composite deck slab was done using trapezoidal profile sheet and the following conclusions were drawn by conducting flexural test.

- ➢ Based on the profile sheet dimensions the various deflection values are obtain in composite deck slab.

- ➢ The minimum deflection value occurs in slab 1 and the maximum deflection value occurs in slab 3. Therefore the slab 3 has more strength when compared to the other two slabs (slab 2 and slab 1).

- ➢ The crack formation occurs suddenly in slab 1. Hence, the strength of slab 1 is low when compared to slab 2 and slab 3.

- ➢ Although the deflection increases as the load increases

- ➢ In slab 3, it has enough strength to prevent failure when compared to the other two slabs.

- ➢ Provision of shear connectors has increased the bonding strength in all the slabs.

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