EXPERIMENTAL INVESTIGATION ON COMPOSITE SLAB

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ABSTRACT*:An experimental study is described of the behaviour of composite slab and also cost analysis in between composite and conventional slab. In many cases, the load carrying capacity of composite slabs depends on the shear-bond resistance at the sheet-concrete interface. But composite slab with shear connector are used in multi-storey building construction, because its load carrying capacity more than fifteen tones and its cost also more. Therefore composite slab without shear connector enough for normal construction. To identify the cost and load carrying capacity of the composite slabs, simply supported composite slab and conventional slab are tested. Although composite slabs are simple and economic construction elements, the verifications that are required for their design (structural safety and serviceability) are long and complicated.*

KEYWORDS*:* Composite slab, comparison with conventional and composite slab.

INTRODUCTION

Composite slabs are normally used to span between 3 m and 4.5 m onto supporting beams or walls. The ability of the decking to support the construction loads, without the need for temporary propping, generally dictates such spans (longer spans are possible when props are used). Slab thicknesses are normally in the range 100 mm to 250 mm for shallow decking, and in the range 280 mm to 320 mm for deep decking. When the concrete has gained sufficient strength, it acts in combination with the tensile strength of the decking to form a 'composite' slab. It can be considered as a reinforced concrete slab, using the decking as external reinforcement. The load carrying capacity of composite slabs is normally dictated by the shear bond, enhanced by interlock, between the decking and the concrete, rather than by yielding of the decking.

From tests, it is known that this shear bond generally breaks down when a 'slip' (relative displacement between the decking and the concrete) of 2 to 3 mm has occurred at the ends of the span. In practice, this will not occur below ultimate load levels. An initial slip, which is associated with the breakdown of the chemical bond, may occur at a lower level of load.

The interlock resistance is therefore due to the performance of the embossments in the deck (which cause the concrete to 'ride-over' the decking), and the presence of re-entrant parts in the deck profile (which prevent the separation of the deck and the concrete).

Composite slabs are usually designed as simply supported members in the normal condition, with no account taken of the continuity offered by any reinforcement at the supports. Two methods of design are generally recognized, both of which use empirically derived information on the 'shear bond' resistance of the slab from uniformly distributed loading arrangements.

The more traditional method, and one which is given in both BS EN 1994-1-1 and BS 5950-4, is the so-called 'm and k' method. However, this method has limitations and is not particularly suitable for the analysis of concentrated line and point load conditions. An alternative method of design is included in the Euro code, which is based on the principles of partial shear connection. This method provides a more logical approach to determine the slab's resistance to applied concentrated line or point loadings. It is not normally necessary for designers to understand the design methodology in detail, as manufacturers normally present the design data in the form of load span tables, but these are only applicable for uniformly loaded conditions.

PRESENT INVESTIGATION
DIMENSIONAL DETAILS OF THE SPECIMEN

The dimensional details of conventional and composite slab is given in Table

TABLE-1: Specimen Details

Conventional slab	Dimension
Length	**1m**
Breadth	**0.75m**

Thickness	**100mm**
Main reinforcement	**10mm @ 100mm c/c spacing**
Distribution reinforcement	**8mm @ 150mm c/c spacing**
Composite Slab	**Dimension**
Length	**1m**
Breadth	**0.75m**
Thickness	**100mm**
Main reinforcement	**10mm @ 100mm c/c spacing**
Distribution reinforcement	**8mm @ 150mm c/c spacing**

MIX DESIGN

The mix design was arrived M25 grade of concrete as per IS: 10262-2009. The proportion found from mix design was 1:1.87:2.83:0.5(Cement: Fine Aggregate: Coarse Aggregate: Water) with a cement content of 394 kg/m

FABRICATION OF COMPOSITE SLAB WITH PROFILE DECKING

Profile decking sheet and reinforcement as shown in Fig. It is collected from the manufactures for the required length and breadth. The composite slab is made as through profile decking sheet, reinforcement and concrete.

FIG-1: Fabrication of composite slab

TEST SETUP

The test main goal is to determine the ultimate load carrying capacities of the both conventional and composite specimens. The slab are tested in load frame of 100 tones capacity, and the load is applied through jack and proving ring of 10 tones. The deflections are taken down at the mid span by using Dial gauge of least count 0.01mm. The steel concrete composite and conventional slabs tested are simply supported. The load is applied using proving ring and manually operated screw jack arrangement. The load is applied as two line loads distributed across the width of the beam by transferring the load through a slab section to two smaller sections placed across the width of the slab. The Dial gauge is connected to its stand and placed at the bottom of the slab. The Figure shows the test setup of conventional slab and Steel concrete composite slab.

FIG – 2: Test setup for conventional slab

FIG – 3: Test setup of Steel and concrete composite slab

TEST PROCEDURE

For the static test, the specimens were placed over the supporting hinge arrangements and the loading points were marked. The load is applied manually by increment of 1.5kN, up to the stage when the cracks are propagated well in depth. The mid span deflection of the slab is measured by means of dial gauge. The conventional slab and composite slab is tested by this procedure up to ultimate load and the failure pattern has been studied. The conventional RCC slab and steel concrete composite slab are tested by this procedure up to ultimate load and the failure pattern have been studied.

BEHAVIOUR OF CONVENTIONAL RCC SLAB

The experimental behaviour of conventional slab is studied. The Ultimate load carrying capacity of the conventional is determined experimentally. The Load Vs deflection curves are drawn. From the curve parameters such as stiffness and energy absorption capacity are determined. The failure mode of the conventional slab is studied experimentally.

LOAD CARRYING CAPACITY

The first minor crack is witnessed at the load level of 30 kN. As the load level is increased, the cracks are propagated and further cracks have developed in other portions. The Ultimate load carrying capacity of the conventional slab obtained is 75 kN. The Table shows the Experimental load carrying capacities.

LOAD DEFLECTION BEHAVIOUR

The slab is gradually loaded by increasing the load level by increment of 1.5 kN up to failure. The deflection readings measured at the mid span of the slab are recorded and are as shown in Table

TABLE – 2: Behaviour of conventional RCC slab

S.No	Load (kN)	Deflection (mm)
1	0	0
2	7.5	0.23
3	15	0.56
4	22.5	0.88
5	30	1.28
6	37.5	1.68
7	45	2.1
8	52.5	2.6
9	60	3.08
10	67.5	3.5
11	75	4.2

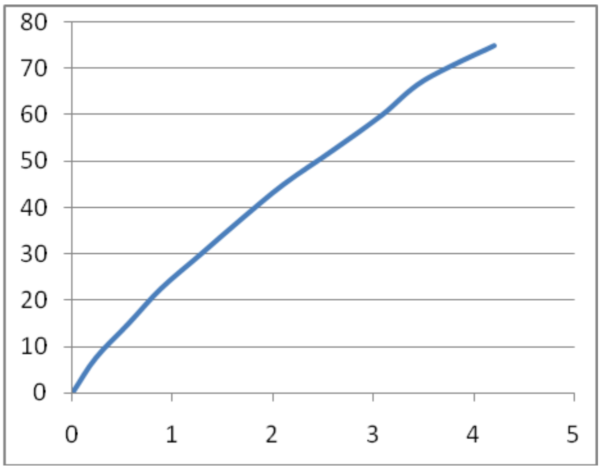

FIG – 4: Load Vs Deflection

BEHAVIOUR OF STEEL CONCRETE COMPOSITE SLAB

The experimental behaviour of steel concrete composite slab is studied. The Ultimate load carrying capacity of the steel concrete composite slab is determined experimentally. The Load Vs deflection curves are drawn. From the curve parameters such as stiffness and energy absorption capacity are determined. The failure modes of the steel concrete slab are studied experimentally.

LOAD CARRYING CAPACITY

The first minor crack is witnessed at the load level of 28 kN. As the load level is increased, the cracks are propagated and further cracks have developed in other portions. The Ultimate load carrying capacity of the steel concrete composite slab is 75 kN. The table shows the Experimental load carrying capacities.

LOAD DEFLECTION BEHAVIOUR

The slab is gradually loaded by increasing the load level by increment of 1.5 kN, up to failure. The deflection readings measured at the mid span of the composite slab are recorded and are as shown in Table.

TABLE – 3: Load Vs Deflection values of steel concrete composite slab

S.NO	LOAD	DEFLECTION
1	0	0
2	7.5	0.4
3	15	0.82

4	22.5	1.8
5	30	3
6	37.5	4.5
7	45	5.85
8	54	7.65
9	63	10.5

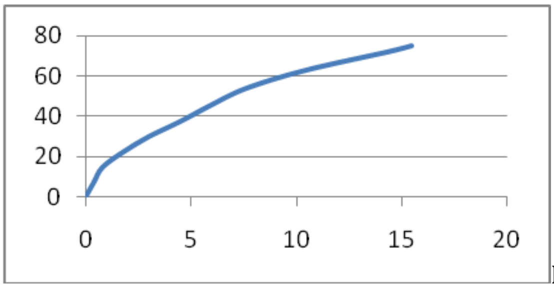

FIG – 5: Load Vs Deflection curve of steel concrete composite slab

STIFFNESS

The Stiffness is defined as the load required to cause unit deflection of the slab. But here for the calculation purpose the slope of the load vs deflection curve plotted in the graph directly gives the stiffness of the beam.

ENERGY ABSORPTION CAPACITY

The Energy Absorption Capacity of the beam is the area under the load vs deflection curve achieved by the results in the graph. That is, the total area under the Load Deflection curve formed by the beam. The energy absorption capacity of conventional slab and composite slab are listed in table

TABLE – 4: Energy Absorption Capacity

Designation	Conventional	Composite
EAC	182kN.m	242kN.m

DUCTILITY FACTOR

Earthquakes imparts tremendous amount of lateral forces on the structures. Structures which has a high amount of deformable capacity and still retaining its vertical load carrying capacity is preferred so that the structure has the capacity to absorb considerable energy due to seismic activity. This property of the structure will prevent the total collapse of the structure. Hence resistance to seismic and lateral forces demands for higher energy absorption or ductility along with vertical load carrying capacity. Ductility factor with respect to the top storey drift of the proposed test model is defined as the ratio of the maximum drift at any load level to the first yield drift. The Ductility factor of conventional slab and Composite slab are listed in table

TABLE – 5: Ductility factor

Designation	Conventional	Composite
Ductility factor	1.74	1.84

BEHAVIOUR AND MODES OF FAILURE

The Steel and concrete composite slab and conventional slab is subjected to load up to failure of the slab. The slab was deflected significantly. As the load level is increased further, the crack is developed on the top, bottom and side of the slab portion. When the needles of the hydraulic jack reversed, no further load increment has been taken place. The corresponding load level is noted as the ultimate load carrying capacity of the steel and concrete composite slab and conventional slab.

FIG – 6: Failure mode of conventional slab

FIG – 7: Failure mode of composite slab

DISCUSSION OF TEST RESULTS

Load Carrying Capacity

The following fig shows the Ultimate load carrying capacity of the conventional RCC slab and steel concrete composite slab. Ultimate load carrying capacity of conventional slab is 70kN.ultimate load carrying capacity of steel concrete composite slab is 75kN.

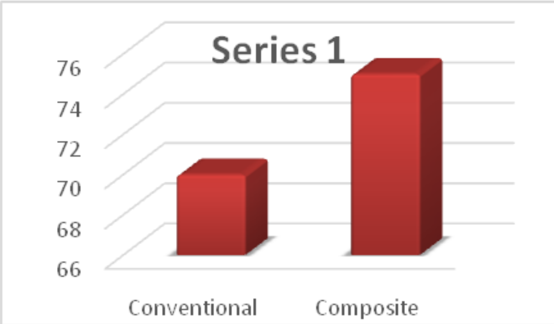

FIG – 8: Comparison of Load Carrying Capacity

Stiffness

The following figure shows the stiffness value of the conventional RCC slab and steel concrete composite slab. The stiffness value of RCC slab is 24.5kN/m, stiffness value of steel concrete composite slab is 30kN/m.

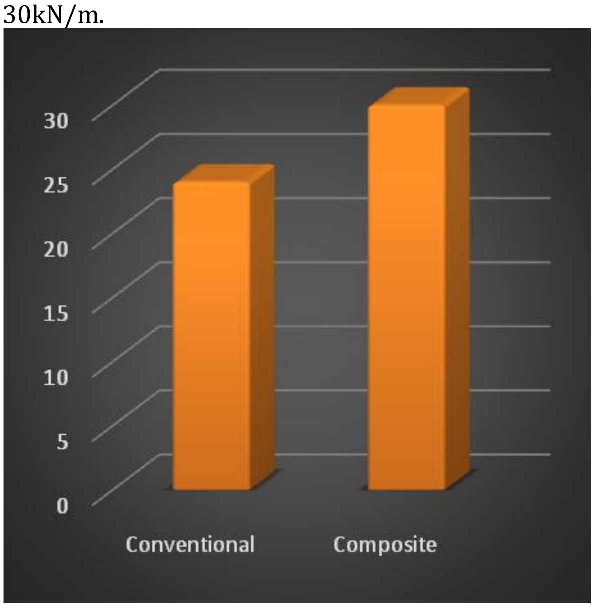

FIG – 9: Comparison of Stiffness

Ductility Factor

The following figure shows the ductility factor of the conventional RCC slab and steel concrete composite slab. The ductility factor of conventional slab is 1.74 ductility factor of steel concrete composite slab is 1.84.

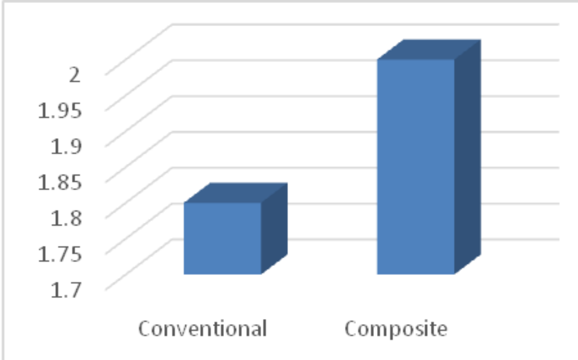

FIG – 10: Comparison of Ductility Factors

Energy Absorption Capacity

The following figure shows the Energy absorption capacity of the conventional RCC slab and steel concrete composite slab. The energy absorption capacity of conventional slab is 182 kN.m, energy absorption capacity of steel concrete composite slab is 242 kN.m.

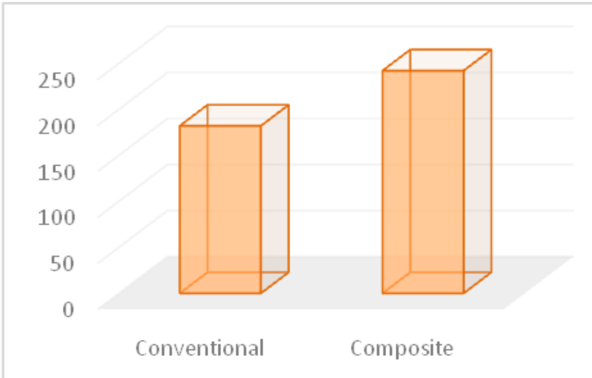

FIG – 11: Comparison of Energy Absorption Capacity

CONCLUSION

Based on the results on the experimental investigation, the following conclusion is arrived.

- ✓ The ultimate load carrying capacity of the steel concrete composite slab with profile decking sheet without shear connector and conventional slab is found to be same capacity.
- ✓ The stiffness of the steel concrete composite slab without shear connector and conventional slab is found to be 24 kN/mm and 30kN/mm. therefore stiffness of both slab almost same.
- ✓ The energy absorption capacity of the steel concrete composite slab without shear connector and conventional slab is found to be 242 kN.m and 182 kN.m. Energy absorption capacity of composite slab more than conventional slab.

- ✓ The ductility factor of the steel concrete composite slab without shear connector and conventional slab is found to be 1.74 and 1.84. Ductility factor of composite slab more than conventional slab.
- ✓ Composite slab required concrete material 30% less than conventional slab. And also formwork may not be required in composite slab construction.

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