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EXPERIMENTAL INVESTIGATION ON FLEXURALBEHAVIOUR OF FERROCEMENT COMPOSITE BEAM USING SELF COMPACTED CONCRETE

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ABSTRACT --The use of High strength mortar composites for infrastructure applications is becoming more popular with the introduction of new high performance materials. Ferro cement laminates are introduced to increase the overall performance of structures, such as composite structures, beams, bearing walls, etc. This projects deals with the experimental investigation on flexural behaviour of Ferro cement composite beam using self-compacted concrete. The Ferro cement largely depends on its durability aspects and corrosion problems of thin reinforcing wire or welded mesh. In composite beam the slab consists of concrete which is Self-Compacting Concrete or Self-consolidating concrete has low yield stress necessary to ensure uniform suspension of solid particles. In particular, the method of shear transfer between composite layers is going to be examined. In this phase the literatures are collected and they are studied in order to get an idea of Ferro cement composite beams and materials required for the project are collected and basic materials testing was done for designing the mix. Various types of composite beam specimens are going to test under a two-point loading system up to failure in next phase. Generally composite beam has good ductility, cracking strength and ultimate capacity. From experimental data the flexural Behaviour and load - deflection of composite beam is to be studied.

Keywords: **Self-Compacting Concrete, Ferro cement, composite beams, Flexural behaviour.**

I. INTRODUCTION

A. GENERAL

Composite construction dominates more in the non-residential building sector for over twenty years. Composite construction success due to the strength and stiffness that can be achieved, with minimum use of materials. The composite construction is so good and that can be expressed in simple way that concrete is good in compression and steel is good in tension. By joining the two materials together structurally these strengths can be achieved to result in a highly economical and lightweight design. Composite construction also offer in terms of speed of construction. Thereductions of floor depth that can be attained using composite construction can also provide importantprofits in terms of the costs of services.

B. COMPOSITE BEAM:

Steel concrete composite beams involves of a steel beam above which a reinforced concrete slab is cast with shear connectors.When a shear connector is provided between concrete slab and steel beams the slip among them is beingremoved and steel beam and concrete slab performance as a composite beam. The behaviour of a composite beam is just like a Tee beam. The basic concept of composite beam lies in the fact that concrete is sturdier in compression than steel is stronger in tension.

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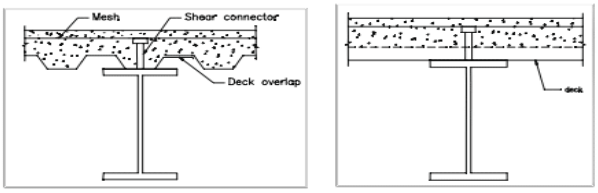

(a) Ribs parallel to the beam *(b) Ribs perpendicular to the beam*

Fig 1.1 Composite Beam

C. FERROCEMENT

Ferro cement is a type of skinny wall reinforced concrete normallymade of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small size wire mesh. It is thin reinforced concrete product and as laminated cement – based composite, Ferro cement has found itself in numerous applications both in new structures and repair and rehabilitation of prevailing structures matched with the conventional reinforced concrete, Ferro cement is reinforced in two directions; therefore, it has homogenous – isotropic properties in two directions. Benefiting from its usually high reinforcement ratio, Ferro cement generally has a high tensile strength and a high modulus of rupture. In this project mesh taken as PVC coated wire mesh for concrete slab for enhancing composite beams.

D. SELF COMPACTED CONCRETE

self-compactingconcrete which has a low stress, high deformability, and moderate viscosity necessary to ensure uniform suspension of solid particles during transportation, placement without external compaction and thereafter until the concrete sets. Ordinarily, concrete is a dense, viscous material when mixed, and when used in construction, requires the use of vibration or other techniques to remove air bubbles and honeycomb-like holes, especially at the surfaces, where air has been trapped during pouring.

E. SCOPE FOR THE STUDY:

The scope of composite Beams is

- By using composite beams, the span of the members can be increased thus improving the architectural view.
- The construction of the building can be completed early thus making of cost effective.
- Higher bearing capacity and stiffness can be achieved by composite beams.

F. OBJECTIVE:

- To obtain the suitable mix design for self-compacting concrete
- To achieve the suitable composite action between Ferro cement slab and steel beam using shear connectors.
- To investigate the flexural behaviour and load carrying capacity of composite beam.
- To study the load-deflection characteristics of composite beam.

II.SUMMARY OF THE LITERATURE

The flexural behaviour of Ferro cement composite beams using Self-compacting concrete and their characteristics are deeply studied with help of literatures different points had been taken for the project

- From various literatures studied from that I have taken for my project that Ferro cement composite beams and also sectional properties from various literatures were taken.
- For Ferro cement composite beams the Ferro cement slab taken for the project has 500X500x100 been taken from various literatures by trial and steel beam for the project has ISMB150 been taken.
- Shear connectors taken for the project its of type stud connector of size is 19mm(d1) and 32mm(d2) of length has 75mm has been taken.
- Mesh taken for the project is PVC coated wire mesh and its size is 470X470mm.
- Self-compacted concrete slab composite beams with mesh are also studied and it has been included in this project.

III.EXPERIMENTAL PROGRAMME

In this experimental programme involves various processes of material testing, mix proportioning, mixing, casting and curing of test specimens. All the testing on materials was done in material testing laboratory, Valliammai engineering college Chennai.

A. MATERIALS USED

The materials used in the preparation of concrete mix include cement, fine aggregates, coarse aggregates. All the materials were tested and its physical properties are described below.

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S.NO	METHOD	OBTAINED VALUES	TYPICAL RANGE OF VALUES
1	Slump Cone Test(mm)	690	650-800
2	T50cm Slump Flow (Sec)	4	2-5
3	V-Funnel Test (Sec)	8	6-12
4	L-Box Test (h2/h1)	0.8	0.8-1.0
5	J-ring test(mm)	7	0-10

i.Ordinary Portland Cement (OPC)
ii.Aggregates
iii.Water

Table 3.1 Properties of materials used

TEST	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
Consistency	30%	-	-
Initial setting time	35min	-	-
Final setting time	355min	-	-
Specific gravity	3.06	2.75	2.79
Fineness	6	2.70	7.3

B. SUPER PLASTICIZERS:

VARAPLAST PC 100 has been primarily developed for applications in the ready mixed and precast concrete industries where the highest durability and performance is required

Table 3.2Properties of super plasticizers

TEST	AS PER STANDARDS
Specific Gravity	1.08 to 20°c
Calcium Chloride Content	Nil
Air Entrainment	Less than 1% additional air is entrained
Setting Time	1-4 hours retardation depending on dosage and climatic conditions.
Chloride Content	Nil to BS 5075.

C. MIX PROPORTION OF SCC

Table 3.3 Mix proportion

Cement	Fine aggregate	Coarse aggregate	water
347	1176.88	817	156
1	3.39	2.35	0.45

Mix proportion for M30 grade for self-compacting concrete is **1:3.39:2.35**

Table 3.4 ACCEPTANCE CRITERIA FOR SCC

D. INSTRUMENTATION AND TEST PROCEDURE

COMPRESSIVE STRENGTH TEST:

Table 3.5 Compressive strength for cubes

Trial	Load in (KN)	Compressive strength in N/mm^2
Trial 1	853 KN	37.91
Trial 2	890 KN	39.55
Trial 3	920 KN	40.88

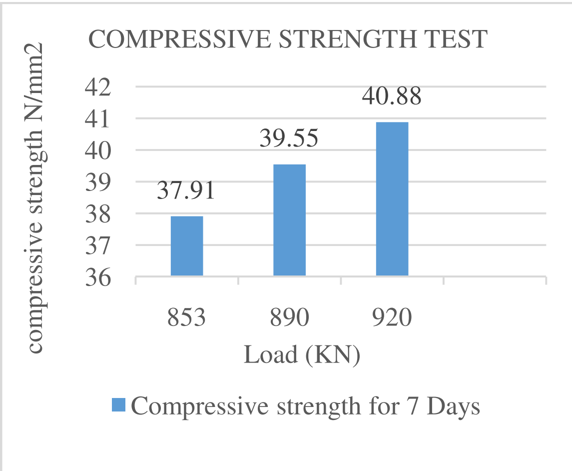

Fig 3.1 Compressive Strength Test Results

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Fig 3.2 Compressive Strength Test (Cubes 150x150x150mm)

SPLIT TENSILE STRENGTH TEST:

Table 3.6 Split tensile strength for cylinders

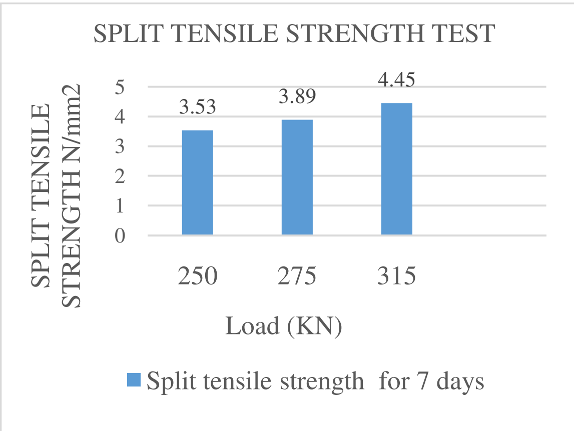

Fig 3.3 Splitting Tensile Strength Test Results

Fig 3.4 Split Tensile Strength Test (Cylinder 150mm dia and 300mm height)

E. PROPERTIES OF COMPOSITE BEAM:

The experimental setup for the "**Experimental Investigation on Flexural Behavior of Ferro cement composite beam using self-compacted concrete**". For this experiment I undergo some of the material properties and sectional properties.

- **Composite Beam:**
  - **SlabThickness** :500mmX500mmX100mm
  - **Ferro Cement Mesh: PVC coated wire mesh** with plastic covering is constructed with galvanized iron wire of high quality. It has PVC powder covering that is processed by an automatic machine. Size of PVC coated wire mesh for the project is taken as 470x470mm
  - **Self-Compacting Concrete:** M30 grade

Trial	Load in (KN)	Split Tensile Strength in N/mm^2
Trial 1	250	3.53
Trial 2	275	3.89
Trial 3	315	4.45

mix

  - **Steel section:** ISMB 150

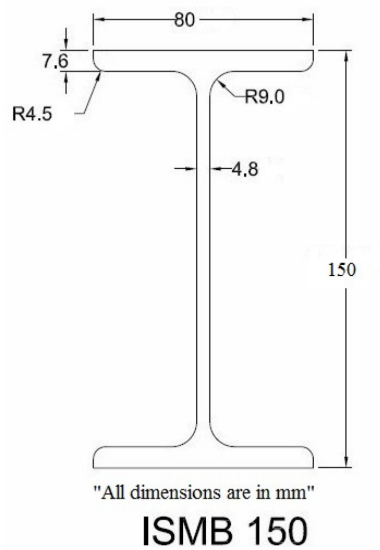

Fig3.5 steel section

STEEL SECTIONAL PROPERTIES: ISMB150

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Table 3.7Steel Sectional Properties

Properties	**Dimensions in mm**
Depth of section(D)	150
Thickness of flange(t_f)	7.6
thickness of web(t_w)	4.8
Width of flange (b_f)	80
Sectional area	1900

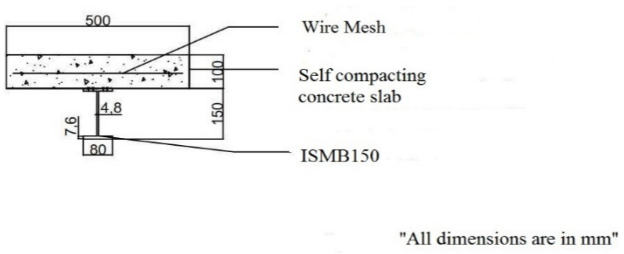

Fig 3.6 Cross section of composite beam

IV. MANUAL DESIGN OF COMPOSITE BEAM

DATA:

Dimension of slab = 500X500X100mm

fy = 250N/mm^2

fck = 30N/mm^2

Density of concrete = 24kN/m^3

The design of composite beams is carried out under IS 11384-1985 and also it involves the following aspects.,

MOMENT CAPACITY:

The maximum moment at construction and composite stage are **24.01 kNm**and **49.82 kNm**respectively. The neutral axis lies within web portion and the depth is **101.21mm.**

SHEAR CAPACITY:

To ensure the adequate capacity for the composite beam is computed as **100N/mm^2**

SHEAR CONNECTOR CAPACITY:

To enable full composite action to be achieved, these must be designed to be adequate. Total ultimate load for calculating the shear connector is **136. 6kN.The** capacity of one shear connector is **49kN**for 16mm dia and 75mm ht.,

The shear connectors are designed based on the Indian code **IS 11384-1985**. The number of connectors are **3**but in order to get accurate slip additionally 2 Nos are added, so **3+2=5** and are spaced according to the double spacing of **100mm.**

SERVICEABILITY CHECKS:

- Deflection
- Stresses

The deflection and stresses are within the maximum permissible limit and the value is **1.5mm** and **217.5N/mm^2** respectively.

V. EXPERIMENTAL SETUP AND TESTING

The two-point load is given because in loading region, the shear is zero, the bending moment is uniform in the loading region and it has pure flexure. The test setup for the flexural behaviour of composite beam is as shown.,

A. TESTING OF CONVENTIONAL COMPOSITE BEAM

[I SECTION WITH CONCRETE SLAB]

The shear stud welded composite beam tested on 11-3-17 and the setup include the LVDTs are used to measure the deflection and slip. The setup is as shown.,

Fig 5.1 Shear connector welded composite beam

Fig 5.2 Crack pattern of conventional composite beam

B. TESTING OF FERRO CEMENT COMPOSITE BEAM

[I SECTION WITH FERRO CEMENT SLAB]

The shear stud welded Ferro cement composite beam tested on 11-3-17 and the setup include the LVDTs are used to measure the deflection and slip. The setup is as shown.,

Fig 5.3Shear connector welded Ferro cement composite beam

Fig 5.4 Crack pattern of Ferro cement composite beam

C. TESTING OF FERRO CEMENT SELF-COMPACTED CONCRETE COMPOSITE BEAM

[I SECTION WITH FERRO CEMENT SELF-COMPACTED CONCRETE SLAB]

The shear stud welded Ferro cement self-compacted concrete composite beam tested on 11-3-17 and the setup include the LVDTs are used to measure the deflection and slip. The setup is as shown.,

Fig 5.5 Shear connector weldedFerro cement self-compacted concrete composite beam

Fig 5.6 Crack pattern of Ferro cement self-compacted concrete composite beam

VI RESULT AND DISCUSSION

The results of load vs deflection and load vs slip characteristics of composite beam shown graphically.

A. RESULTS OF CONVENTIONAL COMPOSITE BEAM

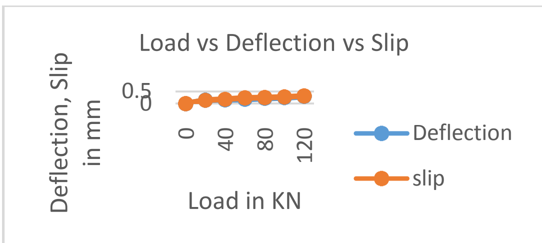

Fig 6.1Load vs Deflection vs slip of Conventional Composite Beam

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From the graph, the deflection occurs at centre and it is more at 120 KN.

Crack attained load =120kN

Ultimate load =120kN

Deflection = 0.30 mm at Centre

Maximum Slip value = 0.32 mm

B. RESULTS OF FERRO CEMENT COMPOSITE BEAM

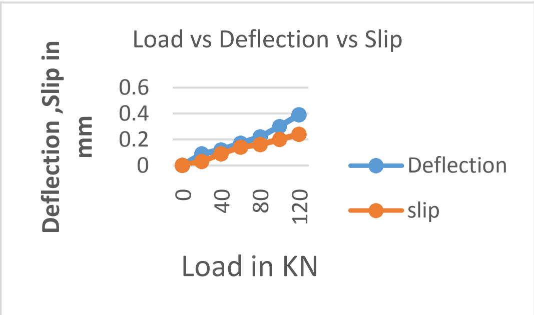

Fig 6.2 Load vs Deflection vs slip of Ferro Cement Composite Beam

INFERNCE

From the graph, the deflection occurs at centre and it is more at 120KN.

Crack attained load =120kN

Ultimate load =120kN

Deflection = 0.39 at Centre

Maximum Slip value = 0.24 mm

C. RESULTS OF FERRO CEMENT SELF-COMPACTED CONCRETE COMPOSITE BEAM

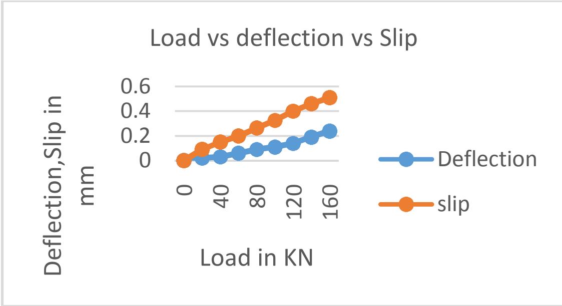

Fig 6.3 Load vs Deflection vs slip of Ferro Cement self-compacted concrete Composite Beam

INFERNCE

From the graph, the deflection occurs at centre and it is more at 160KN.

Crack attained load =160kN

Ultimate load =160kN

Deflection = 0.24 at Centre

Maximum Slip value = 0.51mm

VII CONCLUSION

Experiments have been undertaken for the conventional composite beam, Ferro cement composite beam and self-compacted Ferro cement composite beam. These tests illustrated that increase in load characteristics will increase in deflection and slip characteristics of the composite beams.

- conventional composite beam (ISMB150) – Specimen 1
- Ferro cement composite beam (ISMB150) – Specimen 2
- self-compacted Ferro cement composite beam (ISMB150) – Specimen 3

These specimens were relatively compared and results has been studied. Self-compacted Ferro cement composite beam yielded higher load capacity value which is 25% greater than the conventional composite beam and Ferro cement composite beam in experimental results.

This study explains the load carrying capacity of the composite beam, which proves it to be a good one when compared to other type of beams.

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