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Research Paper

EXPERIMENTAL STUDY ON FLEXURAL BEHAVIORS OF ECC AND CONCRETE COMPOSITE REINFORCED BEAMS

S Santhosh Kumar[1*], K J Pradeep Kumar[2] and C Kavitha[3]

*Corresponding Author: S Santhosh Kumar, ✉ civilsantoz@gmail.com

Engineered Cementitious Composite (ECC) is a class of high-performance cementitious composites with strain-hardening behaviour and excellent crack control. Substitution of concrete with ECC can avoid the cracking and durability problems associated with brittleness of concrete. Extensive inelastic deformation is achieved in ECC through Recron 3's fibre. ECC can be us due to their appearance, high bearing capacity, ductility, fast construction and cost effective. The aim of the paper is to study the flexural behaviour of ECC and concrete composite reinforced beams. Size of the beam is 1200 mm x 100 mm x 150 mm. The percentage of Recron 3'2.5% by weight of cement. Finally conventional beam is compared with ECC beam and also compare ECC at top and bottom of composite beams.

Keywords: ECC, Flexural behavior, Concrete composite, Reinforced beams

INTRODUCTION

Engineered Cementitious Composites (ECC) is a unique representative of the new generation of high performance fiber reinforced cementitious composites, featuring high ductility and medium fiber content. Material engineering of ECC is constructed on the paradigm of the relationships between material microstructures, processing, material properties, and performance, where micromechanics is highlighted as the unifying link between composite mechanical performance and material microstructure properties.

The established micromechanics models guide the tailoring of composite constituents including fiber, matrix and interface for overall performance, and elevate the material design from trial and-error empirical testing to systematic holistic "engineered" combination of individual constituents. The microstructure to composite performance linkage can be further extended to the structural performance level and integrate the material design into performance based design concept for structures. In that sense, ECC embodies a material design approach in addition to being an advanced material and provides an

1 M.E. Student, Civil Engineering Department, Nandha Engineering College, Perundurai, Erode, India.
2 Assistant Professor, Civil Engineering Department, Nandha Engineering College, Perundurai, Erode, India.
3 Assistant Professor, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu 638401, India.

additional degree of freedom in structural performance.

ECC is a class of ultra-ductile fiber-reinforced cementitious composites developed for applications in the construction industry ECC has been optimized through the use of micromechanics in order to attain high tensile ductility and tight micro-crack width at moderate fiber contents (2 vol.% or less). The extreme tensile strain capacity of ECC (beyond 3%) is several hundred times that of normal concrete and its toughness is similar to hat of aluminium alloys. It is the crack widths of ECC can remain small less than 60 lm, even at large deformations. This ultra-ductile behaviour of ECC is the product of distributed micro-cracking. Unlike the normal concrete or fiber reinforced concrete, this feature of ECC allows self-control of crack width independent of steel reinforcing ratio and structural dimensions. ECC, which will benefit the highly robust self-healing behavior

AIM AND OBJECTIVE

- To experimentally study the Flexural Behaviour of ECC and Concrete Composite Reinforced Beams.
- To study the flexural behaviour of ECC and Concrete composite.
- Reinforced Beams. The percentage of Recron 3's fiber to be 0.5 %, 1.5%, 2.5% by weight of cement.To evaluate the following:
  - Mid Span Deflection of the Beam
  - Ultimate Load vs Deflection
  - Beam Stiffness
  - Ultimate Load vs Stiffness
  - First Crack Load

MATERIALS

General

Material investigation is done to test the various materials that are used in making concrete cubes. According to these test results obtained we designed the mix ratios for the materials and prepared the concrete cubes, beams and cylinders. The information are given below,

Cement

PPC in one lot was procured and stored in air tight container. The cement used was fresh, i.e., used within three months of manufacture. It should satisfy the requirement of IS12262. The properties of cement are determined as per IS4031:1968 and results are tabulated.

Fine Aggregate

A fine aggregate obtained from the river is used for experimental purpose. The less amount of clay and silt (<3% by weight). The hire from silt, clay, salt and organic material and it was clean and dry. It is of size retained in 1.19 micron sieve.

Specific Gravity of Fine Aggregate-2.68

Sieve Analysis for Fine Aggregate-2.92

Table 1: Chemical Composition of Manufactured Sand and Natural Sand

Constituents	Natural Sand (%)	Test Method
SiO_2	80.78	IS: 4032-1968
Al_2O_3	10.52	
Fe_2O_3	1.75	
CaO	3.21	
MgO	0.77	
Na_2O	1.37	
K_2O	1.23	
TiO_2	Nil	
Loss of ignition	0.37	

Bulking of Fine Aggregate

- Table the representative of sample of sand, from the available lot at sight.
- Fill the graduated jar with sand up to certain weight compacting.
- Level the sand surface by gentle motion and note down this height.
- Now pour the water into the graduated jar containing sand till the sample is submerged.
- Cover the jar with the disk and give some motion.
- The tamping rod should be moved through out into sample in the jar, so as to ensure to removed of entrapped air completely.

Table 2: Bulking of Sand

S. No.	Initial Height of Sand	Height of Sand After Adding Water	Bulking Factor
1.	600	550	9.09
2.	650	590	10.17
3.	700	650	7.14
Percentage of Bulking			8.8

Coarse Aggregate

The coarse aggregate is strongest and porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. The coarse aggregate used passes in 19 mm and retained in 11.4 mm sieve. It is well graded (should of different particle size and maximum dry packing density and minimum voids) and cubical in shape.

Specific Gravity of Coarse Aggregate-2.73

Sieve Analysis of Coarse Aggregate-7.48

Water

Ordinary drinking water available in the construction laboratory was used for casting all specimens of this investigation. Water helps in dispersing the cement even, so that every particle of the aggregate is coated with it and brought into ultimate contact with the ingredients.

It reacts chemically with cement and brings about setting and hardening of cement. It lubricates the mix and compact property. Potable water, free from impurities such as oil, alkalis, acids, salts, sugar and organic materials were used. The quality of water was found to satisfy the requirement if IS: 456-2000.

Recron 3s Fiber

Recron 3s prevents the micro shrinkage cracks developed during hydration, making the structure/plaster/component inherently stronger. Further, when the loads imposed on concrete approach that of failure, cracks will propagate, sometimes rapidly. Addition of Recron 3s to concrete and plaster arrests cracking caused by volume change (expansion and contraction), simply because 1 kg of Recron 3s offers millions of fibres which support mortar/concrete in all directions.

Cut length	:	6 mm or 12 mm
Shape of fiber	:	Special for improved holding of cement aggregates.
Tensile strength	:	4000-6000 kg/cm^2
Melting point	:	> 250 °C
Dosage rate	:	Concrete Use CT 2024 (12 mm) at 909 g/m^3

Plaster Use CT 2012 (6 mm) at 125 g/cement bag 1:4

Cement/sand ratio Optimize as per application

MIX DESIGN

General

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The main objective is to stipulate the minimum strength and durability. The mix design adopted in our project for the grade of M40.

Casting

The cube mould was placed in position on an even surface. All the interior faces and sides were coated with mud oil to prevent the sticking of concrete to the mould.

Mixing

The concrete using grade M30 (1:1.02:2.26) with water cement ratio 0.38 were used. Concrete is mixed in roller type of mixing machine.

Figure 1: Mixing of Concrete

Figure 2: Curing of Concrete

Placing Concrete

Concrete is properly placed beneath and along the sides of the mould with help of trowel.

Compaction

Hand compaction was done for all the cubes used in the test. The damping mild steel rods having point ends were used to poke the concrete and it is placed in vibrating table to make compaction complete.

Curing

The mould is striped after 24 hours. The test cubes were cured for duration of 14 and 28 days in a curing tank. After the wet curing the specimens were air cured for minimum period 2 hours under laboratory conditions.

TEST RESULT

Testing of concrete plays an important role in controlling and confirming the quality of cement concrete. Cube, Prism and cylinder are tested for its strength characteristics.

Compression Test

The cubes of size 150 x 150 x 150 mm are placed in the machine such that load is applied on the opposite side of the cubes as casted. Align carefully and load is applied, till the specimen breaks. The formula used for calculation

Figure 3: Compressive Test on Concrete

Compressive Strength = Total Failure Load/ Area of the Cube

Compressive Strength Results

Table 3: Compressive Strength for 14 Days

S. No.	Load at Failure (N)	Stress at Failure (N/mm^2)
1.	5770	10.88
2.	4440	8.88
3.	5550	10.44

Table 4: Compressive Strength for 28 Days

S. No.	Load at Failure (N)	Stress at Failure (N/mm^2)
1.	400000	17.7
2.	425000	18.8
3.	430000	19.11

Split Tensile Test

The test is carried out by placing cylinder specimen of dimension 150 mm diameter and 300 mm length, horizontally between the loading surface of compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The failure load of the specimen is noted.

The failure load of tensile strength of cylinder is calculated by using the formula

Tensile strength = 2P/3.14 DL6.2.2

where,

P – Failure of the specimen

D – Diameter of the specimen

L – Length of the specimen

Figure 4: Split Tensile Test for Cylinder Specimen

Split Tensile Strength Results

Table 5: Split Tensile Strength for 14 Days

S. No.	Load at Failure (N)	Stress at Failure (N/mm^2)
1.	110000	1.556
2.	135000	1.909
3.	120000	1.697

Table 6: Split Tensile Strength for 28 Days		
S. No.	**Load at Failure (N)**	**Stress at Failure (N/mm^2)**
1.	160000	2.26
2.	180000	2.546
3.	190000	2.687

Flexural Test

The test is carried out to find the flexural strength of the prism of dimension 100 x 100 x 500 mm. The prism is then placed in the machine in such manner that the load is applied to the uppermost surface as cast in the mould. Two points loading adopted on an effective span of 400 mm while testing the prism. The load is applied until the failure of the prism. By using the failure load of prism

Flexural Strength = Pl/bd^2

P – Failure load of the prism

l – Length of the prism

b – Breadth of the prism

d – Depth of the prism

Figure 5: Flexural Test of Prism

Flexural Test Results

Table 7: Flexural Strength for 14 Days		
S. No.	**Load at Failure (N)**	**Stress at Failure (N/mm^2)**
1.	14.96	7.48
2.	12.88	6.44
3.	15.24	7.62

Table 8: Flexural Strength for 28 Days		
S. No.	**Load at Failure (N)**	**Stress at Failure (N/mm^2)**
1.	17.28	8.64
2.	16.8	8.4
3.	18.6	9.3

CONCLUTION

- In this phase there are three cube, cylinder and prism are casted and tested for 14 days and 28 days.
- The compressive strength, split tensile, flexural strength was determined for these three shapes beams.

FUTURE WORK

Casting and testing of conventional and ECC Composite Beam and testing the beam result for 14 days and 21 days bellow mentioned manner.

Table 9: Future Work on ECC		
Beam	**Type of Beam**	**Numbers**
B0	Conventional concrete beam	2
B1	Composite beam ECC at bottom	2
B2	Composite beam ECC at top	2
B3	Fully composite beam	2

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