EXPERIMENTAL STUDY OF BENDABLE CONCRETE BY USING ADMIXTURE AND FIBER

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ABSTRACT: This paper suggests the need for developing a new class of FRCs which has the strain-hardening property but which can be processed with conventional equipment. It is demonstrated that such a material, termed engineered cementitious composites or ECCs, can be designed based on micromechanical with strain capacity of about 3 to 5% compared to 0.01% of normal concrete. The result is a moderately low fiber volume fraction (<2%) composite which shows extensive strain-hardening. Ductile property of normal concrete can be improved by using PVA fibers in place of coarse aggregate and cement partially replaced by fly ash. For these purpose concrete cubes, cylinders, beams and slabs are experimentally investigated. This paper also focuses on significant pattern of cracks developed during testing of specimens.
KEYWORDS: Engineering Cementitious Composites, Recron3s, Polypropelene, ECC, Ecc concrete.

I. INTRODUCTION

Conventional concretes are almost unbendable and have a strain capacity of only 0.1% making them highly brittle and rigid. This lack of bendability is a major cause of failure under strain and has been a pushing factor in the development of an elegant material namely, bendable concrete also known as Engineered Cementitious Composites abbreviated as ECC. This material is capable to exhibit considerably enhanced flexibility. A bendable concrete is reinforced with micromechanically designed polymer fibres. ECC is made from the same basic ingredients as conventional concrete but with the addition of High-Range Water Reducing (HRWR) agent is required to impart good workability. However, coarse aggregates are not used in ECCs (hence it is a mortar rather than concrete). The powder content of ECC is relatively high. Cementitious materials, such as fly ash, silica fume, blast furnace slag, silica fume, etc., may be used in addition to cement to increase the paste content. Additionally, ECC uses low amounts, typically 2% by volume, of short, discontinuous fibres. ECC incorporates super fine silica sand and tiny Polyvinyl Alcohol-fibres covered with a very thin (nanometer thick), slick coating. Thus an ECC deforms much more than a normal concrete but without fracturing. The different ingredients of ECC work together to share the applied load. ECC has proved to be 50 times more flexible than traditional concrete, and 40 times lighter, which could even influence design choices in skyscrapers. Additionally, the excellent energy absorbing properties of ECC make it especially suitable for critical elements in seismic zones.

(Fig 1 : Beam Section of ECC)

II. FILLERS USED

ECC Concrete is homogenous mixture of Cement, sand, fly ash, water, an optimal amount of fibers and small amount of admixtures. In the mix coarse aggregates are deliberately not used because property of ECC Concrete is formation of micro cracks with large deflection. Coarse aggregates increases crack width which is contradictory to the property of ECC Concrete.

The fillers that are used in experimental process are as follows:

2.1 CEMENT:Ordinary Portland cement (OPC) – 53 grade (Ultratech Cement) was use .

2.2 SAND: Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. soil containing more than 85% sand-sized particles.. Sand is used ingredients of mortar and concrete and for polishing and sandblasting. The weight varies from 1,538 to 1,842 kg/m3, depending on the composition and size of grain. The fine aggregate obtained from river bed of Koel, clear from all sorts of organic impurities was used in this experimental program. The fine aggregate was passing through 4.75 mm sieve and had a specific gravity of 2.68. The grading zone of fine aggregate was zone III as per Indian Standard specifications

2.3 FLY ASH: Fly ash used was pozzocrete dirk 60Fly Ash are the waste materials produced from the industries which can used as a replacement for fillers and also the cost is very low. The Fly Ash that is used in the project Work is obtained from Adhunik.

2.4 SUPER PLASTISIZER: Super plasticizer used was Melamide Formaldehyde

2.5 POLYPROPELYNE FIBRE :Fibers are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. The function of the polypropylene fiber mixed into concrete is not to replace the steel but to avoid the creation of micro cracks in the concrete .This increase the lifetime of the structure. Polypropylene fibers in concrete, in diameter range of 22 to 35 micron by 19mm long, reduce the flow of water through the concrete matrix by preventing the transmission of water through the normal modes of ingress, e.g. capillaries, pore structure, cover concrete, etc.

2.5 RECRON 3S :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/cm2

Melting point :> 250 °C

2.6 WATER :Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Water fit for drinking is generally considered fit for making concrete Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates and cement.

III. MIX PROPORTION FOR ECC

3.1: Proportioning of concrete

The mix design for ECC Concrete is basically based on Micromechanics design basis. Micromechanics are a branch of mechanics applied at the material constituent level that captures the mechanical interactions among the fiber, mortar matrix, and fiber–matrix interface. Typically, fibers are of the order of millimeters in length and tens of microns in diameter, and they may have a surface coating on the nanometer scale. Matrix heterogeneities in ECC, including defects, sand particles, cement grains, and mineral admixture particles, have size ranges from nano to millimimeterscale. Hence the ideal mix proportion given in the literature of ECC-ECC Concrete was used as theguidelines to determine the proportion of various constituents in the concrete. The ideal Mix proportion which was taken as reference is given below:

Mix designation	cement	sand	Fly ash	water	super plasticizer	fiber	w/c ratio
M40	320	1820	110	150	4.6	6	0.36

(Note :- SP is in % with binder material(Cement + Fly ash)

3.2: PLACING, COMPACTION & CASTING OF CONCRETE SPECIMENS.

Before placing of concrete, the concrete mould must be oiled for the ease of concrete specimens stripping. The oil used is a mixture of diesel & kerosene. Special care was taken during the oiling of the moulds, so that there are no concrete stains left on the moulds. Once the workability test of ECC Concrete was done, the fresh concrete must be placed into the concrete moulds for hardened properties tests. During the placing of fresh concrete into the moulds, tamping was done using Tamping rod in order to reduce the honeycombing. After placing the concrete into the moulds, vibrations were done using a table vibrator. The vibration of concrete allows full compaction of the fresh concrete to release any entrained air voids contained in the concrete. If the concrete were not compacted to a proper manner, the maximum strength of the concrete cannot be achieved. After vibration operation, the leveling of concrete was done on the surfaceof the concrete. Leveling is the initial operation carried out after the concrete has been placed & compacted. After the leveling of the fresh concrete was done, the concrete in the mould was left overnight to allow the fresh concrete to set.

3.3: CURING OF CONCRETE SPECIMEN.

After leaving the fresh concrete in the moulds to set overnight, the concrete specimens in the moulds were stripping. The identification of concrete specimens was done. After 24 hours, all the concrete specimens were placed into the curing tank with a controlled temperature of 25 0C in further for 28 days for the hardened properties test of concrete. Some of the cubes were cured in the Accelerated Curing Tank due to time limit. Curing is an important process to prevent the concrete specimens from losing of moisture while it is gaining its required strength. Lack of curing will lead to improper gain in the strength. After 28 days of curing, the concrete specimens were removed from the curing tank to conduct hardened properties test of ECC Concrete

IV. TESTING ON CONCRETE

4.1 : TESTING ON HARDENED CONCRETE

There are many ways that we can used to indicate the strength of concrete. The testing for the strength if concrete is very important in the civil works. This chapter consists of two types of hardened concrete testing. They are compression test and split tensile test. All the procedure used was according to the indian standard code

4.1.1. CRUSHING TEST- (TEST ON CUBES)

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:

Compressive Strength = Total Failure Load/Area of the Cube

Figure 3: Compressive Test on Concrete

4.1.2 : FLEXURAL STRENGHT ON BEAM

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 = 3Pl/2bd2

P – Failure load of the prism

l – Length of the prism

b – Breadth of the prism

d – Depth of the prism

(Figure 4 : Flexural Test of Prism)

V. RESULT

Result using polypropelene fiber

SR.NO	% OF FIBER	NO. OF DAYS	LOAD AT FAILURE	COMP. STRENGH (N/mm^2)
1	0.5	14	250	16
		28	400	26.33
2	1.5	14	310	20.66
		28	567	37.66
3	2.5	14	360.5	24.03
		28	460	30.66

Result using Polypropelene as a fiber :

SR.NO	% OF FIBER	NO. OF DAYS	LOAD AT FAILUR E	FLEXURAL STRENGH (N/mm^2)
1	0.5	14	8	6.96
		28	12	9.28
2	1.5	14	10	7.88
		28	18	13.8
3	2.5	14	8	6.96
		28	16	12.6

Result using Recron 3s as a fiber :(COMPRESSIVE STRENGHT)

SR.NO	% OF FIBER	NO. OF DAYS	LOAD AT FAILURE	COMP. STRENGH (N/mm^2)
1	0.5	14	270	18.96
		28	430	9.28
2	1.5	14	340	28.88
		28	590	39.33
3	2.5	14	388	25.86
		28	510	34

Result using Recron 3s as a fiber :(FLEXURAL STRENGHT)

SR.NO	% OF FIBER	NO. OF DAYS	LOAD AT FAILURE	FLEXURAL STRENGH (N/mm^2)
1	0.5	14	8.9	6.675
		28	12.96	9.720
2	1.5	14	10.5	7.875
		28	20	15
3	2.5	14	8	6.1
		28	16.5	12.6

VI. COST ANALYSIS

SR. NO	DISCRIPTION	AMOUNT
1	Cost of cement	= Rs 6/kg
2	Cost of sand	= 4500/brass
3	Cost of fly ash	= Rs6.8/kg
4	Cost of polypropelene	= Rs 350/kg
5	Cost of recron3s	= Rs 300/kg
6	Cost of melamydeformaladehyde	= Rs 275/litre
7	Cost of water	= -----

VII. CONCLUSION

According to test results, the beam is withstanding high load and a large deformation without succumbing to the brittlefracture typical of normal concrete, even without the use of steel reinforcement. The significant properties of ECCConcreteare ductility, durability, compressive strength, and self-consolidation.

With given w/c ratio workability is not achieved ,so increase in w/c ratio is needed.

Conventional concrete is brittle in nature where as ECC has an appreciable ductility. Flexurle strength of ECC is 60% more than convential concrete, though compressive strength of ECC and convential concrete is nearly same.

The cost of ECC is nearly two to three times that of conventional concrete per cubic yard which depends on availability of fibers, fly ash. However initial construction cost savin can be achieved through smaller structural member size,reduced or eliminated reinforcement elimination of other structural protective system. The advantages offered by ECC over conventional concrete become even more compelling.Also use of fly ash leads to less environmental impact because disposal of fly ash is serious issue, hence Eco Friendly.

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