EFFECT ON COMPRESSIVE STRENGTH OF ECC BY PARTIAL REPLACING CEMENT WITH SLAG SAND

Seema Borole

SEEMA TENU BOROLE, Civil Dept,MCOERC Nashik,Maharashtra,India.

ABSTRACT

Bendable concrete also known as Engineered Cementitious Composite (ECC) is class of High Performance Fiber Reinforced Cementitious Composite (HPFRCC) next to the DUCTAL. The aim of this study is to investigate the properties of ECC with normal Cement Concrete(CC) & also the effect of partial replacement of cement by 10%, 20%, 30% by slag sand less than 500 micron. Then it is tested in Compressive Testing Machine (CTM) for compression.

Keywords— *Engineered Cementitious Composite , Slag Sand, PVA Fibers, Cement Concrete, HPFRCC.*

1. INTRODUCTION

ECC is developed by Dr. Victor .C. Li at the University of Michigan. ECC is made up from basic ingrediants cement, silica sand, Poly Vinyl Alcohol (PVA) Fiber, superplastisizer. Flyash, slag, silica fume is also used with cement to increase paste content. Engineered Cementitious Composite (ECC) is application at construction sites. It should also check the possibility of partial replacement of cement and sand with slag sand obtained as waste product by the iron industries to developed in 2001 by Vector . C. Li to increase the ductility of the normal cement concrete (CC). It is class of High Performance Fiber Reinforced Cementitious Composite (HPFRCC) with high ductility 3-5%.

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Fig. 1. Poly Vinyl Alcohol Fiber

2.LITERATURE REVIEW

There have been various theoretical and practical modelling performed on the topic of Engineering Cementitious Composite (ECC) some of the studies performed in this field. The study on Ductile concrete using ECC by U.L.Deshpande in 2016, then

performs experimentally on concrete by partial replacement on cement by coarse aggregate was carried out by J.Mohammed abdul. In 2015, Badrinarayan Rath & Deo had studied on review on possibility of Sustainable Engineered Cement concrete. Dr. A. W. Dhawale & joshi had studied on ECC for Structural Applications. Before that Dr.Victor C. Li in 2007 had studied ECC Material, Structural, and Durability Performance. After studying the literature on Engineering Cementitious Composite it has been reviewed that there is less literature available on ECC and also as it is new concept to make concrete ductile many research is going on in Japan, USA and others. But it has less scope in Indian construction industry due to availability of PVA fiber. The problem and objective were formulated accordingly.

3.METHODOLOGY

In present study is an experimentally approach, the aim of work to prepare concrete (mortar) known as Engineered Cementitious Composite which has high strain capacity, flexible, less hazardous light in weight.

A. Materials

1) Cement : Cement used is generally Ordinary Portland Cement with flyash or Portland Pozzolona Cement (PPC). PPC of 53 grade is used.

2) Silica Sand: Sand is naturally occurring granular material composed of finely divided rock and mineralparticle. Silica sand is used passing from 1.18mm sieve is used. Its density is about 2.6.Properties of Silica sand is given below in Table I.

Table 1. Properties of silica sand

Constituent	**Properties**
Colour	Blackish
SiO2	44.25%
Fe2O3	Fe2O3 24.10%
CaO 4.60%	CaO 4.60%
Al2O3 9.10%	9.10%

3) Poly Vinyl Alcohol (PVA) fiber: PVA fiber has high strength and modulus of elasticity compared to other general organic fiber. It is of length 5- 6 mm length with elongation 6-10 % . One of remarkable property is strong bond with cement matrix because of formation of layer of Ca(OH)2 called InterfacialTransition Zone , which not observed in other fiber such as Poly Propylene (PP) Fiber. PVA fiber from
China was used.

4) Super Plasticizer: This is utilized to control reological properties of fresh concrete Zentoament FBV was used as superplastisizer

5) Water: Potable water is suited and used for concrete mix. It should be free from alkali, oil, grease or other impurity.

6) *Slag Sand:* Slag sand is waste product from the iron industry Slag sand is also sieved from 1.18 mm sieve.Slag sand from Bhagvati Ferro Metal Pvt. Ltd , Sinnar is used. Properties of slag sand is given below

Table 2. Properties of slag sand

Constituent	**Properties**
Colour	Blackish
SiO2	44.25%
Fe2O3	Fe2O3 24.10%
CaO 4.60%	CaO 4.60%

Al2O3 9.10%	9.10%
MgO 0.40%	0.40%
Cr2O3	Cr2O3 Nil
Total Alkali 2.80%	Total Alkali 2.80%
MnO 8.10%	MnO 8.10%
P2O5 0.32%	P2O5 0.32%
Silt	Nil
Loss on Ignition at 9000C	5.20%

Fig. 2. Slag Sand

B. Mix proportion of ECC

The mix design for ECC Concrete is basically based on icromechanics. PVA fiber is order of thousands of nanometer in diameter and few millimetre in length. However the micromechanics based mix design requires pull test to be carried on the PVA fibers, which is not possible in the aboratory. Hence the ideal mix proportion given in the literature of ECC-ECC Concrete was used as the guidelines to determine the proportion of various constituents in the concrete. The ideal Mix proportion which was taken as reference is given below in Table

Table 3. Mix proportion

Mix	**Cement**	Sand	Slag	**PVA (%)**	**Super Plasticizer (%)**	**W/C ratio**
ECC	1	1	0	1.5	2	0.35
ECC10	0.9	1	0.1	1.5	2	0.35
ECC20	0.8	1	0.2	1.5	2	0.35
ECC30	0.7	1	0.3	1.5	2	0.35

4.TESTING & RESULTS

1.Compressive Test

According to cement association of India (2003), compressive strength of concrete is that value at which material fails completely under uniaxial compressive stress. At the end of 7 days (counted from time of mixing of water with cement and aggregates) three

cubes are taken out. The excess water is allowed to drain off and then the cube is placed in a compression testing machine (CTM). Load is applied gradually till the failure occurs.

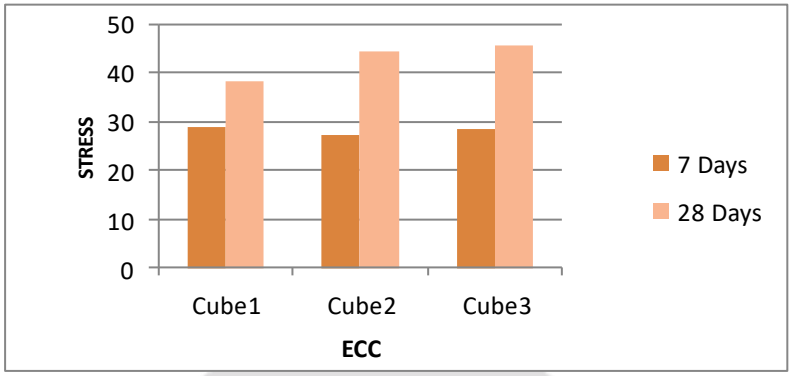

Fig.3. ECC Cube strength after 7 days and 28 days**.**

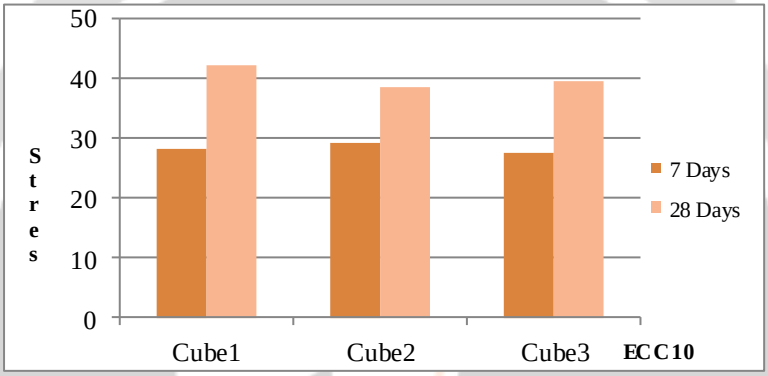

Fig.4. ECC10 Cube strength after 7 days and 28 days

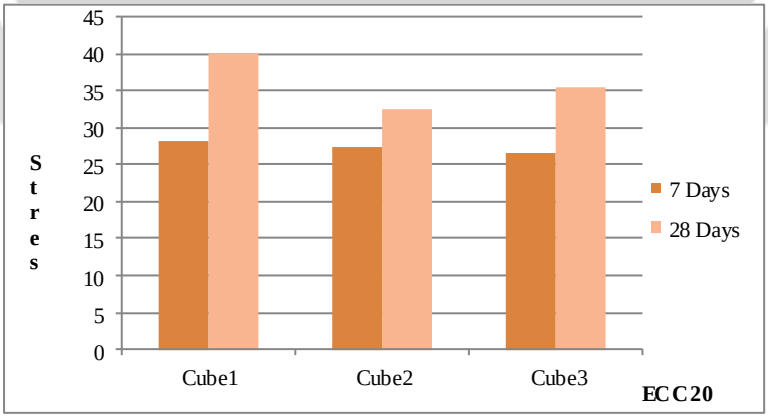

Fig.5. ECC20 Cube strength after 7 days and 28 days

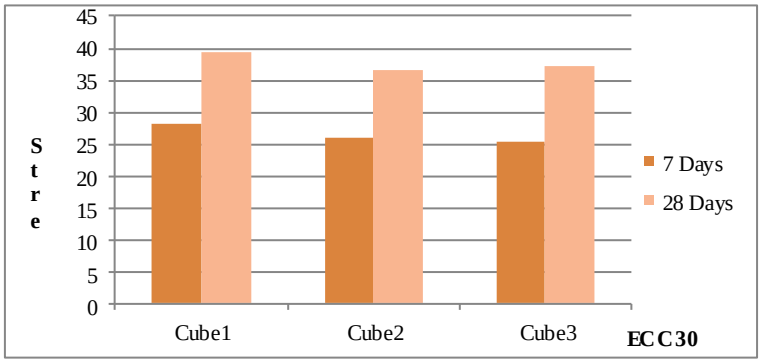

Fig.6. ECC30 Cube strength after 7 days and 28 days

Table 4. ECC, ECC10, ECC20, ECC30 Cube strength after 7 days and 28 days.

	7 days(Average)	**28 days(Average)**
ECC	28.29	42.85
ECC10	28.21	40.08
ECC20	27.31	36.04
ECC30	26.60	36.04

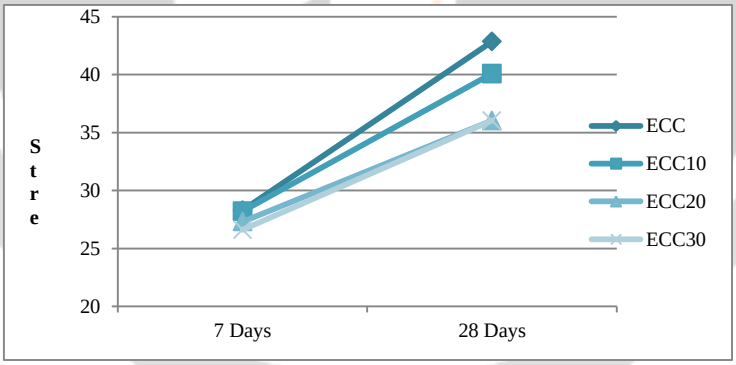

Fig.7. ECC, ECC10, ECC20, ECC30 Cube strength after 7 days and 28 days.

5. CONCLUSION

The compressive strength of ECC is about 65.78% after 7 days and up to 100% after 28 days. The compressive strength of ECC10 is about same as ECC after 7 days and about 93.53% after 28 days. The compressive strength of ECC20 is about 96.53% of ECC after 7 days and about 84.10% after 28 days. The compressive strength of ECC30 is about 94.02% of ECC after 7 days and about 84.10 % after 28 days. Using slag sand as replacement of silica sand and partial replacement of cement decreases the cost and also keep the strength equal to ECC.

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