JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

STUDY THE EFFECT OF DIFFERENT FIBRE BASED ON THE CHARACTERISTICS OF ECC AT A VARIOUS PERCENTAGE OF FLY ASH

[1] **Divya Sethi, Prof. [2]Satyendra Dubey,**
[1]Research Scholar, [2]Asst. Prof,
[1]Department of civil engineering GGITS Jabalpur, (M.P),

Abstract: ECC has a bright application prospect in civil engineering for its high ductility and high toughness in tension. Engineered cementitious composites (ECC, also referred to as strain hardening cementitious composites and pseudo strain cementitious composites) is the name for a special class of high tensile-ductility concretes.

The present analysis considered the effect of three different fibre i.e., Banana, Polypropylene and Polystyrene for developing Engineered Cementitious Composites (ECC) at different percentage of fly ash. An experimental study has been carried out. The density, flowability, compressive strength and flexural strength has been measured.

The uniaxial compressive test, flwxural strength test were carried out to characterize the mechanical behaviour of ECC with 15 mix proportions while varying the type of fibre at different ash content. According the results the banana fibres are more suitable compare than the other two. The analysis has been carried out based on different percentage of ash content.

Index Terms - **Engineered cementitious composites, uniaxial compressive test, fibre, ash content etc.**

I. Introduction

ECC is a type of ultra-ductile fiber reinforced cementitious composite designed for use in high-volume, low-cost construction. Since its launch a decade ago, ECC has witnessed significant advancements in both material research and the variety of potential applications. The IPC group (Aveston et al. 1971), one of the first groups to use fracture mechanics concepts to studying fiber reinforced cementitious composite systems, was essential in the discovery of ECC.

Without the active engagement of many organizations around the world, the recent improvements in ECC technology would not have been possible.

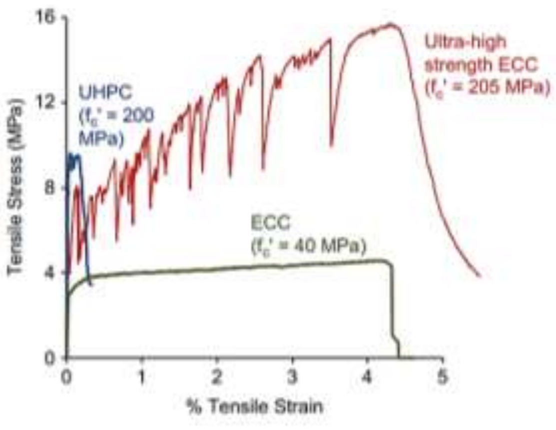


Figure 1.1. The tensile ductility of ECC is shown, with a wide range of compressive strength possible

ECC refers to a group of materials that share the property of being ductile, with tensile strain capacities often above 2%. (Figure 1.1). ECC's design principles are also distinct from those of high-strength concrete (HSC) or ultra-high-performance concrete

(UHPC). Dense particle packing is used to design HSC and UHPC. Instead, based on a body of knowledge known as ECC micromechanics, the material microstructure of ECC is methodically optimised for synergistic interactions between the microstructural components. In other words, when the composite is loaded, the fibre, matrix, and fiber/matrix interface features are designed to interact with one another in a specific way. Engineered Cementitious Composites is named after the emphasis placed on this design foundation.

Figure 1.2 depicts the deformability and various cracking characteristics of ECC. ECC has a strong emphasis on tensile ductility, which strives to promote infrastructure resilience, durability, and sustainability by preventing fracture failure.

Figure 1.2. ECC has a high degree of deformability while also being resistant to brittle fracture. Under bending strain (a) and direct tension (b).

Fundamental of Cementitious Composites

General Introduction of Compositions of Cementitious Composites

Cement

1. Manufacture, compositions, and fineness

Cement is defined as hydraulic cement made by pulverising clinkers mostly composed of hydraulic calcium silicates with a minor amount of one or more kinds of calcium sulphate added as an interground addition, according to ASTM C 150. Clinkers are sintered material nodules with a diameter of 5 to 25 mm that form when a raw mixture with a specific composition is heated to high temperatures.

2. Hydration, setting, and hardening process

When cement is combined with water, its ingredients undergo a series of chemical processes that cause cementitious composites to harden over time. Hydration refers to reactions with water, and the new solids created as a result of hydration are referred to as hydration products. Because the primary properties of any chemical reaction are changes in matter, energy, and speed, hydration can be characterized using reaction stoichiometries, rates of reaction, and heats of reaction. Hydration is defined in cement chemistry as the reaction of non-hydrated cement or one of its parts with water, which is linked to chemical and physical-mechanical changes in the system, most notably setting and hardening.

3. Cementing process and capability

When cement particles are mixed with water, they first produce a workable plastic cement paste (fresh paste), which eventually hardens into a solid, brittle material (hardened paste). The entire process is known as the cementing process, and it is made up of two steps: hydration of cement particles and hardening of hydration products. The cementing process is determined by the ability of the freshly generated hydration products to form a stiff and strong solid structural framework.

II- LITERATURE REVIEW

Using a microwave nondestructive approach, Yuanyuan Li et al. (2018) present a rising relationship model between flexural and compressive strength of engineered cementitious composites (ECCs) . The technique can be used to estimate strength and measure quickly on building sites.

Engineered cementitious composite (ECC) is a form of cement-based material with a variety of functional fillers that has high tensile strength and energy absorption. Steel fibre (SF) and carbon black (CB), two conductive fillers developed by ECC, have a lot of potential in self-sensing. Experiments and numerical simulations were used to investigate the mechanical properties, conductive performance, and self-sensing capacity of two types of ECC: SF-ECC fabricated with 0.58 percent steel fibre and 1.75 percent PVA, and CB-ECC casted with 1 percent weight ratio to cementitious materials and 1.75 percent PVA (Leifeng Shi; 2018).

To examine the stress strain relationship with resistance variation, a four-point bending test with synchronized AC resistance measurement was used. The fracture density growth during the flexural test was simulated using the discrete element technique (DEM). The results are also compared between these two types of ECC in order to determine the sensitivity of the self-sensing characteristic, which will aid in ECC optimization in order to balance loading and self-sending capacity.

Engineered Cementitious Composite (ECC) is a unique sort of cement mixture that contains a unique composition of low volume fibres and various composites to provide excellent ductility, tensile strength, and repairability. Because traditional concrete and fibre reinforced concrete are fragile, they shatter easily under climatic and mechanical pressures, reducing construction durability. Efforts to change the brittle nature of ordinary concrete culminated in the invention of ECCs, which have a wide range of environmental durability, minimal embodied energy, and a negative carbon footprint, making them an environmentally friendly construction material with self–healing capability.

In addition to having a low permeability coefficient and a stronger resistance to steel corrosion than other typical replacements, ECCs have a tight crack width and the development of these cracks actually improves their ability to resist the effects of hot, frost, and humid weather conditions. Manish A. Kewalramani et al. (2016) investigate the appropriateness of ECC in a typical hot arid coastal location with extreme climatic conditions. It necessitates a thorough investigation into the potential of ECC, its influence on relevant engineering properties, and its impact on the construction industry in hot, arid coastal climates.

III. RESEARCH METHODOLOGY

Materials and Method

Materials and Mix Proportions

In this study, the ingredients in the production of ECC include ordinary Portland cement, silica sand, Class C fly ash (collected from Jhabua power plant, Seoni), super-plasticizer (SP), water, and fibre.

Total 15 samples of Fibre-ECC with different mix proportions were designed to examine the effects of fly ash weight percentage, different fibers on the mechanical properties, as given in Table 1.

The mortar matrix cast-off in this study comprised of Portland cement, fine sand, and fly ash (Class C, obtained from Jhabua Thermal Power Plant, Seoni). The admixture is a polycarboxylic-type, high-performance water reducer, produced by Buildcon Infra-Chem Technology. Cement, silica sand and fly ash, were first mixed at low speed for approximately one minute and a half. Water and water-reducing admixture were then added into the dry mixture and mixed for another 3 min. Once a consistent mixture was reached, fibers were slowly added into the mixture until all fibers were uniformly distributed in the cement paste. The whole mixing procedure typically took about 10 min.

The mix design was obtained based on trial tests done in a previous study carried out by Zuanfeng Pan et al 2015.

In this study, three kinds of fibers were used to add or replace i.e., banana fiber, polypropylene fiber (PP fiber) and recycled polystyrene (RP) fiber. The samples were made according to table 3.1.

Table 3.1 Mix proportion (Zuanfeng Pan et al 2015)

Mixture Designation	Cement	Fly ash	Sand-binder ratio	Water-binder ratio	High Range Water Reducer (Ad-mixer)	Fiber Volume fraction	Fibre Type
M-BF-1.2	1	1.2	0.36	0.3	0.0054	1.3	Banana Fibre
M-BF-1.8	1	1.8	0.36	0.3	0.0052	1.3	
M-BF-2.4	1	2.4	0.36	0.3	0.005	1.3	
M-BF-3	1	3	0.36	0.3	0.0048	1.3	
M-BF-3.6	1	3.6	0.36	0.3	0.0047	1.3	
M-PPR-1.2	1	1.2	0.36	0.3	0.0054	1.3	Polypropylene
M-PPR-1.8	1	1.8	0.36	0.3	0.0052	1.3	
M-PPR-2.4	1	2.4	0.36	0.3	0.005	1.3	
M-PPR-3	1	3	0.36	0.3	0.0048	1.3	
M-PPR-3.6	1	3.6	0.36	0.3	0.0047	1.3	
M-PST-1.2	1	1.2	0.36	0.3	0.0054	1.3	Polystyrene
M-PST-1.8	1	1.8	0.36	0.3	0.0052	1.3	
M-PST-2.4	1	2.4	0.36	0.3	0.005	1.3	
M-PST-3	1	3	0.36	0.3	0.0048	1.3	
M-PST-3.6	1	3.6	0.36	0.3	0.0047	1.3	

Testing procedures

Testing of concrete aims

(1) to ensure that it has the required properties called for in the design documents and specifications, and

(2) to determine the properties of concrete in an existing structure.

Many tests can be performed to evaluate certain properties of fresh or hardened concrete. The most commonly used tests are as follows.

IV. RESULT ANALYSIS

Density

Each specimen's dry unit weight after 28 days' curing was measured by the water displacement method. The results are shown in Figure 4.1, which indicates that the average density of a ECC dramatically depends on the type of fibre content and ash content. The density of banana fibre, Polypropylene and Polystyrene fibres are 1350, 946 and 1050 kg/m3 respectively. The fly ash also has less density. The effect of mixing on the mix density is given in figure 4.1. It can be observed that as the fly ash percentage increases it reduces the density. The density is higher for Banana fibre mix while it reduces for polypropylene and polystyrene correspondingly.

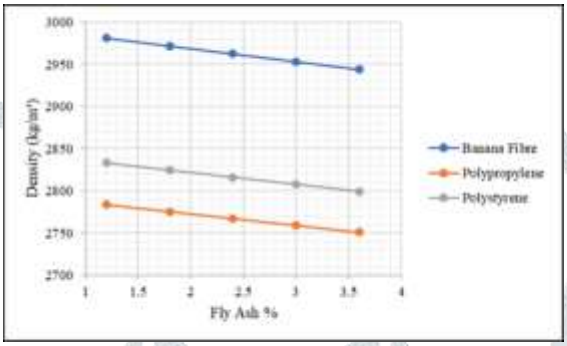


Figure 4.1 Density variation with respect to fly ash content for different fibre mix ECC.

Flowability

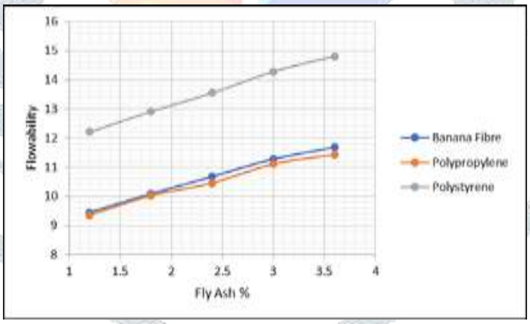


Figure 4.2 Variation in flowability at different fly ash%

Dimensions of slump cone considered for the analysis has the upper and bottom diameter 100 and 200 mm respectively. The flowability is counted with following formulae.

$$Flowability = \frac{(d_1 \times d_2) - (slump\ cone\ dia)^2}{(slump\ cone\ dia)^2}$$

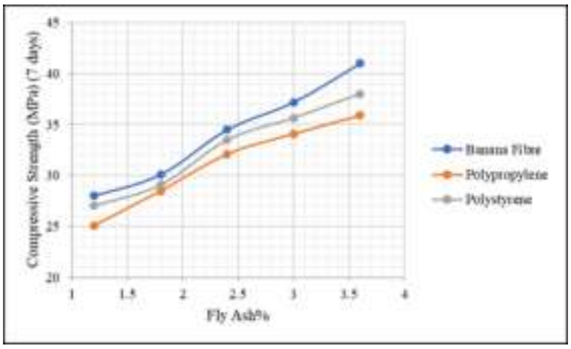
where,

d_1 = maximum dia of flow

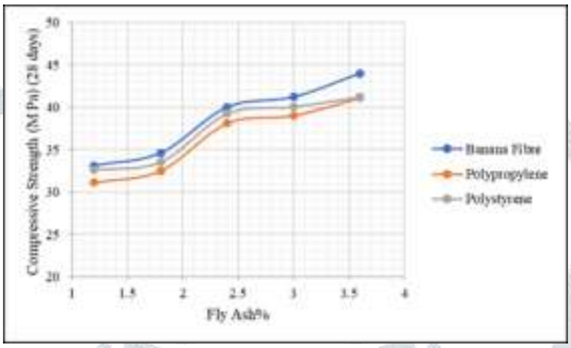
d_2 = minimum dia of flow

It can be observed that the flowability for polysterene fibre is more compare than the other two fibre ECC. The flowability is almost same for both banana and polypropylene fibre ECC. The flowability increases for all the cases when fly ash content increases.

Compressive Strength



(a)



(b)

Figure 4.2 Compressive strength after (a) 7 days curing (b) 28 days curing

V. CONCLUSION

This study demonstrates an adoption of three different fibre i.e. Banana, Polypropylene and Polystyrene for developing Engineered Cementitious Composites (ECC) at different percentage of fly ash. Density, flowability, compressive strength and flexural strength has been measured. The following conclusions can be made

- As the fly ash percentage increases it reduces the density.
- The density is higher for Banana fibre mix while it reduces for polypropylene and polystyrene correspondingly.
- The flowability for polysterene fibre is more compare than the other two fibre ECC.
- The flowability is almost same for both banana and polypropylene fibre ECC.
- The flowability increases for all the cases when fly ash content increases.
- It is observed that the banana fibre contained ECC have greater compressive strength while polypropylene fibre content ECC shows lowest compressive strength for both 7 days and 28 days curing report.

REFERENCES

[1] Benny Suryanto, W. John McCarter, Gerry Starrs, Sam A. Wilson, Ryan M. Traynor, "Smart cement composites for durable and intelligent infrastructure", The 5th International Conference of Euro Asia Civil Engineering Forum (EACEF-5)

[2] Leifeng Shi, Ye Lu, Yu Bai, "Mechanical and electrical characterization of steel fiber and carbon black engineered cementitious composites", 6th Asia Pacific Workshop on Structural Health Monitoring, 6th APWSHM

[3] Rahim Sudin Narayan Swamy, "Bamboo and wood fibre cement composites for sustainable infrastructure regeneration", J Mater Sci (2006) 41:6917–6924, DOI 10.1007/s10853-006-0224-3

[4] Sallal R. Abid, Mohammed S. Shamkhi, Noor S. Mahdi, Yasir. H. Daek, International Conference on Advances in Sustainable Engineering and Applications (ICASEA), Wasit University, Kut, Iraq.

[5] M. LI, Engineered cementitious composites for bridge decks, University of Houston, USA

[6] Manish A. Kewalramani, Osama A. Mohamed, Zubair Imam Syed, Engineered cementitious composites for modern civil engineering structures in hot arid coastal climatic conditions

[7] Mao Xinqi, T. J. Zhao, P. Zhang "Optimization of Shrinkage and Crack Resistance Performance of Engineered Cementitious Composites (ECC)", 978-1-4577-0290-7/11/$26.00 ©2011 IEEE

[8] Miss. Ameena Ahamed, Mrs. Sunitha S, Dr. P. Vinod, Dr. Bindhu K R , "A Comparative Study on the Flexural Behavior of RCC and R/ECC Beams", 978-1-4673-2636-0/12/$31.00 ©2012 IEEE

[9] S.Z. Qian, J. Zhou, E. Schlangen "Influence of curing condition and pre-cracking time on the self-healing behavior of Engineered Cementitious Composites", Cement & Concrete Composites 32 (2010) 686–693

[10] Shuxin Wang and Victor C. Li, "Engineered Cementitious Composites with High-Volume Fly Ash", ACI Materials Journal/May-June 2007

[11] Victor C. Li, "On Engineered Cementitious Composites (ECC) A Review of the Material and Its Applications", Journal of Advanced Concrete Technology Vol. 1, No. 3, 215-230 November 2003 / Copyright © 2003 Japan Concrete Institute

[12] Yuanyuan Li, Kwok L. Chung and Chunwei Zhang, "Flexural Strength Estimation of Engineered Cementitious Composites by Using Microwave NDT", 978-1-5386-4834-6/18/$31.00 ©2018 IEEE

[13] Yingzi Yang, Michael D. Lepech, En-Hua Yang, Victor C. Li, "Autogenous healing of engineered cementitious composites under wet–dry cycles", Cement and Concrete Research 39 (2009) 382–390