International Journal of Science, Technology and Management (IJSTM) ISSN (online): 2321-774X
Volume 10, Issue 1, 2023

Experimental Investigation of Engineered Cementitious Composites by Using Polypropylene Fiber

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Abstract: This paper introduce flexural strength property and other crucial properties of Engineered Cementitious Composites which is invented by Victor Li; Professor at the University of Michigan. It also familiarize various properties of fresh and Harden concrete i.e. workability of concrete, bleeding of concrete, segregation of concrete, Harshness of concrete, compressive strength, flexural strength of concrete. It also distinguishes flexural property of conventional and bendable concrete. Due to lake of ductility quality, ECC is created using normal concrete's ingredients excluding course aggregate and including different kind of polymer fiber of different percentage. Polypropylene fiber creates and investigates strain hardening property of ECC which is much higher (3% to 5%) as compared to traditional concrete (0.01%). Polypropylene fiber is provided with anti friction coating (very thin i.e. nanometer thick) for smoothing of slithering process of fiber to help avoiding fracture. This fiber concrete also comprises industrial waste like fly ash and other metals slag.

Keywords: ECC, Flexural Strength, Compressive Strength, Polypropylene Fiber, Rice Husk Ash.

INTRODUCTION

Concrete can be determined as a hard and strong specimen which is prepared by mixing of cement with water, small size stones generally known as fine aggregate and large size stone normally which are commonly known as course aggregate [5]. Concrete is used in construction in everywhere of world that's why it obtained second position in substance after water which is used in worldwide. It holds market in the world [4]. When all ingredients are combine and homogeneous mixture is possessed then it become strong with highly compressive strength that's why it is vastly used and also reason being for its widespread use. Its ingredients are also special like cement uphold all the ingredients and give homogeneous visual and combines all elements and retain as single unit. Water have its own function like help in chemical reaction i.e., heat of hydration and impart ease by which it can be mixed, transported, placed and finished and The meaning of ECC or elaboration of ECC is Engineered Cementitious Composite which has some important and extra properties from conventional concrete[4][5][6]. Benefit of ECC is that it is prepared from normal concrete's ingredients but in addition it demands for some special kind of fibers which render ductility property to the normal concrete. Another first incredible thing of ECC is that it doesn't include coarse aggregate inside it. Second one is that no requirement of reinforcement or various types of Steel bars to embedded in it these thing make the concrete so special and different from other type of concrete [5]. For different kind of strength the specimen check after 7, 14 and 28 days of curing[5] and you will find 50 times flexibility and 40 times lighter than conventional concrete[6]. It will also 37% less expensive, 39% less emission of carbon dioxide and 40% less energy will developed[10]. It can be created with many types of fiber like jute fiber, polypropylene fiber, polyvinyl alcohol fiber, recron 3S fiber, Steel fiber, plastic fiber, asbestos fiber, glass fiber, Carbon fiber etc. Cement can also replaced with fly ash, rice husk ash, silica fume, blast furnace etc [7].

METHDOLOGY

1. Procurement of required materials cement, sand, coarse aggregate, rice husk ash, polypropylene fiber of essential quality and quantity.
2. Testing on materials like fineness test, consistency test, initial setting time and final setting time test for cement, Sieve analysis, finance modulus, specific gravity, water absorption for sand and impact test abrasion test, fineness modulus, sieve analysis, specific gravity, water absorption test etc. for coarse aggregate.

Figure 1 Consistency Test

Figure 2 Flexural Testing

Figure 3 Compressive Test

3. Calculate the quantity of materials according to design mix ratio 1.365:2.26 for M25 grade of concrete.
4. Filling the standard size of cubes 150 * 150 * 150 mm of 0%, 1%, 2% and 3% polypropylene fiber with 15% rice husk ash.
4. Filling the moulds of beam of 150 * 150 * 500 mm with 0%, 1%, 2% and 3% of polypropylene fiber with 15% rice husk ash.
5. Testing of specimen after 28 days of curing with CTM machine and flexural testing machine to find out compressive and flexural strength.
6. Comparison of flexible concrete and traditional concrete results and make presentation with graphs.

TESTING AND RESULTS

1. Testing on cement-

Fineness test with 10g sample, consistency test, initial and final setting time test are done on Vicat's apparatus with plunger, C type needle and F type needle.

Table 1 Test results of cements

Sr. No.	Name of test	Result value
1	Consistency of cement	29
2	Initial setting time	115 minutes
3	Final setting time	220 minutes
4	Fineness of cement	0.045 grams

2. Testing on sand - Sieve analysis, fineness modulus, specific gravity, water absorption test have done.

Table 2 Test results of fine aggregate

Sr. No.	Name of test	Result value
1	Fineness modulus	2.68
2	Water absorption	.75%
3	Specific gravity	2.78

4. Testing on coarse aggregate- Sieve analysis, fineness modulus, specific gravity water absorption test, impact, crushing and abrasion test has done.

Table 3 Test results of coarse aggregate

Sr. No.	Name of test	Result value
1	Crushing Strength	14.7
2	Abrasion value	15.9
3	Impact value	13.83
4	Water absorption value	0.282%
5	Specific gravity	2.697

4. Compressive test- The size of cube was standard size 150 * 150 * 150 and curing period was 28 days. The compressive strength test conducted on compression testing machine and results are recorded by means of three samples and three categories of cubes were prepared by 1%, 2% and 3%. The weight of normal cube was 8.894 which is made of normal

concrete and cube of fiber concrete was 6.492 so 37% less weight is achieved during Research work and compressive strength of normal and fibrous cube was 28.18 and 29.24 Newton per mm square after 28 days during period.

Table 4 Compressive test results

Cement sand ratio	Fly ash (%)	Polypropylene fiber (%)	Strength after 28 days (N/mm^2)
1.365:2.26:3.88	0	0	28.18
1.365:2.26	15	1	28
	15	2	29.24
	15	3	28.67

5. Flexural Test- The weight of normal concrete cast beam was 26.918 kilogram and weight of fibrous beam was 19.654 kilogram so 37% less weight is achieved. The flexural strength of beam was 2.726 Newton per mm square and strength of fibrous beam was 3.793 Newton per mm square and achieved 39.14% more strength from testing. 150 * 150 * 500 mm size of beam was taken and Three Types of beam specimen were prepared by 1%, 2% and 3% of polypropylene fiber and all are tested on flexural testing machine and curing period was 28 days.

Table 4 Flexure test results

Cement sand ratio	Fly ash (%)	Polypropylene fiber (%)	Strength after 28 days (N/mm^2)
1.365:2.26:3.88	0	0	2.726
1.365:2.26	15	1	3.31
	15	2	3.793
	15	3	3.55

CONCLUSION

1. The result of testing on cement, sand and coarse aggregate were within specified limit.
2. Normal concrete specimen was 37% heavier than fiber concrete specimen due to excluding coarse aggregate and addition of 15% rice husk ash and polypropylene fiber in fiber concrete.
3. Compressive strength of normal concrete cube was 3.76% lesser than fiber concrete cube or we can say that strength of cubes remains same.
4. Flexural strength of fibers concrete beam was 39% more than beam of conventional concrete.
5. Specimens of conventional concrete were badly destroyed after failure but this thing not happened with fiber concrete specimen.
6. The fiber concrete prepared by polypropylene fiber with 1%, 2% and 3% fiber content and best result come from 2% fiber content.
7. Replacement of cement was 15% by Rice husk Ash.

FUTURE OUTLOOK

1. Work can be carried out with different quantity and different type of fibers.
2. Work also can possible with different quantity of rice husk ash and can different materials like silica fume, blast furnace slag, fly ash etc with polypropylene fiber.
3. Study can also done for high strength concrete grades (M55-M70)
4. Self healing property of ECC at various age of concrete can be determined.
5. Research work can also conduct with admixture, super plasticizers to improve workability.

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