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Investigation of Engineered Cementitious Composites by 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].

LITERATURE REVIEW

1. **Kallepalli Bindu Madhavi, Mandala Venugopal, "Experimental study on bendable concrete", IJSRD** Normal concrete has very little tensile strength about 0.01-0.02 % but bendable concrete has tensile strength about 3-5%.These elasticity is achieved by micro crack whose width should be less than 60

Micron. It is passed by the help of fiber like recron fiber. These cracks remain under control and should not grow anymore. In this research ECC concrete is made by Low modulus polyester group fiber. Recron fiber is Polyester type and it creates perfect bond toward other substrates mechanical strength of recron is put in ECC. In this paper they also study and make experiment about replacing of cement with using fly ash. It also tells about flexure strength of ECC when compared with different water cement ratio. They take 192 specimens in this experiment. recron fiber was limited to 2-3%.Superplasticizer are 2%, water cement ratio make fix as 0.5 and replace cement as 20-30% by fly ash. Recron used as second reinforcing material. They add cement, sand and fly ash as dry in drum to two to three minutes and then mix water and plasticizer and then recron fiber. In this BC-2 and BC -12 gave fabulous results. BC was 1:0.5 cement sand 40% fly ash replaced three percent by volume fiber replaced.

2. **Michael D Lepech, Victor C. Li, "A review of the material and its applications", ResearchGate** In this work they show the work in Bridge .They use ECC in link slab in bridge to avoid deck expansion joint. In this work they use high performance fibers reinforcement Cementitious composites (HPFRCC) which is very strong in tension. They use this in Michigan State of America and design in the presence of American Association of state and Highway transportation officials (AASHO). They also check capacity of load and performance of fatigue of link slab. They also observed after 2 years but property remain same and they show that this method is good replacement for conventional expansion joint.

3. **Ganesh S. Ghodke, Nilesh S Dhaphal, "Experimental study of bendable concrete by using admixture and fiber",IJTRIE,2017** In this experimental investigation they define the flexural strength can be achieved 60 times to the conventional concrete. Material used in this experiment was sand, cement, water, fly ash and fiber (they use poly propylene and recron 3S) and super plasticizer and they make a suitable design or mix proportion of the ECC. They made mix for m40 with fibrous material than a proper compaction was done with vibration system and tamping rod and they cured cube for 28 days and after that testing was done for crushing and flexure strength and according to them beam was with stand high value of load and large deformation was achieved without disease even without using the reinforcement

4. **Dr. A. W. Dhawale, Mrs. V. P. Joshi, "Engineered Cementitious Composites for Structural applications", IJAIEM,2013** In this research paper they try to make a new class of FRCs which has strain hardening property with the use of conventional equipment and In this research they observed that they are able to achieve 3-5% strain capacity in ECC with the help of less than 2% of fiber volume. In their slide of work they exercise with OPC (ordinary) Portland cement of 53 Grade (UltraTech), sand fetched from river bed of Koel which permit by 4.75 mm and super plasticizer used as melamine formaldehyde sulfonate and primary class fly ash Pozzocrete dirk 60 and ranged 30-75% of volume of cementitious material and PVA fiber and normal drinking water. In proportioning slide they try different proportions so they will find highest workability and best one was 1:1:1 and BBA fiber 1.2% super plasticizer dosage 60 ml per bag. In casting they add cement, sand, 50% fly ash and 50% water and remaining 50% they add at last and after one lastly they add PVA fiber. They placed test for workability test ie, Slump test, crushing, flexural test, split tensile test on hardened concrete.

5. **K. Selvakumar, R. Kishore, "Experimental study on bendable concrete", ICRTCETM,2017** In this research work they select polyvinyl alcohol fiber for ECC because of its low cost and great performance. This improves the mechanical property of concrete and this is environment friendly reinforcement material. They choose ingredients for ECC are as cement OPC 53 Grade, sand, water, super plasticizer and PVA fiber which limit the length to 12 mm and Diameter 40 Micron and coarse aggregate are not used. They made mould of 700x 750x60 mm and 700x150x 30mm for 30 ml super plasticizer with 2% PVA fiber and water cement ratio restrain at 0.5 to achieve good workability. They mix the ingredients by hand mixing and mixed up the sand, cement and PVA with 50% water and super plasticizer and formed homogeneous mixture and later curing was complete by sink the specimen in water which temperature is 25 degree Celsius and after this flexural and crushing test was conducted on specimen after 7 days 14 days

and 28 days and we observe from data that the strength of ECC specimen was much higher than conventional concrete so ECC is very useful concrete now a day

6. **Sagar Gadhiya, T N Patel, "Bendable concrete: A Review", IJSCER,2015** This research indicates to Ultra ductile fiber reinforced composite material which possess high ductility and flexibility. They display that ECC can 50 times flexible and 40 times lighter than conventional concrete. This property attracts in design of skyscraper and it also play important role in seismic zones due to its great energy absorbing property. In this experiment
four point bending checked at different curing conditions include concentration curing, cyclic wet/dry, water curing and air curing

7. **Vipul Solanki, Dr. Khadeeja Priyan, "A review on bendable concrete",JETIR,2021** They told that ECC can hold different type fibers like Steel, plastic asbestos, glass, carbon etc. which supply tensile strength additionally we have to use high range water reducing agent (HRWR) which confer workability and Cementitious substance like fly ash, silica fume, blast furnace slag which helps in increase the quantity of pest also influence in cost. It constructs strong molecular Bond between PVA fiber and concrete and also averts crack phenomena. ECC lessen emission of greenhouse gases by use industrial west in it. But its starting cost is high and use skilled experts. It has some quality like durable, earthquake resistant, self healing, less repair and maintenance, less curing time etc.

8. **Yadavalli Sandeep, Bandaru Ambika, "Experimental investigation on bendable concrete", IRJET,2019** This observation of test finds that ECC concrete has high ductility, durability, self consolidation and compressive strength. They also conclude that ECC have more strength than normal concrete. The cost of material used in ECC is also less than conventional and in experiment they used natural fiber combination of jute and coir and fly ash, cement and water. They investigate split tensile strength comprises strength and flexural strength at different percentage of fiber like 0%, 0.5%, one percent, 1.5% and 2% but the best result achieved with the percentage of 1.5% (coir and jute) in every type of test. They add super plasticizer for improving workability and strength of ECC. They provide solution of brittleness of conventional concrete and render alternate which can be utilize in construction of bridge deck, Link slab, construction of Building, Road and any other type of structure also.

9. **Dhivya M, Manju, "Structural behavior of bendable concrete-overview", IRJMETS,2020** The experiment defines the various properties of ECC and find 37% less expensive and 39% less carbon dioxide produced and 40% less energy produced than conventional concrete. They find out flexural strength in term of modulus of rupture which means maximum stress than can be withstanding without any failure. Flexural strength was calculated using Tahir Kamal Erdem formula and compressive strength of M30 is 16.4% greater than the traditional concrete and split tensile strength were increased in the addition of percentage of fiber. They also observed that ECC has much strength to upgrade structural performance and damage control of structural element. ECC can develop a joint free link slab or deck slab in the bridge and now a day ECC is also using in various technologies such as self capacity ECC, light weight ECC, self healing ECC, sprayable ECC and much more.

10. **M.Sasi Rekha, T. Akshaya, "An Experimental investigation on flexible concrete", IJETER, 2018** In this research they try to improve ductility of concrete which is composed of all basic ingredients but fiber was polypropylene and cast 178 specimens in which 30 are of cube of size 150*150*150mm and beams of size 500*100*100mm additionally using fly ash and silica fume and naphthalene as super plasticizer . Cement was OPC of 43 grade. In fine aggregate, river sand was used. In last they concluded that if we add 0.1% polypropylene fiber than flexural strength increased by 16%, ductility index 280%, impact strength 163% , modulus of elasticity 42% but compressive strength decreased to 38% because fiber concrete has low workability.

11. **IS 516 (1959): Method of Tests for Strength of Concrete [CED 2: Cement and Concrete]** In this code provisions give all type of guidance regarding different test procedure like preparation of materials and their proportion, their weighing, mixing, size, mould etc. Firstly it provides information about

compressive test. In compressive strength how we prepare the materials like temperature should be room temperature 27(+, - 3), grade of concrete should be proper and proportion should be by volume or weight. Than mixing of ingredients done by machine mixing or hand mixing and instantly consistency should be applied for check the workability and size of specimen should be 15*15*15cm , cylindrical specimen should have length twice the diameter means 15cm diameter than length should be 30cm and mould should be of metal i.e., steel or cast iron. And tamping rod should be of steel bar of 16mm diameter and 0.6 meter long and lower end should be pointed. The compacting should be done by hand or by vibration, then curing is done and testing on specimen will done at the age of 7 days, and 28 days and number of specimen should be at least three than calculation was done using this code provisions. Then procedure for flexural test is taken place. Specimen standard size is 15*15*70 cm alternatively 15*15*50 can also be adopted and remaining procedure is also used in testing.

CONCLUSION

1. Ductility of concrete can be increased by the help of different types of fibers.
2. The compressive strength of ECC remained approximate same as of traditional concrete.
3. Flexural strength of beam and tensile strength of cylinder of ECC always increase by the use of very little percentage of fibers.
4. Some percentage of cement can be replace by Fly ash, silica fume, rice husk ash, metal slag etc materials.
5. Specimens of conventional concrete badly destroyed after failure but this thing not happened with fiber concrete specimen.
6. ECC can be used in construction of jointless bridge Deck, roads, skyscrapers, seismic resistant buildings, dams etc and has self healing property, less repair and maintenance, less curing time also.

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