EXPERIMENTAL STUDY ON PROPERTIES OF CONCRETE USING COMPOSITE FIBER (POLYPROPYLENE WITH GLASS FIBER)

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ABSTRACT

Concrete is the most commonly used man made construction material. It has become very popular not only among Civil Engineers but among common people also. The secret of its popularity lies in the simple fact that except cement, all other ingredients of concrete are commonly available. Therefore, it is no surprise that the concrete is being used as a construction material from small pavements to runways and expressways from small hutments to multistory buildings and from small culverts to long multi-span bridges. But concrete is found to have insufficient compressive and tensile strength at early stages. In modern practices it is generally requires a concrete mix which provides good strength parameters at early stage, for which various types of fibers are introduced in the mix which enhances the compressive and tensile strength of the concrete. Concrete structure cracking is a huge problem in Civil Engineering. A number of causes have been identified including plastic shrinkage, early age settlement as well as other number of issues. Fibers are a possible solution to many of the causes of concrete structure cracking. They have been shown to help early age properties like shrinkage and movements, fibers improve post cracking behavior. More understanding of the benefits and uses of fibers in concrete is needed.

KEYWORDS: Polypropylene Fiber, Plastic Shrinkage, Cracking.

Concrete is very most commonly used construction material for worldwide. We know that plain concrete is considered to be a brittle material, when it is subjected to tensile stress non-fibered concrete will crack and fail very fast as compared of fibered concrete. Since mid of 1800's steel reinforcement has overcome to this problem which was only on the basic principle of reinforced concrete as all tensile load would be taken by steel and all compressive load would be taken by concrete only .Other than this, there are various types of problem on concrete structure as micro-crack, shrinkage, low tensile load capacity, water absorption, brittleness etc can be reduced by application of small quantities of fiber material on concrete.

EXPERIMENTAL

Materials

The materials used for the fibrous control concrete mixture consisted of the normal Type I Portland cement, the gravel having a maximum size 20 mm, and the sand having a fineness modulus of 2.6.Superplasticizer of 6th generation. The mix proportion of cement:water:gravel:sand was 370:136:1217:725 kg/m3. The additives are polypropylene fibers and glass fibers, and super plasticizer they are showed in Fig. The diameter of PP fibers is 1mm, the length is 12mm, the elastic modulus is 5.88 GPa, and the tensile strength is 320MPa.The glass fibers have length between 12 mm. Three compositions of fibers are used. glass & polypropylene fibers in the proportion of .05% .1%, 0.10% 0.05 and 0.075% & .075% of total volume of concrete at 2.7 kg/m3, .45 kg/m3, 0.91 kg/m3,1.35 kg/m3, 2.7 kg/m3, .45 kg/m3

Polypropylene fiber

Glass Fiber

Mixing

The mixing process started with the dry mixing of the coarse and fine aggregates for 1 min. The cement was added; the dry mixing kept for another 1min, and then added water and mixed for 2min.After the former process,

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the specified amount of fibers was added to the wet concrete. The mixture was mixed for 3min to ensure that the fibers can evenly disperse throughout the concrete. The fresh concrete was filled in 150mm×300mm cylinder molds and 150mm×150mm×530mmrectangle molds. The former is for the tests of compressive and spilt tensile strengths, and the latter is for modulus of rupture (MOR). Both moulds were removed after 24 h, and the specimens were allowed to cure in a water cabinet at 23±1 ◦C. Property tests were performed after the samples had cured for 28 days. In addition, the fresh concrete was filled in 100mm×100mm×500mm drying shrinkage test moulds.The mold was removed after 24 h, and initial values of test specimens were measured.

Test methods

The IS code test method was used to determine the compressive strength of cube specimen. The cylindrical specimens were place hydraulic testing machine ,and the load was increased at a rate of 0.3MPa/s until the specimens failed. The IS code test method was used to measure the splitting tensile strength of cylindrical specimen. The continuous load was increased at a rate of 0.9MPa/s until the specimens failed. The flexural strength (MOR) test, conducted using test beam under third-point loading, followed the IS code test for flexural toughness and first-crack strength of fiber-reinforced concrete.

RESULTS AND DISCUSSION

Slump

Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199 – 1959 is followed .The apparatus used for doing slump test are Slump cone and Tamping rod .The slump changed due to the different fiber content and form. For pure concrete, the slump is 16.5 cm. When adding glass with polypropylene fibers at .05% .1%, 0.10% 0.05 and 0.075% & .075% of total volume of concrete at 2.7 kg/m3, .45 kg/m3, 0.91 kg/m3,1.35 kg/m3, 2.7 kg/m3, .45 kg/m3 the slump fell down to 15.5,16,14 cm, respectively. The reason of lower slump is that adding hybrid fibers can form a network structure in concrete, which restrain mixture from segregation and flow. Because of the high content and large surface area of fibers, fibers are sure to absorb more cement paste to wrap around, and the increase of the viscosity of mixture makes the slump loss.

Slump test

Compressive strength

For any concrete structure compressive strength is a very important parameter because generally it is considered that the whole compressive loads coming on structure are taken by concrete only. For determination of compressive strength of concrete, two different fiber as PP and glass fiber are mixed in the proportion of .05% .1%, 0.10% 0.05 and 0.075% & .075% of total volume of concrete

The compressive strength, splitting tensile strength, and modulus of rupture of polypropylene hybrid fiber reinforced concrete. The strengths improved to different extents in response to the fiber content. the increase of compressive strength of polypropylene hybrid fiber-reinforced concrete. Comparing with pure concrete, adding glass & polypropylene fibers in the proportion of .05% .1%, 0.10% 0.05 and 0.075% & .075% of total volume of concrete at 2.7 kg/m3, .45 kg/m3, 0.91 kg/m3,1.35 kg/m3, 2.7 kg/m3, .45 kg/m3 can increase 4.5%,5.5%,5% The polypropylene hybrid fiber-reinforced concrete has better compressive strength increase.

The reason is glass & polypropylene fiber has the high Young's modulus and stiffness for the rough shape, and when these fibers are at high content, similar to effectiveness of function the steel fiber, therefore they may withstand more resistant to compression capacities

Compression Testing Machine

Splitting Tensile Strength

The increase of splitting tensile strength of Polypropylene hybrid & glass fiber concrete Compared with the pure concrete, as the fiber content increases, the splitting tensile strength of polypropylene hybrid fiber-reinforced concrete rises by 5%, 6%,8% respectively. Also, the hybrid fiber reinforced concrete increases more splitting tensile strength than the single fiber-reinforced concrete does. In primary stage of cracking of concrete, there are numerous fibers bridging the micro cracks and preventing the expansion. When the tensile stress kept ruins the specimens, the stress was transferred to the monofilament fibers, which are coarser and stronger, so it can arrest the propagating macro cracks and substantially improve the splitting tensile strength.

Split tensile strength test

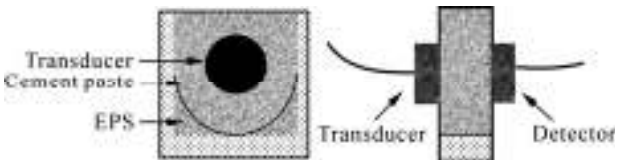
Flexural Strength Test

Polypropylene and glass fibers. Comparing with pure concrete, the augmented percentages of polypropylene hybrid fiber-reinforced concrete are 12%, 15%, and 20%. When the load put on the beams, the hybrid fibers can withstand the tensile stress in the tensile zone below the neutral axis. When fine staple fibers fail, coarse monofilament fibers can keep bridging and disperse the stress of macro cracks until they cannot sustain. Therefore, hybrid fiber-reinforced concrete has higher MOR. Because the fibers have high elastic modulus and stiffness, the major parts of fibers are pulled out. This fracture model is similar to steel fiber on concrete.

Flexural testing machine

UPV Measurement

The device for measuring the UPV is shown in Fig.1.The mould was made of PMMA with the size of 40 mm×120 mm×120 mm and the wall thickness was 2 mm. Inorder to reduce the boundary effects, a U-shaped groove made of expanded polystyrene foam was placed inside the mould. The distance between the bottom of the groove and the bottom of the mould was 2 cm. The ultrasonic transducer and detector were tightly attached to the wall with coupler, and fixed. in the proportion of .05% .1%, 0.10% 0.05 and 0.075% & .075% of total volume of concrete at 2.7 kg/m3, .45 kg/m3, 0.91 kg/m3,1.35 kg/m3, 2.7 kg/m3, .45 kg/m3 are 3.5,3.8,4m/s.



CONCLUSION

(1) The holding effect of different fibers in reduced the surface bleeding of concrete and the sedimentation of the aggregates, and improved the uniformity of the mixture. However, the slump of the mixture reduced somewhat as well

(2) Strength development of cementitious material is very fast in between Fibers, especially equal composition of glass-PP fibers combination, also

(3) Addition of fiber effectively reduced the shrinkage of concrete.

(4) It increases the flexural strength of concrete significantly.

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