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Effects on Compressive Strength of Concrete by use of Natural Human Hair as Fibrous Material

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Abstract—*Natural Human Hair Fiber (HHF) is studied in this paper as a reinforced material in concrete for resists the cracks and crack propagation. The aim of this study is examine the Effect on compressive strength of concrete by use of human hair as a fiber reinforced material, by tested many concrete specimens, in which dissimilar percentage of human hair is used by mass of cementitious material & aggregates, on the basis of standard w/c ratio. HHF of several lengths and equivalent diameter were utilized with an aspect ratio ranged from 200 to 500. Study of human hair fiber is taken because of its excellent attributes which are available in very low cost as compared other fibers which are costlier, for improve the strength of concrete structures. The experimental findings in all tested samples will encourage future researches in this direction for long term performance to extending this cheap or economical type of fibers for use in structural application and reduced the environmental problems.*

Keywords*: Fiber Reinforced Concrete (FRC), Natural human hair as fiber (HHF), Compressive Strength and Aspect Ratio.*

1. INTRODUCTION

The concept of using concrete in construction of structures is very old, so everybody has heard about the concrete which is a mixture of binding material (either lime or cement) and different aggregate (fine & course) possessing low tensile strength, limited ductility and less resistance to crack phenomena and also knows that it is a thing which is used in construction of buildings. And also very few of us have heard about the fiber reinforced concrete (FRC) in which, fibers are used as a reinforcing material in place of steel bars in concrete.

Fibers have been used as reinforcement since ancient times. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers such as horse hair, straw in mud bricks and many plants type such as coir, sisal, jute, bamboo etc. So we can say, The concept of using fibers as reinforcement is not new because In 19th century, asbestos fibers were used in concrete and in beginning of 1950s concept of composite material was introduced as fiber reinforced material.

By the 1960s, many types of fiber such as steel fiber, glass fiber which known as glass fiber reinforced concrete (GFRC) and synthetic fibers such as polypropylene fibers came and today's also research in this concept is going. Fiber addition in concrete helps to make it good homogeneous and isotropic, and also helps to transform it from a brittle to ductile manner. Fibers also help to arrest a micro-cracking mechanism and crack propagation, thus strength and ductility of concrete is increases and also under loading condition, reinforced fibers will stretch more than concrete. From this major point, fibrous material or fiber reinforcing takes over and holds the concrete together. Fibers are actually used in concrete to control plastic shrinkage and dry shrinkage. They also reduced permeability of concrete, bleeding and segregation etc. Fiber reinforced concrete (FRC) has started making its place or importance in many areas of civil construction applications especially where the necessity for repairing, increased durability is more. This is used in civil structures where corrosion is to be avoided at first. In the seismic zones, the use of fiber reinforced concrete helping to minimize the human casualties.

But with these advantages of using fiber in concrete, many disadvantages are also there in which major drawback of using fiber is its fabrication. The process of spreading fibers into the cement matrix is labour intensive and costlier than the production of simple concrete or plain concrete. The major advantages gained by the use of FRC overcome this disadvantage. The fiber is often described by a convenient parameter called aspect ratio. The aspect ratio of the fiber is defined as the ratio of its length to its diameter.

Natural Human Hair (NHH) is used as a fiber reinforcing material in construction materials such as in concrete because it has a good tensile strength which is nothing but equal to that of a copper wire with similar diameter. It is also available in abundance and at a very less cost, and it helps to prevent the concrete from spalling.

2. OBJECTIVE

I. To improve Compressive Strength of concrete by using natural human hair as a fibrous material which are available in market at very low cost and abundance.
II. To control the environmental problems by utilizing of waste natural human hair because human hair has non-degradable property.

3. EXPERIMENTAL WORK

3.1 Material

Many different types of materials are used in present experimental work such as binding material which is ordinary Portland cement, coarse aggregate and fine aggregate, highly water reducer chemicals known as super-plasticizers, cleaned water and discontinuous fibers. So properties of given materials are as follows:

Ordinary Portland Cement: In this investigation work ordinary Portland cement of 53-grade is used as a binding material which has 53 N/mm^2 characteristics strength and specific gravity of this cement is 3.14 with 53 min and 240 min is initial setting time and final setting time respectively. Cement should be free from some undesirable knots which happen when cement is come in moisture condition, due to this moisture specific gravity and other many attributes of cement can be changed so it can reduce our strength.

Fine Aggregates: Clean River sand is used as fine aggregate of size less than 4.75 mm. The specific gravity and water absorption of this type of aggregate is 2.63 and 0.67 respectively as per IS Code 2386:1963, and percentage of passing from 4.75 mm sieve is within the limits as per IS: 383-1970. These fine aggregates are used specially for fill the voids of mixture or in other words it helps to fill empty space between two course aggregates.

Fig. 1: Curing Tank

Course Aggregates: The coarse aggregate used here of size less than 20mm, with crushed angular shape and free from dust particles. The specific gravity and water absorption of this type of aggregates is 2.74 and 0.95 respectively as per IS Code 2386:1963, and the impact value was found to be 12%. The percentage of passing from 20 mm sieve is within the limits as per IS: 383-1970. Course aggregate gives important role in preparation of concrete or in any concrete structure. They provide compressive strength, durability, hardness, rigidness etc to concrete. Course aggregates must be free from dust particles and we avoided round shaped aggregates because rounded shaped aggregates give more voids or in other word, empty space between two aggregates is more than angular shaped.

Natural Human Hair: Natural human hairs of circular cross-section are used in this experimental work as fiber reinforced material instead of steel bars for improves strength of concrete. The size or diameter range of circular hair is in between 50 μm – 100 μm with 10 mm – 30 mm length. Human hair has oily surface so that they come in form of knot when they meet together, and that is not desirable or good for concrete.

4. PREPARATION OF SPECIMENS

Concrete cubes specimens (100 mm x 100 mm x 100mm) were casted for determining compressive strength of concrete in accurate proportion of materials and all the specimens were tested after 7-days and 28-days curing period. Three cubes were casted as per IS standard guide line in M30 Proportion with three different percentages of natural human hair fiber which are 0.25, 0.50 and 0.75 percentages of total mass of binding material and aggregates. Fibers were added through manually distribution, directly in rotating drummer so that it mixed properly. We adopt manually distribution because, due to oily surface of hairs, they convert in the form of knot when they meet together so to avoid this we adopt manually distribution method.

Fig. 2: Cube Moulds Filled with Concrete Mixture

Firstly prepared the mixture of cement concrete with human hair fiber and then it placed in cube shape moulds which are made up of cast iron as shown in fig. 2 and before placing of concrete mould must be oiled so that they can be easily de-mould. After placing concrete, use the vibrator to vibrate the moulds so that air voids can be easily removes. Vibration of

moulds is very important step of concrete casting. After 24 hours, when moulds will come in dry position then they can be de-mould and after that put cubes in water tank for required curing period as shown in fig. 1, and water should be clean or free from dust particles.

5. COMPRESSION TEST OF SPECIMENS

a. The compression test was carried on compression testing machine of capacity 2000 KN.
b. Compression Test is easy and simple to perform, it conduct only cubical shape samples which has standard size of 150 mm x 150 mm x 150 mm and 100 mm x 100 mm x 100 mm as per Indian standard.
c. This test is conducting on hardened concrete.
d. In this test load is applied by axially or vertically from upper side.
e. There are two plates attached on both sides, upward as well as downward side which known as base plate.
f. Always keep smooth surface on upper side so that load can distribute equally on entire the area.
g. This base plate is fixed with plunger and upper side plate is movable.
h. All the three cubes of each proportion of human hair were tested after calculating mass (in Kg) of each sample so that density of sample can be determines. Where density is nothing but mass divided by volume.

Fig. 3: Compression Testing Machine

i. Strength of sample is nothing but force applied or load applied to the cross-sectional area. In other words

$\sigma = P/A$

Where,

P = Load Applied by mechanism

A = Cross-sectional area

j. In this test critical load is counted on which cracks will come on concrete sample and due to that load we can calculate compressive strength of sample.

6. RESULT AND DISCUSSION

After completion of this work on fiber reinforced concrete, where natural human hair (NHH) used as fiber reinforced, determine that:

a. Density of this type of reinforced concrete is not depends on the percentage of fiber content. Density of FRC is slightly changed by change the percentage of fiber.
b. During Test of FRC samples, it found that the load bearing capacity of samples is improved by using discontinuous fiber.
c. In terms of compressive strength, there are positive or direct relationship between compressive strength and load carried by sample so due to increase the load bearing capacity of FRC sample, compressive strength of sample is also increased.
d. Due to use of human hair as a reinforcing material, ductility of samples is increased. Sample makes more ductile because when applied a heavy load and sample came in crack propagation then noted that, it broke in a single manner or in other words it didn't failed in pieces, but if normal concrete came in crack propagation, it broke in small pieces as shown in Fig. 4 and 5.
e. After testing of FRC samples, when we compared all result of each percentage of hair, found that load bearing capacity of cubical samples is decreases continuously when fiber percentage is increased from 0.25 of total mass of binding material and aggregates.
f. On 0.25 percentages of human hair, load bearing capacity and compressive strength obtained maximum which is 16.45% more than normal concrete's strength, and after that by increasing the quantity of fiber, strength decreasing as shown in chart 1 and 2.

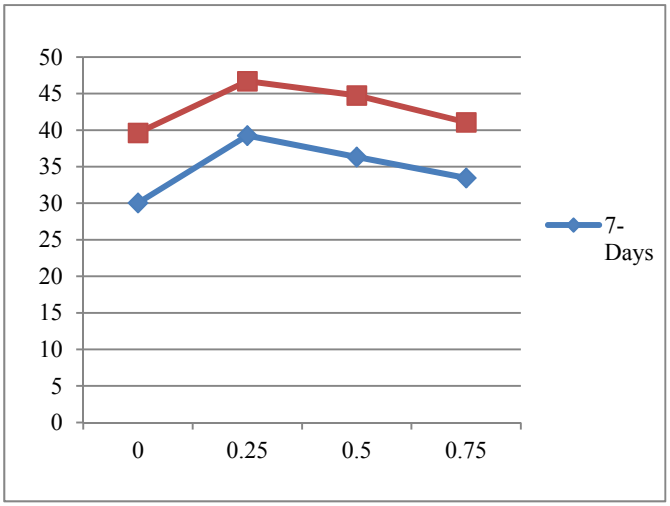

Chart 1: Relation between Avg. Compressive Stress (x-axis in N/mm^2) and Percentage of Human Hair (y-axis)

Fig. 4: FRC Cube Sample in Crack Propagation

7. CONCLUSION

At the end of this experimental investigation we concluded that following points which are given below:

a. Density will slightly change with change of percentage of human hair fiber.
b. Human hair fibers deliver our important role in concrete to produce extra strength in very low cost.
c. Human hair as a fiber or reinforcing material can be used in concrete to convert it brittle to ductile manner. This can be check from failing condition of cubical FRC samples and normal concrete samples diagram.
d. Maximum of natural human hair percentage can be used in terms of mass of binding material and aggregates, is 0.25.
e. The major drawback of this type of reinforcing fiber is distribution in mixture because human hairs have oily surface so it converts in form of knot, so to overcome this big issue we can adopt

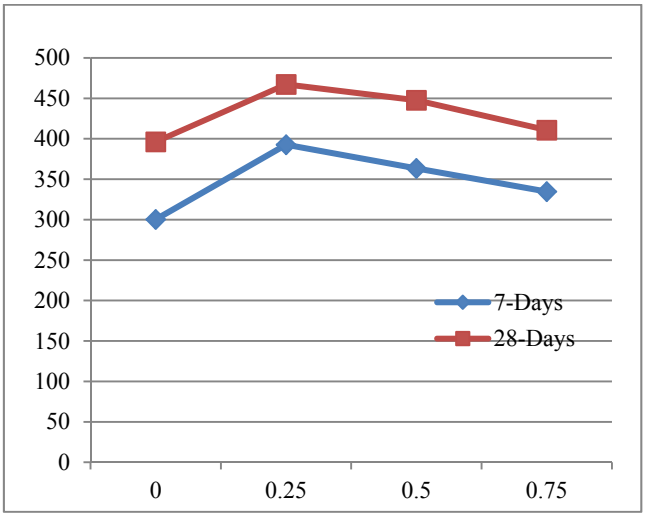

Chart 2: Relation between Avg. Compressive Load (x-axis in KN) and Percentage of Human Hair (y-axis)

Fig. 5: Normal Concrete Sample in Crack Propagation

manually spreading or manually distribution method so that it can be mixes in concrete mixture properly.

Finally from this research work I reached only on that decision which is, "human hair fiber can be used in concrete to become it longer lifer."

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