EFFECTS OF INCLUSION OF HUMAN HAIR ADDITIVES AND POLYPROPYLENE FIBRE IN CONCRETE

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ABSTRACT

Human Hair is an alternative for fiber reinforced polymer which is available in abundance and at a very cheap cost. It also creates environmental problem for it decomposition. Human hair is also non-degradable and on whole, about three to four tons of human hair are found as a waste in India.

Fibre reinforced concrete can offer a convenient, practical and economical method for overcoming micro-cracks and similar type of deficiencies. Since concrete is weak in tension hence some measures must be adopted to overcome this deficiency. Human hair and polypropylene is strong in tension; hence it can be used as a fibre reinforcement material. By testing we found that there is an increment in the various properties and strength of concrete by the addition of human hair and polypropylene as fibre reinforcement which makes it suitable for an alternative additive for concrete to enhance its mechanical properties.

This paper explores and assesses use of human hair in concrete from the perspective of expanding its utilization as a resource as well as convenient, practical and economical method to overcome the micro-cracks and similar types of deficiencies in concrete.

Keywords: *Fibre Reinforced Concrete, Hair fibre, Tensile strength, Polypropylene Fibre.*

1. INTRODUCTION:

Fibre-reinforced concrete (FRC) is a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibres which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres – each of which lends varying properties to the concrete. In addition, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities. Fibres are usually used in concrete to control cracking due to plastic shrinkage and due to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion, and shatter resistance in concrete.

Fibre is a small piece of reinforcing material possessing certain characteristic properties. The fibre is often described by a convenient parameter called aspect ratio. The aspect ratio of the fibre is the ratio of its length to its diameter. Typical aspect ratio ranges from 30 to 150

Hair are used as a fibre reinforcing material in concrete to study its effects on the compressive, crushing, flexural strength and cracking control to economize concrete and to reduce environmental problems created by the decomposition of hair.

Today, polypropylene fibres are also use widely as a fibre reinforcing material in concrete for increasing water proofing ability of concrete, making concrete dense and strong, use for roof slabs and other slabs.

1.1 Advantages of Fibre Reinforced Concrete:

1) FRC is used in civil structures where corrosion is to be avoided at the maximum.
2) FRC is better suited to minimize cavitation /erosion damage in structures where high velocity flows are encountered.
3) A substantial weight saving can be realized using relatively thin FRC sections having the equivalent strength of thicker plain concrete sections.
4) When used in ridges it helps to avoid catastrophic failures. In quake prone areas the use of fibre reinforced concrete would certainly minimize the human casualties.
5) Fibre reduces internal forces by locking microscopic cracks from forming within the concrete.
6) Studies have been proven that fibre reinforced concrete is found to improve the following mechanical properties of ordinary concrete:
   Compressive Strength, Modulus of Elasticity and flexural strength, Toughness, Splitting, Tensile Strength, Fatigue Strength, and Impact Resistance.

1.2 Disadvantages Of Fibre Reinforced Concrete

The fibres have to be uniformly mixed and spread throughout the concrete mix. At times, this is found to be a difficult process and time consuming. If this limitation has been overcome by new and effective methods of fabrication, fibre reinforced concrete is found to be more adaptable for common concreting works.

1.3 Reasons For Using Fibre In Concrete:

Fibres are usually used in concrete for the following reasons:

i. To control cracking due to both plastic shrinkage and drying shrinkage.
ii. They also reduce the permeability of concrete and thus reduce bleeding of water.
iii. Some types of fibres also produce greater impact, abrasion and shatter resistance in concrete.
iv. The fineness of the fibres allows them to reinforce the mortar fraction of the concrete, delaying crack formation and propagation. This fineness also inhibits bleeding in the concrete, thereby reducing permeability and improving the surface characteristics of the hardened surface.

1.4 Using Hair Fibre:

Human hair is considered as a waste material which is a common constituent found in our environment which causes enormous environmental problems. This particular topic has been first chosen as a method of finding the possibilities of hair rather than considering it as a non-bio degradable waste material. It is also available in abundance and at a very low cost. It reinforces the mortar and prevents the spalling of concrete. The properties like high tensile strength, unique chemical composition, thermal insulation etc. makes it suitable to be used as a reinforcing material.

2. EXPERIMENTAL PROGRAMME AND RESULT:

2.1 Collection of material required:

The materials required for the preparation of concrete specimens are given in table 1.

Table -1: Details of necessary materials required for M30 grade per m^3 [As per IS 10262 (2009)]

Cement	Fine. Agg.	Coarse Agg. (Total=10mm+20mm)	Water	Fibre (1% of mass of cement)	Water cement ratio
450 kg	693 kg	1172Kg	197 kg	4.5 kg	0.4

2.2. Treatment of hair fibre:

The hair needed for the preparation of concrete was collected from salons and beauty parlors. It needs treatment before to be added in the concrete specimens. It is carried out as in the following steps:

- Separating hair from other waste: Depending on the source, the collected hair may contain wastes. This has to be removed.
- Washing: After sorting, the hair is washed with water to remove impurities.
- Drying: The hair is then dried under sun or in oven. After drying, the hair can be stored without any concern for decay or odor.
- Sorting: The hair is then sorted according to length, color, and quality. The hair fibres are checked at random for its length and diameter.

2.3. Testing Of Specimens:

Testing of hardened concrete plays an important role in controlling and confirming the quality of raw materials, which help to achieve higher efficiency of material used and greater assurance of performance of concrete. In the present study test conducted on hardened concrete were carried out by using Compressive Testing Machine(CTM) of capacity 200 KN and Universal Testing Machine (UTM) of capacity 2000 KN as per IS 516:1959[23] .

2.3.1 Compressive Strength Test:

A cube compression test was performed on standard cubes of size 150mm x 150mm x 150 mm after 7 days and 28 days of curing. Results are shown in Table 2 and Fig. 1, 2 &3 shows graphical representation of compressive strength. The compressive strength of specimen was calculated by the following formula:

$$f\text{cu} = P_c / A$$

where P_c = Failure load in compression, N
A = Loaded area of cube, mm^2
$f$cu = Compressive strength, N/mm^2

Table-2: Compressive Test Results Of Cubes

Sr No	Type	Compressive Strength (N/Mm^2)						Avg. Compressive Strength ($N/Mm^{2)}$
		7 Days Test			28 Days Test			
		Cube1	Cube2	Cube3	Cube1	Cube2	Cube3	
1	Concrete Without Fibre	19.11	18.67	17.77	32	32.44	33.33	32.59
2	Concrete With Polypropylene Fibre	20	18.67	18.22	31.56	33.33	34.67	33.19
3	Concrete With Hair Fibre	23.11	19.11	18.67	32.44	33.78	38.22	34.81

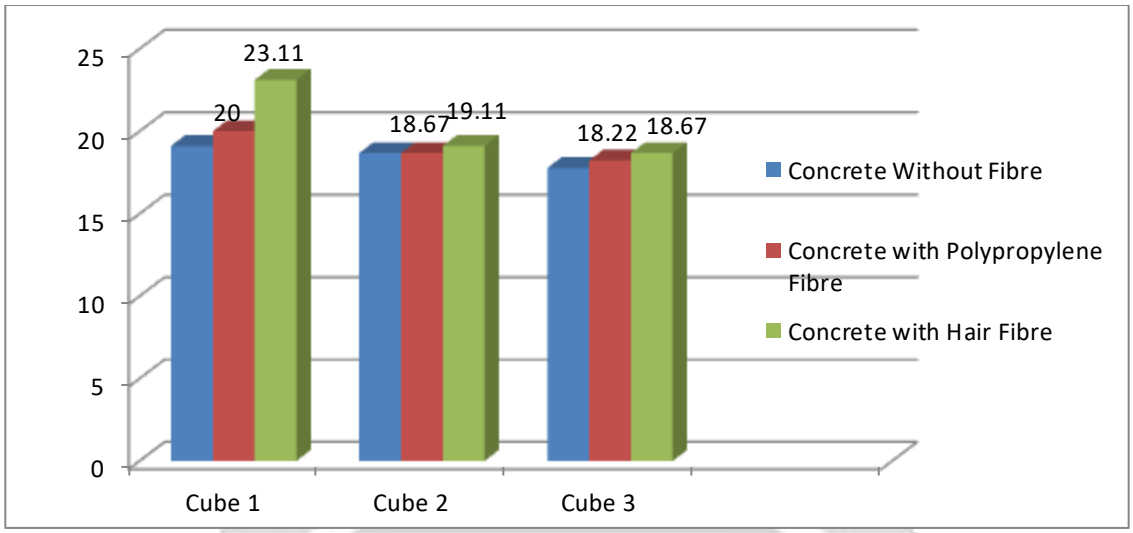

Fig-1: Comparison On The Basis Of Compressive Strength After 7 Days

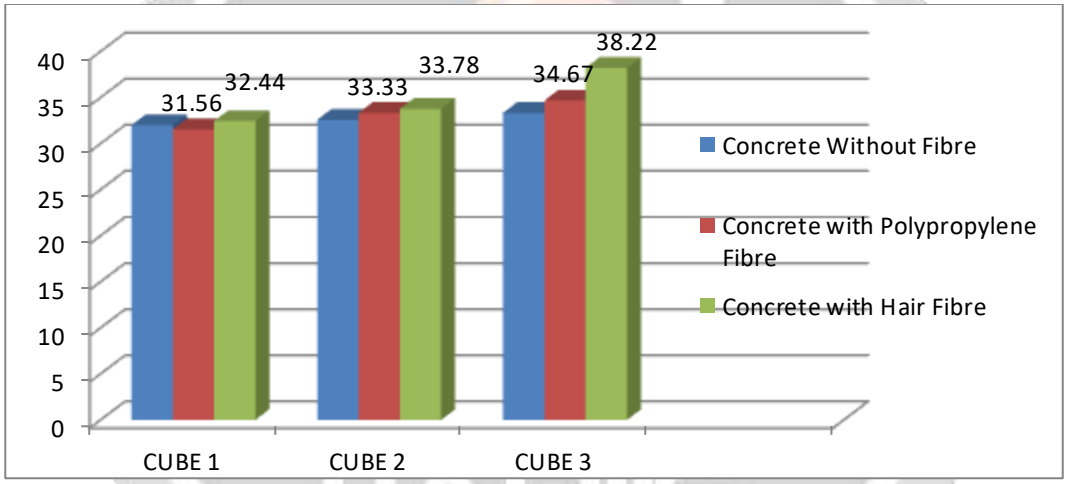

Fig-2: Comparison On The Basis Of Compressive Strength After 28 Days

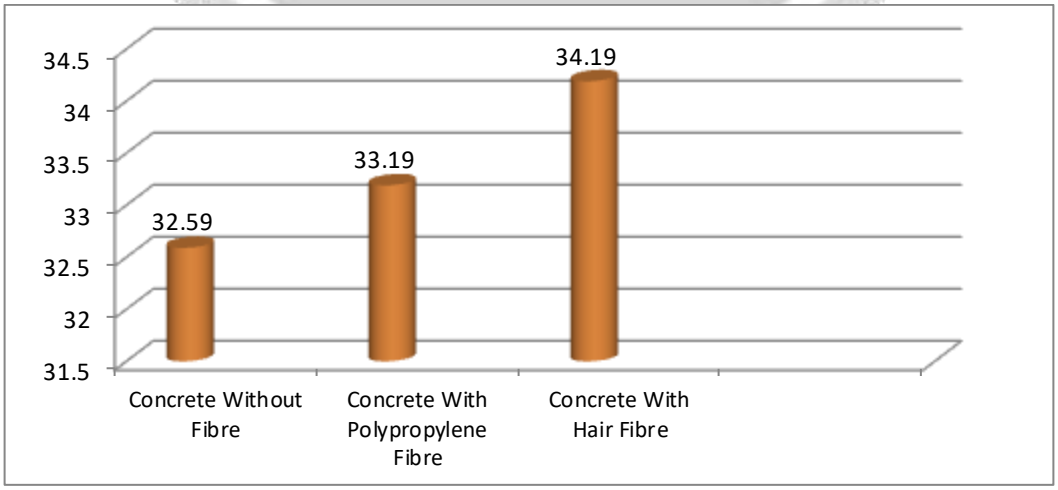

Fig-3: Comparison On The Basis Of Avg. Compressive Strength

2.3.2 Split Tensile strength test:

For Split tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were de-molded after 24 hours of casting and were transferred to curing tank wherein they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category three cylinders were tested and their average value is reported.

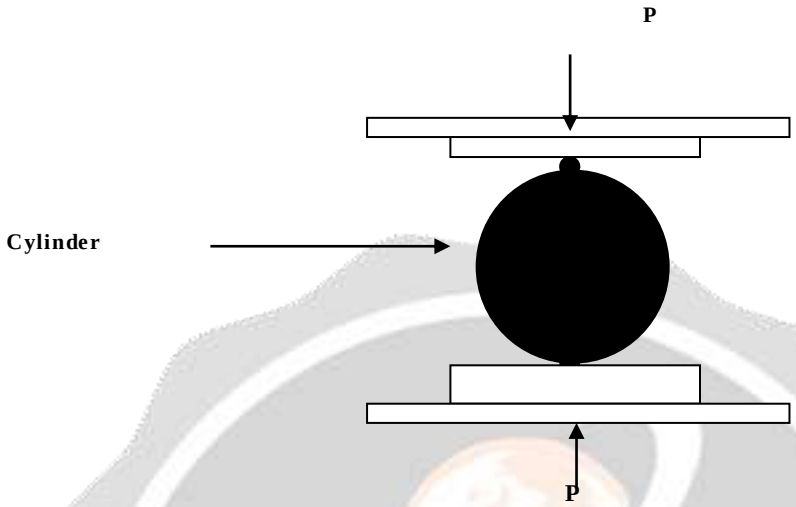

Fig-4 : Cylinder split tensile test setup

The split tensile strength of cylinder is calculated by the following formula.

$$f_{cys} = 2P_{sp} / \pi D L$$

where,

f_{cys} = Split Tensile strength, Mpa
P_{sp} = Load at failure, N
L = Length of cylinder, mm
D = Dia. Of cylinder, mm

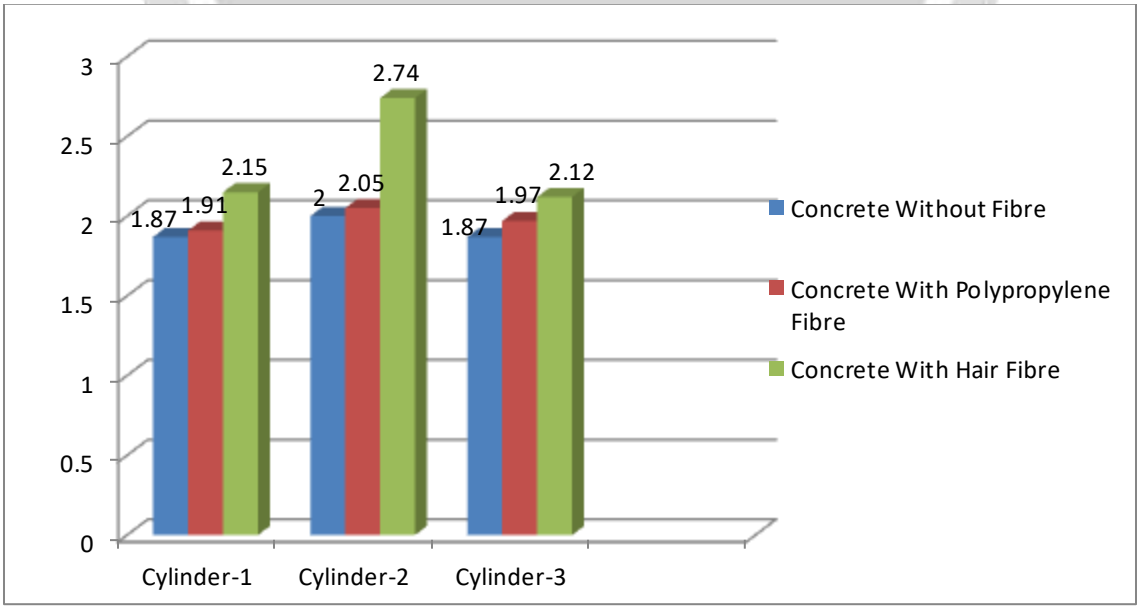

Fig-5: Comparison On The Basis Of Tensile Strength After 28 Days

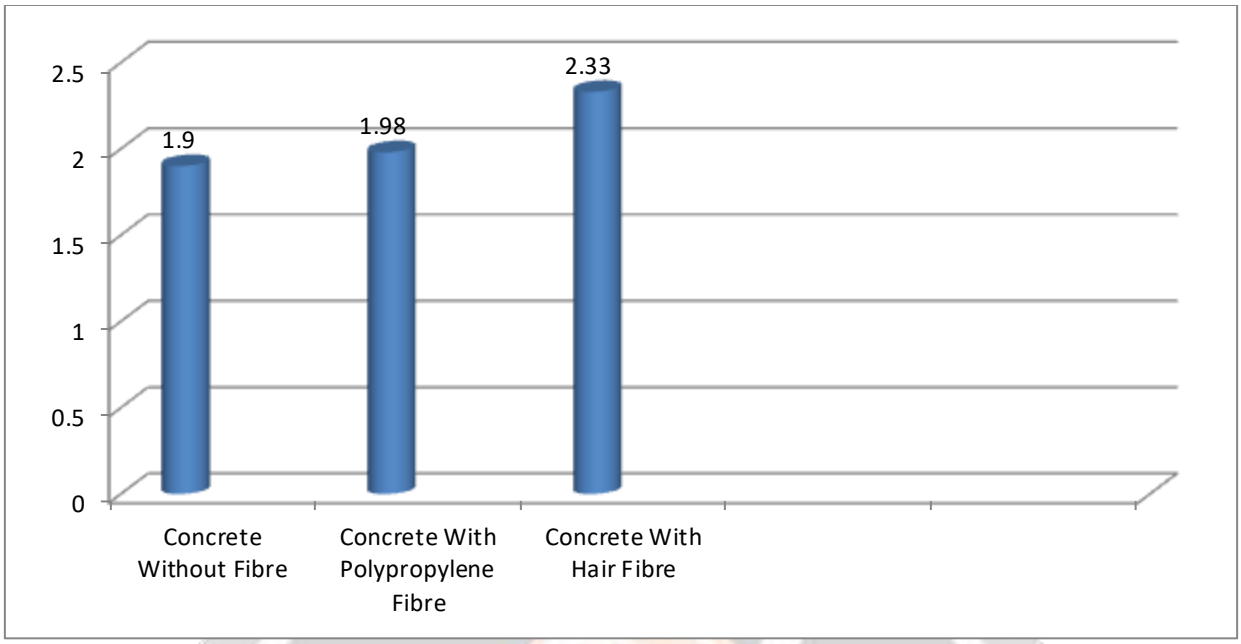

Fig-6: Comparison On The Basis Of Avg. Tensile Strength

3. CONCLUSION AND DISCUSSION:

- By addition of hair fibre and polypropylene fibre by weight of concrete, it is observed that there is remarkable increment in strength of concrete. Better results can be obtained in the tensile strength.
- From the results obtained, it is observed that there is a gradual increment in the strength of concrete by addition of fibre.
- Concrete with hair fibres gives more strength as compared to the concrete with polypropylene fibre.
- Crack formation and propagation are very much reduced showing that FRC can have its applications in seismic resistant construction.

3.2 Future Scope:

- We also faced the problem of uniform distribution of hair and polypropylene fibre in the concrete during our research. So an efficient method of mixing of hair fibre to the concrete mix is to be found out.
- A wide study on partial replacement of cement using fibre is to be carried out.
- Introduction of hair fibre reinforced concrete in the construction of seismic resistant structures.
- The study of admixtures and super plasticizer which would distribute the hair and polypropylene without affecting the properties of concrete.
- The use of animal hair in concrete.
- The research can be further extended to study the influence of hair and polypropylene fibre on other properties of composites such physical, thermal properties and appearance.

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