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Experimental Study on Human Hair as Fiber Reinforced Concrete

Yogendra Patil[1], Ishwar Patil[2], Subhashchandra Sharma[3]
[1, 2, 3]*D. N. Patel College of Engineering, shahada, India*

Abstract: ***Most important and advanced invention in terms of new material being employed in concrete has been the development of Fiber reinforced concrete which proves to be a solution for problems relating to the formation of micro cracks. Fiber reinforced concrete is one among those advancements which offers 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 is generally strong in tension; hence it can be used as a fiber reinforcement material. Human hair Fiber is an alternative non-degradable matter available in abundance and at cheap cost. It also reduces environmental problems. Also addition of human hair fibers enhances the binding properties, micro cracking control, Imparts ductility and also increases swelling resistance. The experimental findings in our studies would encourage future research in the direction for long term performance to extending this cost of effective type of fibers for use in structural applications. Experiments were conducted on concrete cubes and beams of standard sizes with addition of various percentages of human hair fiber i.e., 0%, 1%, 2% and 3%, by weight of cement and results were compared with those of plain cement concrete of M-20 grade. For each percentage of human hair added in concrete, three cubes and three beams were tested at curing periods of 3 , 7 and 28 days. It is concluded that the 2% replacement of hair fibre by weight of cement is possible without compromising the strength with 28 days curing.***

I. INTRODUTION

Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses & impact loads, where tensile strength is only approximately one tenth of its compressive strength. As a result for these characteristics, concrete member could not support such loads & stresses that usually take place, majority on concrete beams & slabs. Historically, concrete member reinforced with continuous reinforcing bars to withstand tensile stresses & compensate for the lack of ductility & strength. Furthermore, steel reinforcement adopted to overcome high potentially tensile stresses & shear stresses at critical location in concrete member. The additional of steel reinforced significantly increase the strength of concrete, but to produce concrete with homogenous tensile properties, the development of micro cracks is a must to suppress. The introduction of fibres was brought in as a solution to develop concrete in view of enhancing its flexural & tensile strength, which are a new form of binder that could combine Portland Cement in the bonding with cement matrices. Fibres are most generally discontinuous, randomly distributed throughout the cements matrices.

A fiber is a small piece of reinforcing material possessing certain characteristics properties. Addition of fibers to concrete influences its mechanical properties which significantly depend on the type, length and percentage of fiber. Generally, concrete is weak in tension and has a brittle character. Hence fibers are added to increase its tensile strength and improve the characteristics of construction materials.

II. LITERATURE REVIEW

This chapter presents the background information on the issues to be considered in the present research work and to focus the significance of the current study.

Jain.D and Kothari.A, published paper in Research Journal of Recent Sciences on Hair Fibre Reinforced Concrete. He observed that there is remarkable increase in properties of concrete according to the percentages of hairs by weight of in concrete. When M-20 grade concrete with 1% human hair is compared with the plain concrete, it is found that there is an increase of 10% in compressive strength and 3.2% in flexural strength. When M20 concrete with 1.5% human hair is compared with PCC, it is found that there is an increase of 22% in compressive strength and 8.6% in flexural strength. When M-20 grade concrete with 1% human hair is compared with the plain cement concrete, it is found that there is no increase in compressive strength and 2% in flexural strength. When M20 concrete with 1.5 % hair is compared with the plain cement concrete, it is found that there is an increase of 8.8 % in compressive strength and 5.5 % in flexural strength.

Dr. Sinan abdulkhaleq yaseen, published a paper on “An Experimental Investigation into the mechanical properties of New Natural Fiber Reinforced Mortar”. This study highlights use of human hair fiber as reinforced material in cementitious material.

Experiments were carried to study the effects of fiber on the mechanical properties of concrete. Energy absorption capacity and ductility factor were modified significantly with the fiber content increased, which makes using the Human Hair fibre suitable for Earthquake resistant structures. Riya Babu M, Neena Rose Davis, published paper in "International Journal of Research in Advent Technology" on Hair Fibre Reinforced Concrete . In this study they observed that there is slight increase in strength of concrete according to the percentages of hairs by weight of cement. There was an overall increase of 1 - 10% in the compressive strength of concrete test specimens by the addition of human hair fibers in different proportions. They concluded that the maximum increase is noticed in the addition of 2% hair fiber, by weight of concrete in all the mixes. Crack formation and propagation are very much reduced showing that fibre reinforced concrete can have its applications in Earthquake resistant structures.

III. MATERIAL AND METHODOLOGY

The Human Hair Fiber was locally purchased. Keratin is a protein that is responsible for the formation of human hair. Length of the Human hair fiber is 4 cm. Diameter is 60-100µm. Human hair creates environmental problems, to minimize that it can be used as reinforcing agent as a fibre. Addition of hair fiber to the concrete increases the mechanical properties.

Table- 1: Physical properties of human hair

Properties	Value
Length(cm)	40
Diameter(µm)	60-100
Plastic modulus(G Pa)	3.5
Linear density(g/cm)	1.32
Yield strength(M Pa)	74.34
Breaking strength(M Pa)	119
Strain at break (%)	29
Tensile strength(M pa)	384.79

The cement is a material that has cohesive and adhesive properties in the presence of water, consist primarily of silicates and aluminates of lime. The OPC (53 Grade) is used for this study. The fine aggregate are material passing through an IS sieve that is less than 4.75 mm gauge beyond which they are known as coarse aggregate. The main function of the fine aggregate is to provide workability and uniformity in the mixture. The fine aggregates uses in this study are locally available river sand which conforms to zone III as per BIS code. The coarse aggregate form the main matrix of the concrete, whereas fine aggregate form the filler matrix between the coarse aggregate. The maximum size of aggregate used in this study is 20 mm. The coarse aggregate is confirmed by IS 383:1977 and is 20 mm maximum size. In this study mixes, we are planned to make with hair fiber with varying proportion of 0%, 1%,,2% and 3% by weight of cement.

The cement, fine and coarse aggregates required for experimentation are tested in the laboratory and the results are shown in Table – 2

Table – 2 : Properties of OPC, Fine and Coarse Aggregate

Properties	Value
(a) Cement	
Specific gravity	3.15
Initial setting time	75min
Final setting time	360min
(b) Fine Aggregate	
Specific gravity	2.65
Water absorption	1%
Fineness modulus	3.3
(c) Coarse Aggregate	
Specific gravity	2.68
Water absorption	0.5%
Fineness modulus	7.02

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IV. EXPERIMENTAL PROGRAMME

The cement concrete mix is prepared as per the procedure given in the BIS 10262:2009. For optimal dosage selection of Hair Fibre in concrete mix, modified cubes (percentage ranging from 1% to3%) are prepared and compared with plain cement concrete cubes and beams with mix proportion of 1:1.59:3.05 are prepared. The addition of OPC with hair fibre is made on weight basis. The w/c ratio is taken 0.5% for all the mixes. The result of mix design of the concrete is shown in Table – 3.

Table-3: "Mix Specification for 1 m^3 Concrete"

Particulars	Plain concrete mix	1%	2%	3%
Cement in kg/m3	383	383	383	383
Sand in kg/m^3	620.8	620.8	620.8	620.8
Coarse aggregate in kg/m^3	1157.5	1157.5	1157.5	1157.5
Hair fibre in kg/m^3	0	3.83	7.66	11.49
Water in kg/m^3	191.6	191.6	191.6	191.6

In this investigation 12 cubes and 12 beam specimen are tested. The Cubes with the dimension of 150 x 150 x 150 mm and beams with dimension of 150 x 150 x 750 mm are prepared for each batch of mixes to measure compressive strength and flexural strength of concrete respectively at the age of3 days, 7 days and 28 days of curing. All the specimens are kept in water tank for curing and thereafter tested as per BIS norms and standard. All the cube specimens are tested for compressive strength in compression testing machine (CTM) and all beam specimens are tested for flexural strength in universal testing machine (UTM).

V. RESULT

The compressive strength and flexural strength of cement concrete containing various % of Hair Fibre at the age of 3, 7 and 28 days are given in Table 4 and 5 respectively.

Table – 4: Compressive Strength (N/mm**2**)

Concrete Type	Compressive Strength		
	3 Days	7 Days	28Days
OPC	6.20	12.10	24.75
1% Hair fibre	6.35	12.90	24.80
2% Hair fibre	6.40	13.15	25.70
3% Hair fibre	6. 40	13.45	25.80

Table – 5 : Flexural Strength Test Results (N/mm**2**)

Concrete Type	Flexural Strength		
	3 Days	7 Days	28Days
OPC	1.42	2.31	3.28
1% Hair fibre	1.78	2.46	3.55
2% Hair fibre	1.82	2.80	4..10
3% Hair fibre	1.60	2.50	3.50

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VI. DISCUSSION AND CONCLUSIONS

The main aim of the study is to obtain the suitability of Hair Fibre in addition with OPC in concrete. The results of compression test and flexural test are shown in Chart-1 and Chart -2. It may be observed from the results that the properties of can be maintained with Hair fibre in addition with cement in concrete up to 2% by weight of cement.

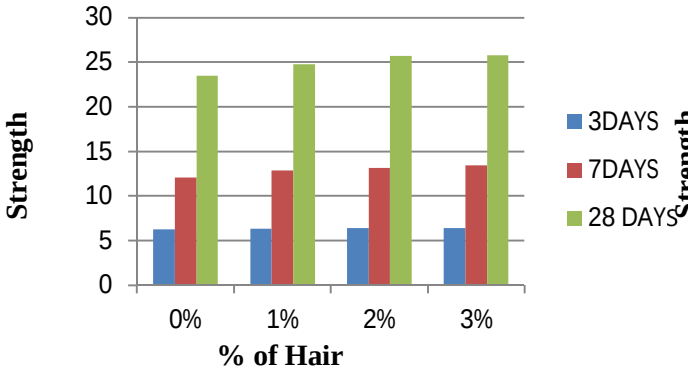

Chart -1: Compressive Strength Result

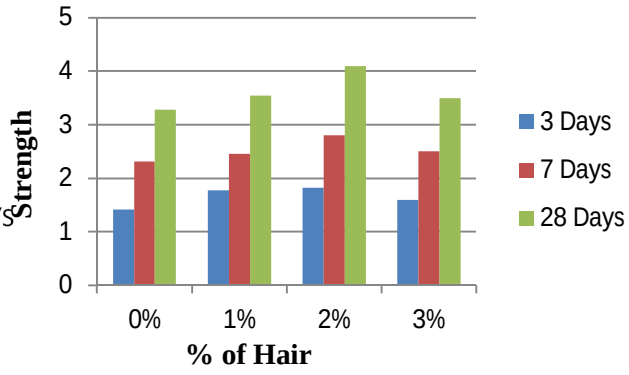

Chart -2: Flexural Strength Result

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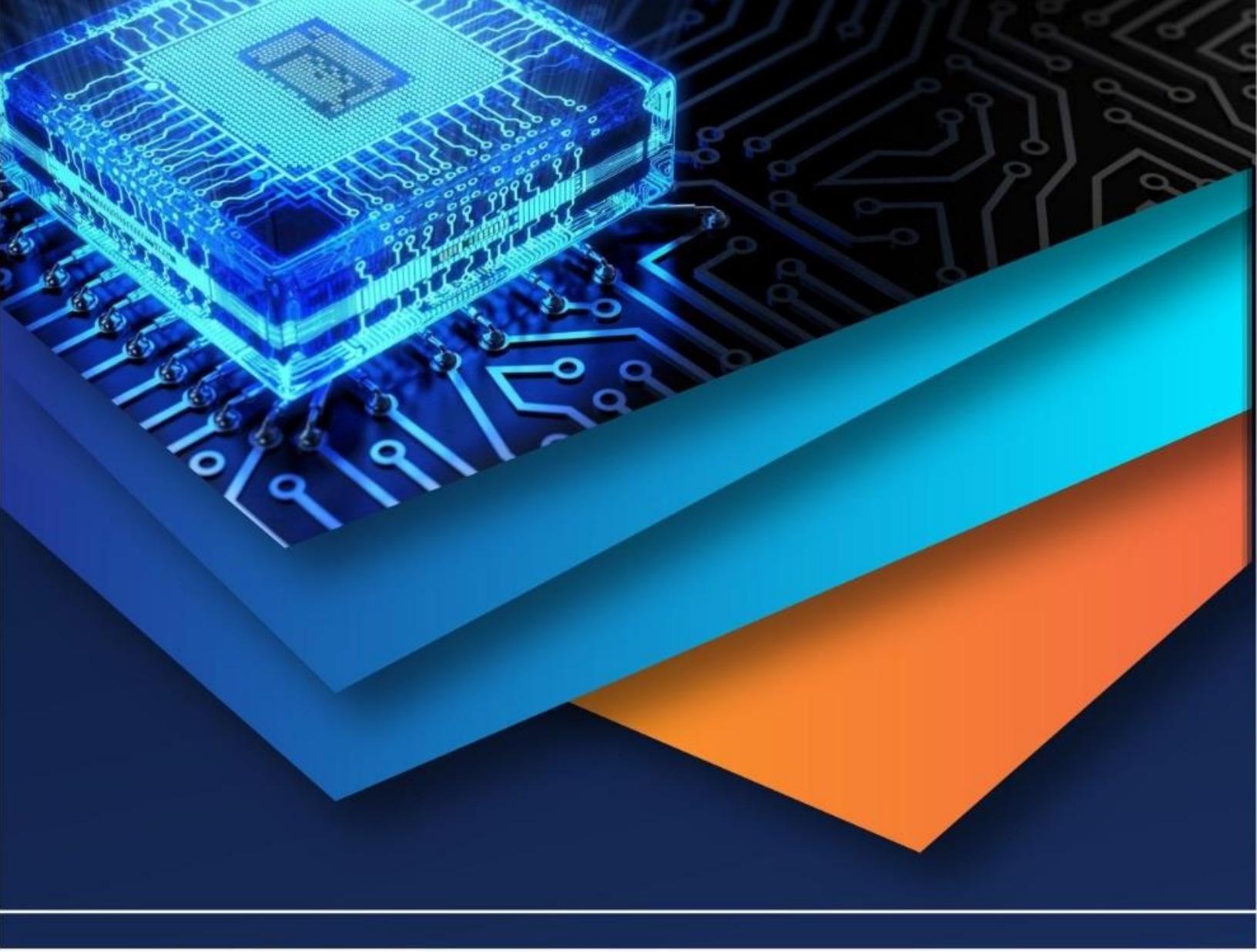

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