

An Experimental Investigation on Human Hair Fibre Concrete

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ABSTRACT: 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 is strong in tension; hence it can be used as a fibre reinforcement material. Human Hair Fibre (HHF) is an alternate non-degradable matter is available in abundance and at a very cheap cost. It also creates environmental problem for its decompositions.

Present studies has been undertaken to study the effect of human hair on plain cement concrete on the basis of its compressive, split tensile, flexural strength and cracking control to economize concrete and to reduce environmental problems. Experiments were conducted on concrete cubes, beams, cylinders with the addition of various percentages of human hair fibre i.e. 0%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9% and 1.0% by weight of concrete. For each combination of proportions of concrete one beam, one cylinder and six cubes are tested for their mechanical properties. By testing of cubes, beams and cylinders we found that there is an increment in the various properties and strength of concrete by the addition of human hair as fibre reinforcement. Also, hair fibre reinforced concrete can be an alternative method for the hair waste management.

KEYWORDS: Fibre reinforced concrete, Human hair fibre, Compressive strength, Split tensile strength, Flexure strength.

I. INTRODUCTION

Fibre reinforced concrete (FRC) is Portland cement concrete reinforced with more or less randomly distributed fibres. In FRC, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. The concept of using fibres as reinforcement is not new. Fibres have been used as reinforcement since ancient times.

FRC is cement-based composite material that has been developed in recent years. It has been successfully used in construction with its excellent flexural-tensile strength, resistance to splitting, impact resistance and excellent permeability and frost resistance. It is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. Fibre is a small piece of reinforcing material possessing certain characteristic properties.

In the past, attempts have been made to impart improvement in tensile properties of concrete members by way of using conventional reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength of concrete members, they however, do not increase the inherent tensile strength of concrete itself.

FRC is gaining attention as an effective way to improve the performance of concrete. The fibres are added to fresh concrete during the batching and mixing process to allow them to be equally distributed throughout the concrete. Hair is used as a fibre reinforcing material in concrete for the following reasons:

- i. It has a high tensile strength which is equal to that of a copper wire with similar diameter.

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- ii. Hair, a non-degradable matter is creating an environmental problem so its use as a fibre reinforcing material can minimize the problem.
- iii. It is also available in abundance and at a very low cost.
- iv. It reinforces the mortar and prevents it from swelling.

Specimens were made to test the compressive strength, tensile strength and flexure strength. For that different proportions of hair fibres are added to the concrete. Those are 0%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9% and 1.0% by weight of concrete. For testing all those proportions, M-20 grade Concrete was used. For each proportion of concrete mix six cubes, six cylinders and six beams were casted. Hence altogether 196 specimens were casted and tested.

The curing was started after 24 hours of casting the specimen for a period of 7 to 28 days. The specimens were subjected to compression, split tensile tests under digital compression testing machine and flexural test under universal testing machine respectively.

II. OBJECTIVES AND SCOPE OF THE PRESENT INVESTIGATION

- Addition of the Human hair fibres to the concrete.
- Human Hair Fibres in different volumes has been added and the performances has been Compared.
- This project investigates the, compressive strength, Split tensile strength, Flexure strength, ultimate load, cracking characteristics of cubes, cylinders, prisms respectively, which are made up of Human Hair Fibre Concrete.

III. LITERATURE REVIEW

Jain D and Kothari A (2011) Published a paper on “ Hair Fibre Reinforced Concrete ”. They have studied the effect of human hair on plain cement concrete. Experiments were conducted on concrete beams and cubes with various percentages of human hair fibre i.e. 0%, 1%, 1.5%, 2%, 2.5% and 3% by weight of cement. For each combination of proportions of concrete one beam and three cubes are tested for their mechanical properties. By conducting the tests on cubes and beams it was found that there is an increment in the various properties and strength of concrete by the addition of human hair as fibre reinforcement.

The specimen for both the test is made in the following manner like for Compression test, three cubes are made for each M-15, M-20 and M-25 with 0%, 1%, 1.5%, 2%, 2.5% and 3% hair by weight of cement and for flexural Strength test, one beam is made for each M-15, M-20 and M-25 with 0%, 1%, 1.5%, 2%, 2.5% and 3% hair by weight of cement.

Achal Agarwal, Abhishek Shrivastava, Siddarth Pastariya, Anant Bhardwaj were studied the effect of human hair on cement concrete for compressive & flexural strength and various experiments were conducted on concrete cubes and beams with different percentages of hair fibre as 0%, 1%, 2%, 3%, 4% and 5% by weight of cement.

Cubes were casted to evaluate compressive strength of concrete. 3 Cubes of each mix proportion were casted. Test were conducted in Compressive Testing Machine. Compressive strength is the ability of concrete to resist crushing force. Maximum load at failure was recorded and was divided by the area under loading to gives its compressive strength. Cubes are of 2 sizes 150 mm*150 mm*150 mm and 100 mm*100 mm*100 mm of a mix of M20 grade i.e. 1:1.5:3. have been used.

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Khansaheb made an attempt to utilize the large amount of bagasse ash for the partial replacement of cement in concrete as a binding material which is a residue from an in-line sugar industry and bagasse-biomass fuel in electric generation industry. He carried out studies on the ashes obtained directly from the industries to study pozzolanic activity and their suitability as binders, partially replacing cement.

Experimental work includes the specimens like cubes, cylinders, prisms are made with M 20 grade concrete with replacement of cement by 5 % bagasse and addition of human hair fibres of 0.5 % and 1 %. The specimens were tested for compressive strength, split tensile strength and flexure at 7 days, 14 days and 28 days. Exemplar based inpainting technique is used for inpainting of text regions, which takes structure synthesis and texture synthesis together. The inpainting is done in such a manner, that it fills the damaged region or holes in an image, with surrounding colour and texture. The algorithm is based on patch based filling procedure. First find target region using mask image and then find boundary of target region. For all the boundary points it defined patch and find the priority of these patches. It starts filling the target region from the highest priority patch by finding the best match patch. This procedure is repeated until entire target region is inpainted. The algorithm automatically generates mask image without user interaction that contains only text regions to be inpainted.

IV. EXPERIMENTAL INVESTIGATION AND RESULTS

4.1 General

The properties of materials used for preparing the concrete M20 will be described in the following sections.

4.1.1 Materials Used

Cement, fine aggregate, coarse aggregate, Human hair fibre, super plasticizer and water were used in this investigation. The following are the properties of the materials used.

4.1.2 Cement

Ordinary Portland cement of grade-53 conforming to Indian standard IS: IS: 8112-1989 has been used in the present study. The specific gravity of cement used is 3.15.

4.1.3 Fine aggregate

Locally available sand in market is used as fine aggregate.

4.1.4 Coarse Aggregate

The fractions from 20mm to 4.75mm are used as coarse aggregate. The coarse aggregates from crushed Basalt rock, conforming to IS: 383 is being used. The flakiness and elongation Index were maintained well below 15%

4.1.5 Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully.

4.1.6 Human hair fibre

Human hair fibres were collected through near by saloon shops. The fibre is often described by a convenient parameter called aspect ratio. Typically aspect ratio ranges from 250 to 320. And the length of human hair fibre ranges from 6 mm to 50 mm.

4.1.7 Plasticizer : Sulphonated naphthalene formaldehyde is used as a plasticizer.

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Table 4.2 DETAILS OF A SPECIMEN

S.no	Name	Details	Number
1	Cubes	Without fibre	6
2	Cubes	Human hair fibres of percentages as 0.1%,0.2%,0.3%,0.4%,0.5%,0.6%,0.7%,0.8%,0.9%,1.0%	60
3	Beams	Without fibre	6
4	Beams	Human hair fibres of percentages as 0.1%,0.2%,0.3%,0.4%,0.5%,0.6%,0.7%,0.8%,0.9%,1.0%	60
5	Cylinders	Without fibre	6
6	Cylinders	Human hair fibres of percentages as 0.1%,0.2%,0.3%,0.4%,0.5%,0.6%,0.7%,0.8%,0.9%,1.0%	60

4.3 COMPRESSIVE STRENGTH TESTS ON CUBES (150MM*150MM*150MM) WITH ADDITION OF HUMAN HAIR FIBRE

The compressive strength for different percentage of human hair added to concrete were tested at the end of 7 days and 28days using compressive strength testing machine as shown in figure 4.3 The percentage of human hair were taken as 0.1%, 0.2 %, 0.3 %, 0.4 %, 0.5 %, 0.6 %, 0.7 %, 0.8 %, 0.9 %, 1 %. Three cubes of each percentage of human hair are casted and the average of three test results is taken for the accuracy of the results. the concrete cubes were cured at room temperature. The values of compressive strength obtained are tabulated.



FIG 4.3

FIG 4.3 SHOWS COMPRESSIVE STRENGTH TESTING MACHINE

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Table. 4.3 Compressive strength test values

S.NO	% OF HAIR FIBRE IN CONCRETE	VALUES @7DAYS		VALUES@28DAYS	
		Normal load(KN)	Normal stress(N/mm ²)	Normal load(KN)	Normal stress(N/mm ²)
1	0.00	370.00	16.44	610.66	27.40
2	0.10	380.00	16.92	630.45	28.20
3	0.20	390.05	17.34	650.02	28.90
4	0.30	370.25	16.56	620.10	27.60
5	0.40	400.01	17.82	660.83	28.70
6	0.50	420.40	18.73	700.50	29.23
7	0.60	440.50	19.78	740.18	29.97
8	0.70	460.23	20.55	770.06	31.25
9	0.80	430.52	19.35	720.50	30.26
10	0.90	410.20	18.17	680.15	30.19
11	1.00	390.82	17.70	670.50	30.01

4.4.SPLIT TENSILE STRENGTH TEST ON CYLINDERS (15CM dia, 30CM ht)

The split tensile strength for different percentage of human hair added to concrete were tested at the end of 7 days and 28 days using compressive strength testing machine as shown in figure 4.4 The percentage of human hair was taken as 0.1%, 0.2 %, 0.3 %, 0.4 %, 0.5 %, 0.6 %, 0.7 %, 0.8 %, 0.9 %, 1 %. Three cylinders of each percentage of human hair are casted. The concrete cylinders were cured at room temperature. The values of split tensile strength obtained are tabulated.

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Fig.4.4

Fig 4.4 Shows compressive strength testing machine.

Table. 4.4 Split tensile strength test values

S.NO	% OF HAIR FIBRE IN CONCRETE	VALUES @7DAYS		VALUES@28DAYS	
		Normal load(KN)	Normal stress(N/mm ²)	Normal load(KN)	Normal stress(N/mm ²)
1	0.00	148.365	2.10	219.721	3.11
2	0.10	153.310	2.17	225.373	3.19
3	0.20	158.962	2.25	231.025	3.27
4	0.30	165.321	2.34	235.264	3.33
5	0.40	170.266	2.41	242.329	3.43
6	0.50	173.092	2.45	248.688	3.52
7	0.60	181.570	2.57	259.992	3.68
8	0.70	187.929	2.66	270.095	3.823
9	0.80	183.690	2.60	265.644	3.76
10	0.90	180.864	2.56	262.111	3.71
11	1.00	175.215	2.48	260.698	3.69

4.5 LOAD DEFLECTION TEST ON PRISMS (50CM*10CM*10CM)

The flexure strength for different percentage of human hair added to concrete were tested at the end of 28 days using universal testing machine as shown in figure 4.5. The percentage of human hair was taken as 0.1%, 0.2 %, 0.3 %, 0.4 %, 0.5 %, 0.6 %, 0.7 %, 0.8 %, 0.9 %, 1 %. Three prisms of each percentage of human hair are casted. The concrete prisms were cured at room temperature. The values of flexure strength obtained are tabulated.

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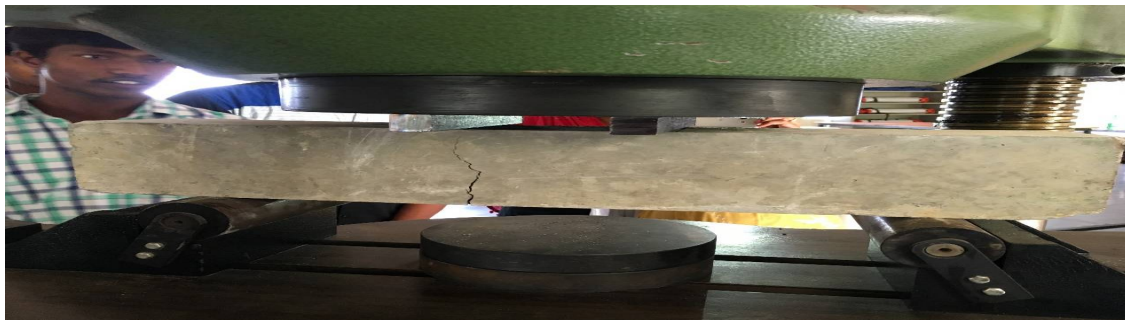


Fig 4.5

Fig 4.5 Shows Universal testing machine

Table 4.5 flexure strength test values

SL NO	% OF HAIR FIBRE IN CONCRETE	PEAK LOAD (KN)	DISPLACEMENT (mm)	Flexure strength (N/mm ²)
1	0.00	38.00	0.60	3.23
2	0.10	38.50	0.60	3.28
3	0.20	38.90	0.50	3.33
4	0.30	39.40	0.30	3.38
5	0.40	39.80	0.50	3.43
6	0.50	40.50	0.50	3.52
7	0.60	40.60	0.40	3.60
8	0.70	41.20	0.60	3.59
9	0.80	41.70	0.50	3.64
10	0.90	41.30	0.55	3.69
11	1.0	42.00	0.50	3.75

V. CONCLUSION

Based on the experimental results, the following conclusions are drawn.

1. Human hair waste can be effectively managed to be utilized in fibre reinforced concrete constructions.
2. According to the test performed it is observed that there is remarkable increment in properties of concrete according to the percentages of hairs by weight of cement in concrete.
3. The human hair fibre concrete has the high compressive strength compared to the normal Concrete
4. Better split tensile strength was achieved with the addition of the human hair in concrete. The strength has increased

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when compared to that of the conventional concrete specimen.

5. There was an overall increase of 1-25% in the compressive strength of concrete and up to 26 % in the split tensile strength of concrete test specimens by the addition of hair fibres in different quantities.
6. There was an overall increase of 1-16 % in the flexure strength of concrete .
7. It is well observed that the maximum increase is noticed in the addition of 0.7 % hair fibre, by weight of concrete, in all the mixes.
8. The human hair fibre concrete beam exhibit greater reduction in displacement at all load levels when compared to the control beam.

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