

Study on Concrete Reinforced With Human Hair as Fibre

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ABSTRACT: Waste management has gained a lot of attention of the research community now a day. Maintaining non-biodegradable waste is an international issue. Human hair is a waste material and it is a common constituent found in municipal waste streams, causes environmental problems. Fibre reinforced concrete provides good flexural strength with less crack development. Since concrete is weak in tension, So an attempt has been made to achieve improved strength results by using hair as fiber in conventional concrete and by utilizing hair we can also decrease environmental problems. Human hairs are strong in tension, non-bio-degradable and are available in abundance and at a very low cost. In this study, an attempt has been made to identify the various properties necessary for the design of concrete mix by adding human hair. M20 grade concrete has been chosen as the reference concrete specimen. In this study, human hairs were collected, cleaned and added to cement concrete as 0%, 1%, and 3% by weight of cement. For every proportion of human hair mix in concrete cubes compressive strength, for beams flexural strength and for prepared sample workability test are evaluated to investigate the optimal use of human hair as a fibre in cement concrete. By testing of concrete cubes with human hair as fiber cement concrete an improved strength is obtained.

KEYWORDS: HRC, FRC, Materials Testing, Workability (slump cone) Test, Compressive Strength, Flexural Strength)

I. INTRODUCTION

As known, Concrete is most important part of the construction, but very few of us have heard about the Fibre Reinforced Concrete. Fibre Reinforced Concrete (FRC) was invented by French gardener Joseph Monier in 1849 and patented in 1867. Uses of fibres in concrete or mortar are not a new process. This can be proved by the following: From ancient times horsehairs were used in mortar and straw in mud bricks. In the early 1900s, asbestos fibres were used in concrete, and in the 1950s the concept of composite materials came into being and fibre reinforced concrete was one of the topics of interest. Mixtures of cement mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibres called fibre reinforced concrete. These are not considered to be discrete fibres, Continuous meshes, woven fabrics and long wires or rods. Types of fibres are steel fibres, glass fibres, synthetic fibres and natural fibres. There had been news in a local news paper describing the problems caused by human hair waste from saloons and beauty parlors in and around Thrissur district in Kerala. Earlier times, the hair waste has been collected and exported Tamil Nadu for making amino acids from hair fibre. But later on, the company ended its functioning which created problems in disposal and removal of hair waste in the district. We conducted a rough survey among the workers of beauty parlors and saloons about the disposal of hair waste and majority of them agreed that there is no effective method for the disposal of non bio degradable hair so that they have been discarding it as such[6].

According to Jain D. & Kothari A. [5], Fibre is a small piece of reinforcing material possessing certain characteristics. The fiber is always described by appropriate parameters, called aspect ratio. The aspect ratio of the fiber is the ratio of its length to its diameter. Typical aspect ratio varies from 30 to 150 [5]. Human hairs are used as a fibre reinforcing

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 6, Issue 10, October 2017

material in concrete, to analyze it some important tests were done, compressive strength, flexural strength and cracking control to economies concrete and to reduce environmental problems created by the decomposition of hair.

1.8 HUMAN HAIR TREATMENT

The hairs needed for the preparation of concrete cubes were collected from salons and beauty parlours. It needs treatment before to be added in the concrete specimens because hairs are not clean hairs can be of dyed, colored, etc. 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 acetone to remove impurities.

Drying: The hair is then dried under the sun or in an 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 fibers are checked at random for its length and diameter.



Fig.1 Cleaning of Human Hair with Acetone



Fig. 2 Cutting of Hair

II. MATERIALS AND TEST PROCEDURE

Materials required for the formation of human hair reinforced concrete are:

Cement, Sand, Coarse aggregate , Water, Human hair

Obtained test results of aggregates are given in tabular form:

Table : mechanical properties of coarse aggregates

PROPERTIES	VALUE AS PER TEST RESULTS	VALUE AS PER IS CODE FOR R.C.C. WORK
IMPACT TEST	31.1%	< 45%
LOS ANGLES ABRASION VALUE	39.2%	< 50%
WATER ABSORPTION	1.1%	< 2%

Cement Test Results

characteristics	Values obtained experimentally	IS codes specified values
Standard consistency %	35	Penetration should be 33 to 35 mm from top
Fineness value	3 gm	not more than 10% of original sample
Soundness value	10mm	10mm (max)

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Vol. 6, Issue 10, October 2017

Physical properties of Coarse Aggregates

Characteristics	Value
Colour	Grey
Shape	Angular
Nominal Size	20 mm

TESTS PERFORMED ON TEST SAMPLES

Following tests were carried out to find out suitability of HRC in civil engineering works: Compression test, Flexural test, Workability test

COMPRESSION TEST

This test is conducted on cube samples for testing their compressive strength. Various cubes of size 15x15x15cm were prepared. After curing period of 7 days and 28 days these cubes were tested in universal testing machine. Load was applied gradually at the rate of 140kg/cm² per minute till the specimens failed. At the time of failure value of load is recorded. This value of load is further divided by area of specimen and this gave us the compressive strength of concrete for the given sample.

Calculation

Compressive stress = failure load/ cross sectional area

FLEXURAL TEST

Flexural test is the measure of strength of concrete in bending. The flexural strength of concrete is said to be an indirect measure of tensile strength. The flexural strength is also expressed as modulus of rupture and can be determine by standard test methods (third point loading) or (centre point loading). For the present study the method of centre point loading is used.

Calculation

$$M/I = \sigma_b/Y$$

Where,

M = Moment of Resistance I = Moment of Inertia about neutral axis,

σ_b = Bending stress y = Extreme fibre distance from neutral axis,

$$\sigma_b = 3PL/2bd^2$$

Where,

p = Maximum load at which beam fails (N) b = width of the beam (mm)

d = depth of the beam (mm) L = length of beam (mm)

Workability Test (Slump cone test)

Concrete slump test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. The slump test is the most simple workability test for concrete, involves low cost and provides immediate results.

Procedure (by IS code)

- Clean the internal surface of the mould and apply oil.
- Place the mould on a smooth horizontal non- porous base plate.
- Fill the mould with the prepared concrete mix (2:4:6) with water cement ratio 0.78 in 4 approximately equal layers.
- Each layer tamped with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
- Remove the excess concrete and level the surface with a trowel.
- Raise the mould from the concrete immediately and slowly in vertical direction.
- Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

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III. TEST RESULTS AND DISCUSSIONS

COMPRESSIVE STRENGTH TEST RESULT

The compressive strength test was performed on the cubes of size 15 x 15 x 15 (cm) to check the compressive strength of human hair reinforced concrete & the results obtained are shown in table given below:-

Table 2: 7 Days Compressive Strength

S.N	% HAIR Mix	MAX. LOAD RECORDED (KN)			AVG. COMPRESSIVE STRENGTH(N/MM2)
		CUBE 1	CUBE 2	CUBE 3	
1	0	276	275.2	394.80	12.24
2	1	287	283	285	12.67
3	3	298	171	290	13.06

It has been observed from the above table, an increase in the percentage of hair, compressive strength also increases. 394.80 KN load recorded in third cube of 0% hair cement concrete and 171 KN load recorded in 2nd cube of 3% hair cement concrete were excluded from compressive strength calculation.

Table 3: 28 Days Compressive Strength

S.N	% HAIR Mix	MAX. LOAD RECORDED (KN)			AVG. COMPRESSIVE STRENGTH(N/MM2)
		CUBE 1	CUBE 2	CUBE 3	
1	0	500	521	530	22.97
2	1	568	521	559	24.41
3	3	570	576	588	25.68

We also observed 28 days compressive strength increases with increase in HRC percentages increases.

FLEXURAL STRENGTH TEST RESULTS

The flexural strength was performed on the beams of size 50x10x10 cm to check the flexural strength of the human hair reinforced concrete and the results obtained while performing the flexural test on UTM are given in table

Table 4: 7 Days Flexural Strength

S.N	% HAIR Mix	MAX. LOAD RECORDED (KN)			AVG. FLEXURAL STRENGTH(N/MM2)
		BEAM 1	BEAM 2	BEAM 3	
1	0	18.2	25.6	22.3	16.5
2	1	28.3	30.1	26.3	21.2
3	3	38	40.3	36.2	28.6

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From the above results, it was observed that the flexural strength of HRC was better than of conventional concrete (i.e. 0% replacement).

Table 5 : 28 Days Flexural Strength

S.N	% HAIR MIX	MAX. LOAD RECORDED (KN)			AVG. FLEXURAL STRENGTH(N/MM ²)
		BEAM 1	BEAM 2	BEAM 3	
1	0	31.3	25.8	26.3	20.85
2	1	39.2	37.9	36.6	28.43
3	3	25.1	42.3	44.5	32.55

28 days flexural strength increases with increase in HRC. 25.1 KN load recorded in 3% hair mix cement concrete was excluded from flexural strength calculation.

4.3 WORKABILITY TEST RESULTS

Slump cone test performed in 0%, 1% and 3% human hair mix and found result shown in table below:

Table 6: WORKABILITY RESULTS

S.N	%AGE HAIR MIX	SLUMP VALUE (MM)
1	0	24
2	1	25
3	3	27

As percentages of hair increases slump value also increase.

DISCUSSION - In this study, we found that increasing hair percentages from 1% to 3% compressive strength increases. By this study, it can be concluded that human hair can be added into concrete mixes without a considerable reduction in compressive strength up to 3% by weight of cement. 7 days results and 28 days results both show a considerable increase in compressive strength. The variation of compressive strength with respect to the variation of percentages of human hair is shown in the figure below:

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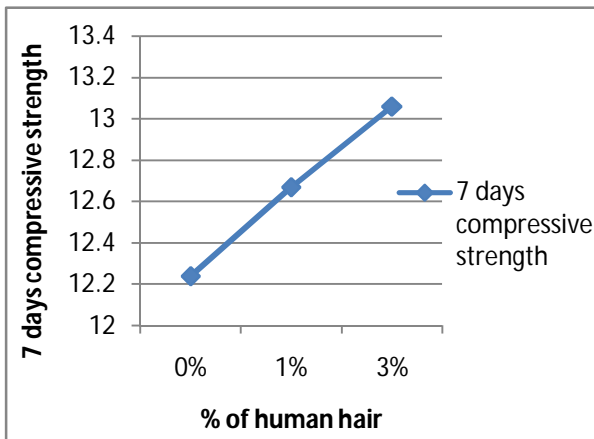


Fig.: Compressive Strength v/s %age HRC Mix

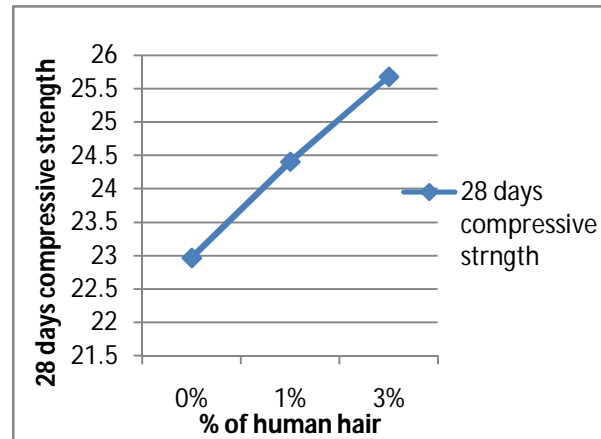


Fig.: Compressive Strength v/s %age Human Hair

In this study, we found that increasing hair percentages from 1% to 3% flexural strength increases. By this study, it can be concluded that human hair can be added into concrete mixes without a considerable reduction in flexural strength up to 3% by weight of cement. 7 days results and 28 days results both show a considerable increase in flexural strength. The variation of flexural strength with respect to the variation of percentages of human hair is shown in the figure below:

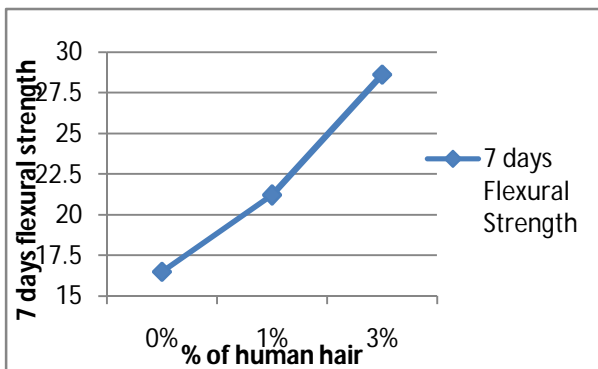


Fig.: 7 Days Flexural Strength v/s %age Human Hair

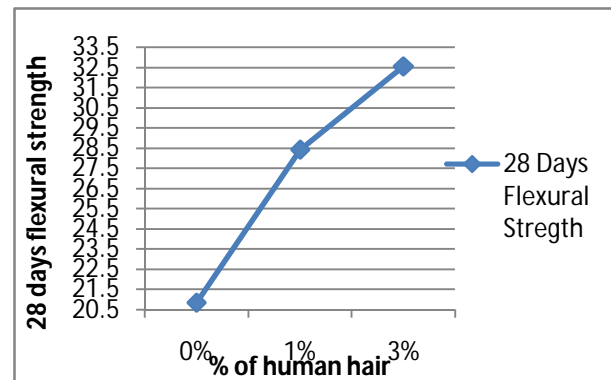


Fig. 4.4 28 days Flexural Strength v/s %age Human Hair

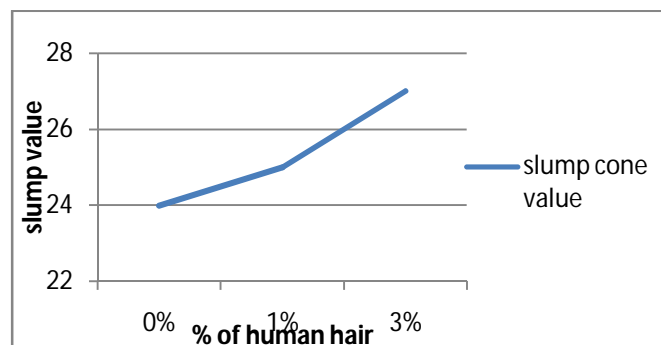


Fig. 4.5: Slump Cone Value v/s %age Hair

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Comparative analysis between other research works:

Table 4.6: 7 days compressive strength of achal agrawal and my results

DESIGN MIX	%AGE HAIR MIX	7 DAYS COMPRESSIVE STRENGTH	
		ACHAL AGRAWAL, ABHISHEK SHRIVASTAVA, .ET.AL RESULTS	MY RESULTS
M20	0%	14.46	12.24
M20	1%	14.53	12.67
M20	2%	14.77	-
M20	3%	14.85	13.06

Table 4.7: 28 days compressive results of other researchers

DESIGN MIX	%AGE HAIR MIX	28 DAYS COMPRESSIVE STRENGTH(KN/MM2)			
		JAIN D. & KOTHARI A. RESULTS	NILA V. M, RAIJAN K. RESULTS	ACHAL AGRAWAL, ABHISHEK SHRIVASTAVA, RESULTS	MY RESULTS
M20	0%	21.88	20.58	20.80	22.97
M20	1%	22.52	-	20.96	24.41
M20	1.5%	22.92	20.77	-	-
M20	2%	-	21.88	21.37	-

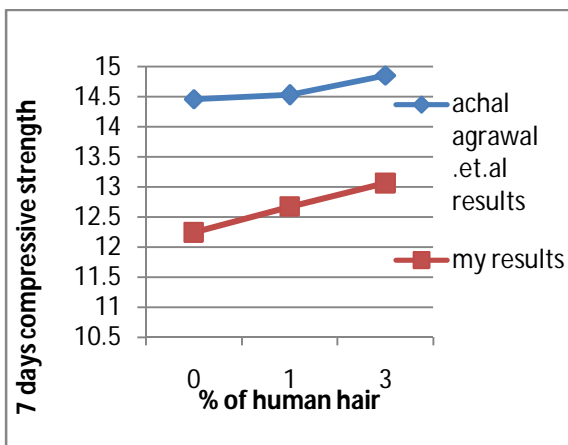


Fig. 7 days comparative compressive strength

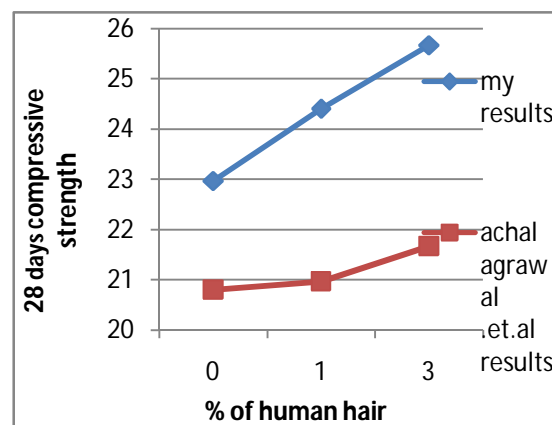


Fig. 28 days comparative compressive strength

IV. CONCLUSION AND FUTURE SCOPE

This research work can be concluded under following points as per the results:-

- When 1% human hair added to cement concrete compared with plane cement concrete found 3.51% increase in 7 days compressive strength test.
- When 3% human hair added to cement concrete compared with plane cement concrete found 6.7% increase in 7 days compressive strength test.

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- When 1% human hair added to cement concrete compared with plane cement concrete found 5.4% increase in 28 days compressive strength test.
- When 3% human hair added to cement concrete compared with plane cement concrete found 13% increase in 28 days compressive strength test.
- When 1% human hair added to cement concrete compared with plane cement concrete found 28.48% increase in 7 days flexural strength test.
- When 3% human hair added to cement concrete compared with plane cement concrete found 73% increase in 7 days flexural strength test.
- When 1% human hair added to cement concrete compared with plane cement concrete found 36.35% increase in 28 days flexural strength test.
- When 3% human hair added to cement concrete compared with plane cement concrete found 56 % increase in 28 days flexural strength test.
- Human hair is a waste material produces daily basis and create an environmental problem so we can effectively utilize it in cement concrete and fulfill two purposes as strength gain the second one is waste management.
- Crack formation and propagation are very much reduced showing that hair fibre reinforced concrete can have various applications in seismic resistant and crack resistant constructions, road pavement constructions etc.
- Uniform distribution of hairs is the problem identified in this study, because we found that hairs clubbed together, difficult to segregate them.
- In comparative analysis we found that in every research work they found some increase in compressive strength and flexural strength both it proves that human hairs have positive effects on construction works.

ACKNOWLEDGMENT

I would like to express my deepest sense of gratitude and indebtedness to my parents for their encouragement and persistent support which has helped me to do better in all of my endeavors also to my guide and motivator Dr. R. K. Dixit, and lab in charge Mr. Balgangadhar, Civil and Environmental Engineering Department, NITTTR Bhopal, for their valuable guidance and support in all the phases from conceptualization to experimental and final completion of the project. I would also like to thank all the faculties and lab assistants of Civil and Environmental Department NITTTR Bhopal.

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