AN EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF HUMAN HAIR FIBRE REINFORCED CONCRETE (M30 Grade)

Amit Rai[1], Sanjay Bhandari[2], Sareesh Chandrawanshi[3]

[1]Research Scholar, Department of Civil Engineering, SATI, Vidisha (M.P.)

[2]HOD, Department of Civil Engineering, SATI, Vidisha (M.P.)

[3]Asst. Prof, Department of Civil Engineering, SATI, Vidisha (M.P.)

1. ABSTRACT

Fibre reinforced concrete offers a practical and economical method for Over Coming micro- cracks and similar type of deficiencies Fibres are usually use in concrete to control plastic shrinkage and dry shrinkage cracking and also to lower the permeability of concrete. It also reduces greater impact, abrasions and shatter resistances in concrete. It is an effective method of construction of light weight seismic resistant structures. 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. Hair Fibre (HF), an alternate non-degradable matter, is available in abundance and at a very cheap cost. It also creates environmental problem for its decompositions.This particular work has been undertaken to study the effect of human hair on plain cement concrete on the basis of its workability, compressive strength, flexural strength, and split tensile strength.Experiments were conducted on concrete beams and cubes with various percentages of human hair fibre i.e. 1%, 2% and 3% by weight of cement. For each combination of proportions of concrete 14 beams, 14 cylinder and 21 cubes were tested for their mechanical properties. By testing of cubes and beams we found that there is an increment in the various properties and strength of concrete by the addition of human hair for 2% as fibre reinforcement.

2.INTRODUCTION

Concrete is a very popular material used in construction of structures because of its economics and durability. Use of hair as a fiber to be mixedas an ingredient to form concrete is a relatively new concept. But what exactly is it? The strict Environmental regulations and economical purpose recycling of saloon waste hair the use of alternative Eco- friendly Natural reinforcements to produce advanced composite materials. The large quantities of human & animals hair fiber are not always well managed or utilized. In India, Three to four tons of human hair fiber wasted annually. These composites are having low density and cost as well as satisfactory mechanical properties make them an attractive due to easy availability and renewability of raw materials.

Hair is used as a fiber reinforcing material in concrete for the following reasons:

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

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

3. LITERATURE REVIEW

Fawad Khan (2018) found out the properties (mechanical) of hair fiber reinforced concrete. The effect of loading on fiber and the length of fiber on mechanical behavior like compression strength, tensile strength, flexural strength and toughness of resulting compounds are investigated. Testing was carried out on polymer compounds with distinct percentages of hair fiber added by weight of cement i.e. 0%, 2%, 4%, 6%, 8%, 10% and with varying length of hair fiber i.e.0.5-2cm.By testing of resulting specimens ,it has been not iced that there is remark able effect of human hair fiber on the mechanical properties of resulting compounds.

S. Manivel et al (2017) studied the influence of human hair and GGBFS on the mechanical properties of the reinforced cement concrete and thereby reducing environmental problem by proper utilization. In this investigation, M30 grade concrete was used and the tests were performed on concrete (cubes and cylinder) with and without addition of human hair fiber as 0%, 0.5%, 1%, 1.5%, 2%, 2.5%, and 3% by the weight of concrete. The optimum use of GGBFS in concrete is to be determined. The mechanical characteristics were determined for finding the optimum percentage of Human Hair Fiber and GGBFS.

Ajinkya Y. Surwade (2017) 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

Akash Sharma (2017) analysed the possibility of using human hair as a fiber reinforcement material by testing concrete cubes in compression testing machine at the laboratory for comparing the compressive strength of plain cement concrete with fiber reinforced concrete having human hair in different percentages like 1%, 1.5%, 2% and 8% by weight of cement for the curing period of 7, 14 and 28 days as per IS 456: 2000 (Indian standard Plain and Reinforced Concrete-Code of Practice). The main result of this current research work will lead to the finding of the fact that whether the compressive strength increases or not by using human hair as a fiber reinforcement material in concrete mixture.

4. EXPERIMENTAL INVESTIGATION

The experimental program is designed to check the effect of length of human hair on mechanical properties on M30 grade of concrete i.e. workability, compressive strength, split tensile strength and flexural strength and results will be compared with conventional concrete.

Total 30 cubes of size 150mm x 150mm x 150mm, 30 beams of size 100 mm x 100 mm x 500 mm and 30 cylindersof size 150 mm diameter and 300 mm height were casted and tested.

4.1MATERIAL USED

In this experimental work, various materials are used like….

1. Cement

2. Fine aggregate
3. Coarse aggregate
4. Water
5. Human hair

4.1.1 CEMENT

Ordinary Portland cement of53 grade is used in this experimentalwork and its properties were tested as per Indianstandards IS 4031. Ordinary Portland cement conforming to IS 12269:198711 with specific gravity 3.15 is used.

Fig. 1: Cement used

4.1.2 FINE AGGREGATE

The sand used for this experimental work was locally procured and passing through 4.75mm sieve with specific gravity 2.80. It should have fineness modulus 2.50-3.50 and silt contents should not be more than 4%. It is also noteworthy that the material's gradation was determined by sieving analysis in the laboratory. The physical properties of fine aggregate were noted to predict the overall impact on the concrete mix.

Fig. 2: Fine Aggregate

4.1.3 COARSE AGGREGATE

Crushed aggregate of maximum size 20mm & minimum 10mm are used in the present study. Its specific gravity is 2.85.Locally available coarse aggregate are used. It should be hard, strong, dense, durable and clean. It must be free from vein, adherent coatings and injurious amount of disintegrated pieces, alkalis, vegetable matters and other deleterious substances. It should be roughly cubical in shape.

Fig. 3: Coarse Aggregate

4.1.4 WATER

Fresh water free from any organic matter and potable water was used. Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Water which is suitable for drinking is satisfactory for use in concrete. Water should be free from acids, oils, alkalis, vegetables or other organic impurities. Soft waters also produce weaker concrete.

4.1.5 HUMAN HAIR

Human hair is considered as a waste material in most parts of the world and is a common constituent found in municipal waste streams which cause environmental problems3. 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 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. In our research work we will use human hair of length 2, 4, 6 cm and it is procured from market.

Fig. 4: Human hair

5. MIX DESIGN

Mix design is made for M30 grade concrete according to IS 10262-2009. Total90samples of beams, cubes and cylinders were prepared; 9sampleswere made of ordinary Portland cement (no fiber added). The remaining 81samples were prepared by adding human hair of length 2, 4, 6 cmin different proportions. The amount of water, coarse aggregate and fine aggregate were calculated for all the mixes and are reported in the Table 3.6 shown below.

Table 3.4:Mix Proportions

Mix	Human hair %	Human hair (Kg/m^3)	Cement (Kg/m^3)	CA (Kg/m^3)	FA (Kg/m^3)
M1	-	-	413	1043	793
M2	1	4.13	413	1043	793
M3	2	8.26	413	1043	793
M4	3	12.39	413	1043	793

The experimental program is planned for the workability and for the mechanical properties i.e. the compressive strength, split tensile strength and flexural strength of human hair based concrete ofM30 grade.The program consists of casting and testing of total 30cubes, 30 beams and 30 cylinders specimen of standard size cube of 150mm x 150mm x 150mm, standard beam of 150mm x 150mm x 700mm and standard cylinder of 150 mm diameter and 300 mm height were cast with and without human hair of different length.

6. RESULTS AND DISCUSSIONS

6.1 WORKABILITY TEST

This test was conducted to find out the degree of workability of human hair based concrete. By increasing the hair content in the concrete theworkability is decreasing.

Fig.5: Slump Test Result

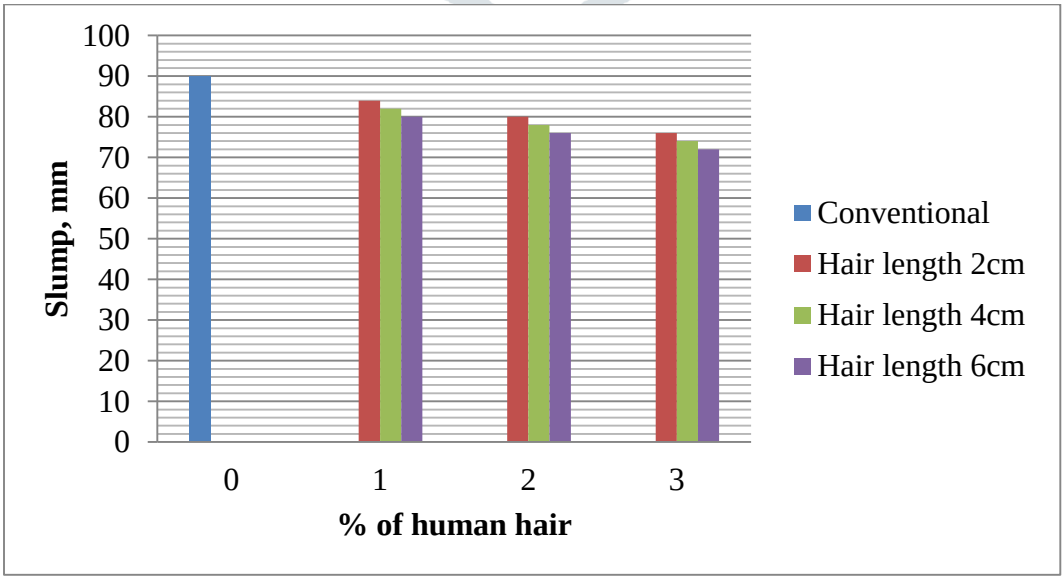

Fig.6: Slump Test Result

As the workability is decreasing with the increase in thehair content so it can be inferred that hair reinforcedconcrete should not be used in pumpable concrete.Loss in workability with increase in hair contentsignifies that relatively more effort one has to employ inorder to achieve proper mixing of concrete.

6.2 COMPRESSIVE STRENGTH TEST

The compressive strength of concrete is one of most important properties of concrete in most structural applications. For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm and cylindricalspecimen of size 300 x 150 mm were cast forM30 grade of concrete. After curing, these cubes were tested oncompression testing machine.

Fig. 7: Compressive Strength Test

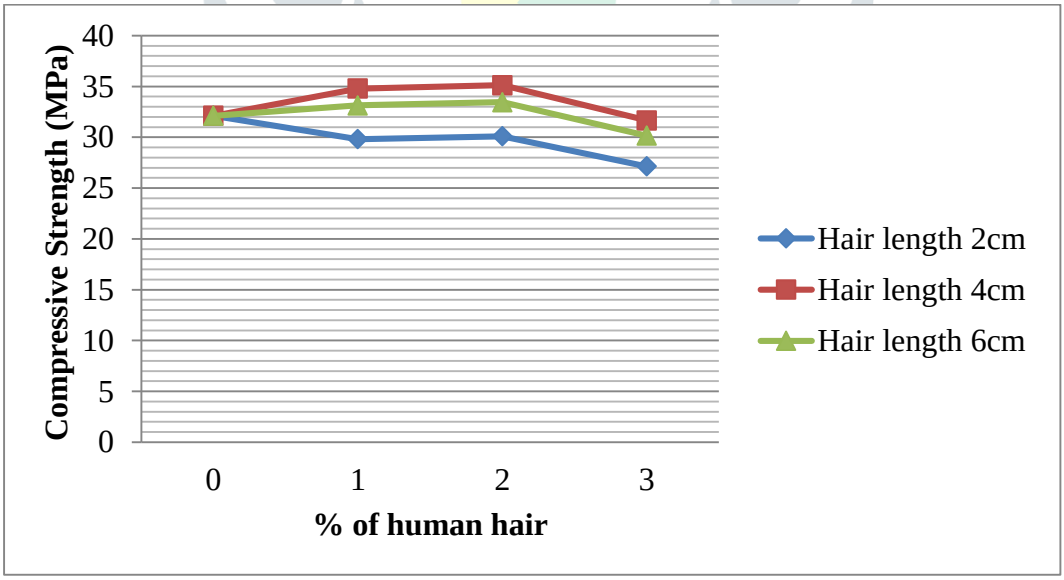

Fig. 8: Variation of compressive Strength for different length of human hair at 28 days

It is observed that at 28 days with increasein percentage till 2% of human hair compressive strength increases for hair length of 2, 4 and 6cm. The maximum value of compressive strength recordedfor length 4 cm at 2% of human hair. Hence for obtaining maximum strength 2 % human hair with length 4 cm is the optimum dosage.

6.3 FLEXURAL STRENGTH TEST RESULT

The maximum flexural strength of M30 grade of human hair mixed concrete is 24.50 MPa. The Flexural strength of concrete increases till 2% ofhuman hairafter that it is decreases for hair length of 2, 4 and 6 cm. The concrete with 2% of human hair and of length 4 cmshows highest flexural strength. The variation of Flexural Strength of M30 Grade of concrete for control mix as shown in Fig. 4.6.

Fig. 9: Flexural Strength Test

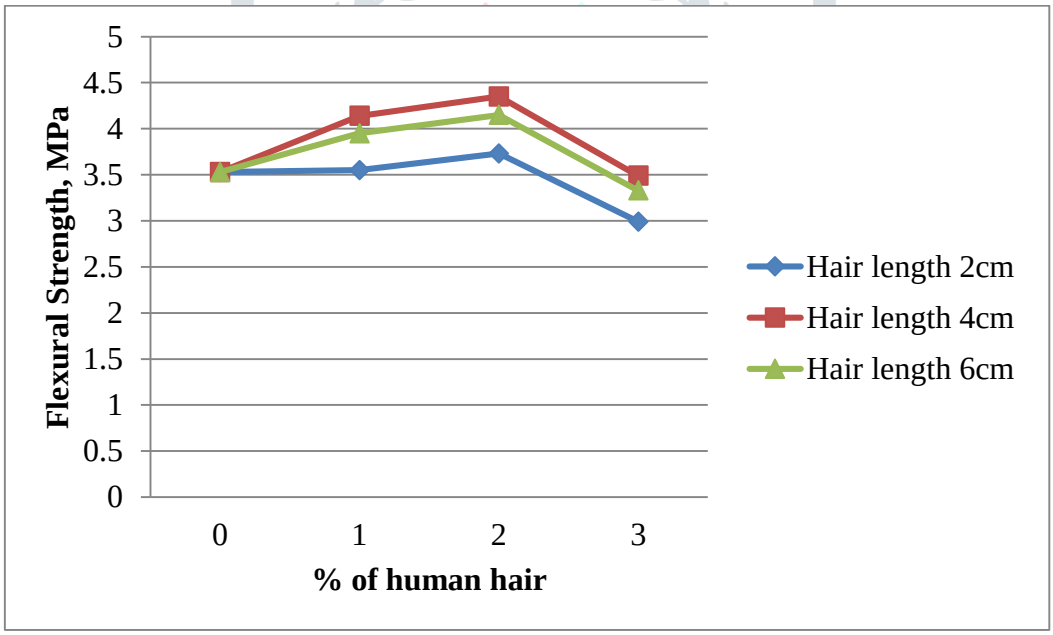

Fig.10:Flexural Strength of M30 grade at 28 days

6.4 SPLIT TENSILE STRENGTH TEST RESULT

The split tensile test have been performed on cylindrical specimens confirming IS 5816:1959 using compression testing machine and results are shown fig. 4.5 and table 4.3 below. From the test of split tensile strength of M30 grade of control concrete is 7.864 MPa. The split tensile strength of concrete increases with the proportions of human hair (1%, 2% & 3%) and length. Higher split tensile strength was obtained at 3 % of human hair of length 4cm. With increase in the proportions of human hairtensile strength increases. The variation of tensile strength of M30 Grade of concrete for control mix as shown in Fig. 4.7.

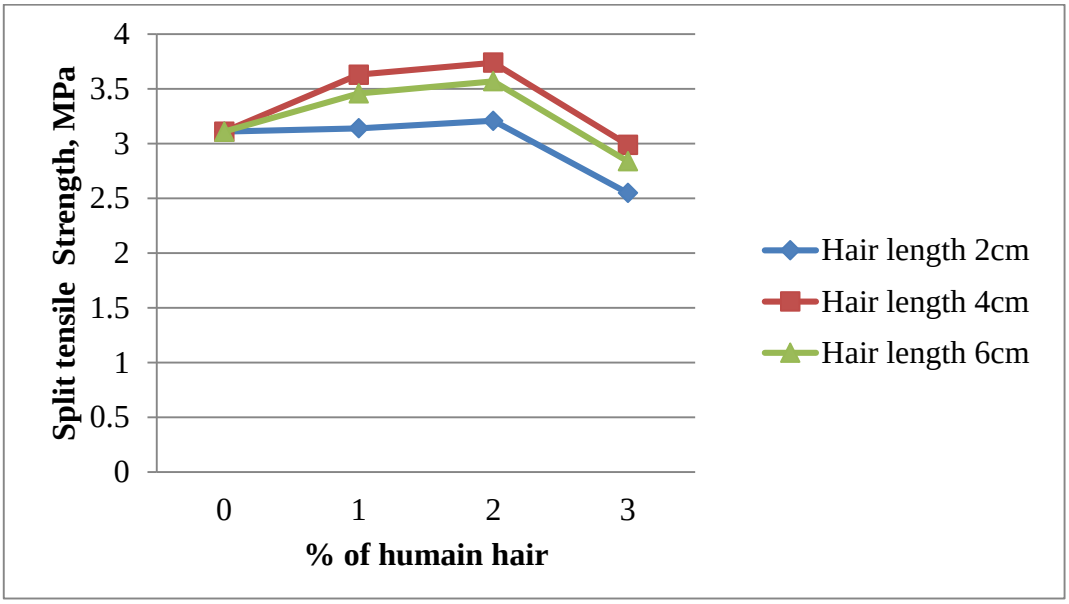

Fig.11:Split Tensile Strength of M30 grade at 28 days

Fig. 12: Split Tensile Strength Test

7. CONCLUSION

Results were obtained from various test performed in laboratory. Following conclusions were drawn on the basis of study of results. They were as follows:

1. The addition of human hairs to the concrete modifies various properties of concrete like tensile strength, split tensile strength and compressive strength.
2. As the percentage of human hair added increases, the workability reduces. This reduction is observed for all proportions added of fiber. It's basically the tendency of human hair that has a water absorption capacity of about 30% of its own weight. Thus, when we add fiber to concrete water is adsorbed, resulting in low workability.But as the hydration of cement takes place this adsorbed water is utilized. Hence it the structure and strength was not reduced to addition of fiber.

3. It is observed that at 28 days with increase in percentage till 2% of human hair compressive strength increases for all hair lengths of 2, 4 and 6cm. The maximum value of compressive strength recorded for length 4 cm at 2% of human hair is 33.45 MPa. Hence for obtaining maximum strength, 2 % of human hair with length 4 cm is the optimum dosage and length.
4. The maximum flexural strength of M30 grade of human hair based concrete is 4.35 MPa. The Flexural strength of concrete increases till 2% of human hair after that it is decreases for hair length of 2, 4 and 6cm. The concrete with 2% of human hair and of length 4cm shows highest flexural strength.
5. From the test of split tensile strength of M30 grade of control concrete is 3.74 MPa. The split tensile strength of concrete increases with the proportions of human hair (1%, 2% & 3%) and length of 2, 4 and 6cm. Higher split tensile strength was obtained at 2 % of human hair for length 4cm. With increase in the proportions of human hair tensile strength increases after 2% of human hair split tensile strength decreases.

REFERENCES

[1] Fawad Khan (2018), Mechanical Properties of Human Hair Concrete, International Journal of Advance Engineering and Research Development, 5(3), 120-127.

[2] S. Manivel, S. Nisanth Kumar, S. Prakashchandar, S. Anil Kumar (2017), Experimental Study on Human Hair Fiber Reinforced Concrete with Partial Replacement of Cement by GGBFS, International Journal of Civil Engineering and Technology, 8(4), 1145-1155.

[3] Chinnadurai P, Anuradha R (2017),A Study on Mechanical Properties of Concrete using Hair IBRE Reinforced Concrete, International Journal of ChemTech Research, 10(8), 167-176.

[4] Ramya.T, Tamilamuthan. B (2017),Human Hair Fiber Reinforced Cement Concrete, International Journal for Research in Emerging Science and Technology, 4(11), 1-6.

[5] S.Aishwarya (2017), Experimental Investigation of Hair Fiber Concrete as an Alternate Low Cost Building Material, International Journal of Engineering Technology, Management and Applied Sciences, 5(5), 476-482.

[6] Ajinkya Y. Surwade (2017), Effects of Inclusion of Human Hair Additives and Polypropylene Fiber in Concrete, International Journal of Civil Engineering and Technology, 1768-1774.

[7] Akash Sharma (2017), Analysis of Fiber Reinforced Concrete: Using Human Hair as aFiber Reinforcement, International Journal of Recent Scientific Research, 8(4), 16715 – 16720.

[8] M. Kumanachakravarthi (2017), Human Hair as Fiber Reinforcement in Concrete, Advances in Natural and Applied Sciences, 11(8), 351-355.

[9] S Pavan Kumar (2017), An Experimental Investigation on HumanHair Fiber Concrete, International Journal of Innovative Research in Science,Engineering and Technology, 6(1), 435-442.

[10] Akarsh Verma (2016), Human Hair: A Biodegradable Composite Fiber – A Review, International Journal of Waste Resources, 6(2), 2-4.

[11] Alok Jain (2016), Use of Human Hairs in Concrete, International Journal for Scientific Research & Development, 4(6), 80-82.

[12] Nila V. M (2015), Hair Fiber Reinforced Concrete, International Journal of Research in Advent Technology, Thrissur, Kerala, June, 10-11.

[13] T. Naveen Kumar (2015), An Experimental Study on Mechanical Properties of Human Hair Fiber Reinforced Concrete (M-40 Grade), IOSR Journal of Mechanical and Civil Engineering, 12(4), 65-75.

[14] Jain D. and Kothari A. (2012), Hair Fiber Reinforced Concrete, Research Journal of Recent Sciences, 1, 128-133.