An Experimental Study of Human Hair in Concrete as Fibre Reinforcement

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Abstract - Since the ancient times, many researches and advancements were carried to enhance the physical and mechanical properties of concrete. 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., fine & coarse aggregate and results were compared with those of plain cement concrete of M-20 grade.

Keywords – Human Hair, Concrete, Fibre.

I. INTRODUCTION

Fiber Reinforced Concrete (FRC) is concrete containing fibrous material which increases as structural and is gaining importance. It contains short discrete fibers that are uniformly distributed and randomly oriented. The concept of using fibers as reinforcement is not new. Fibers have been used as reinforced since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the early 1900s, asbestos fibers were used in concrete, and in the 1950s the concept of composite materials came into being and fiber reinforced concrete was one of the topics of interest. Later, the use of asbestos for concrete reinforcement was discouraged due to the associated health risks. New materials like steel, glass, and synthetic fibers replaced asbestos for reinforcement.

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. Fibers are usually used in concrete for the following reasons:-

1) To control cracking due to both plastic shrinkage and drying shrinkage.

2) They also reduce the permeability of concrete and thus reduce bleeding of water.

3) They produce greater impact, ductility, strength, abrasion and shatter resistance in concrete.

4) The fineness of the fibers allows them to reinforce the mortar fraction of the concrete, delaying crack formation and propagation.

II. METHODOLOGY

In this study mixes, we are planned to make with fiber with varying proportion of 0.7%,1.2% and 1.75%.Control mix was taken with 0%fiber.

A.Collection of Raw Materials:The materials used in this study are: Ordinary Portland cement (OPC): 53grade ACC Cement Human hair fiber: Human hair fiber collected from the saloon shop in the Jaipur district.

These fibers are chapped into 3.8cm length and washed these fibers in the acetone for washing or polishing purposes.

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1) Water: Collected from the local fresh water sources

2) Fine Aggregate: River sand passing through 4.75mm sieve size.

3.Coarse aggregate: Coarse aggregate of 20mm sizes.

A. Basic Test Results of Materials

For all the materials used in the project following basic tests were conducted according to the IS specifications

B. Basic Test Results for Cement

fineness of cement=7.18%

specific gravity of cement=3.198

Normal consistency of cement=31.7

Penetration depth for initiail setting time=5.2mm

Penetration depth for final setting time=32.3mm

C. Basic Test Results for Fine Aggregate

Sieve analysis for fine aggregate=zone-1

Specific gravity of fine aggregate=2.535

Water absorption for fine aggregate=0.25

D. Basic Test Results for Coarse Aggregate Sieve analysis for coarse aggregate table 2 of IS 383-1970

Specific gravity for coarse aggregate=2.707

Water absorption for coarse aggregate=1.689

Material	Water	Cement	Fine Aggregates	Coarse Aggregates
In kg/m^3	186	294	724.889	1169.645
Ratio	0.5	1	2.467	3.979

III. EXPERIMENTAL WORK

A. Mixes: Four mixes are planned by cement content with human hair in percentages of 0,0.7,1.2,1.75 by weight of cement material was incorporated in all the mixes.Plain concrete in which 0% human hair fiber was taken as control mix. For each mix 4Cubes of 150x150x150 mm size and 3 Cylinders of 150mm dia and 300mm length and 3 beams of 700mm x150mm x150mm sizes were casted.

Mix Proportions (M20 Grade, As per IS 10262-2009)

Mix proportions for human hair fiber reinforced concrete blended with concrete (M20grade): Taking control mix proportions as reference, mix proportions for other mixes were calculated. Here,the mix proportions for the mix in which and 0.5% fiber was incorporated are given below.6

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Material	Water	Cement	Fine Aggregates	Coarse Aggregates
In kg/m^3	186	294	724.888	1173.946
Ratio	0.5	1	2.466	3.992

Casting the specimens taking the control mix design (i.e.0% fiber) as reference weights of materials are calculated as shown above. In all the concrete mixes human hair fiber was varied in the percentages of 0.5%, 1.0%, 1.5%, by the weight of cement material content was incorporated for the w/b ratio 0.5.Total 16 Cubes (150x150x150mm), 12Cylinders (150mm dia and 300mm length) and 12beams (700mmx150mmx150mm) for all the 4mixes including control mix.

Mix 1: 0% fiber, Mix 2: 0.7% fiber, Mix 3: 1.2% fiber, Mix 4: 1.75% fiber

B. Workability

To determine workability of fresh concrete the following tests were conducted.

1) Slump cone test.
2) Compaction factor test

C. Tests

To know the hardening properties of concrete the following tests are conducted on the specimens for 3,7 and 28 days from time of mixing the water to the dry materials.

1) Compressive strength test (Cubes)
2) Split tensile strength test (Cylinders)
3) Flexural strength test (beams)

IV. RESULTS

A. Workability

Workability of human hair fiber reinforced concrete is decreased than the control mix,due to the presence of human hair fiber. The results of workability are shown in the following Table-1.

S.No.	Mix No.	Slump value (cm)	Compaction Factor
1	Mix 1	5.56	0.94
2	Mix 2	6.32	0.95
3	Mix 3	6.22	0.94
4	Mix 4	4.56	0.99

Table 1: Results of Workability of Mixes

B. Compressive Strength

The compressive strength of concrete is determined by testing the cubes under compressive testing machine. The results of compressive strength are shown in the Table-2.

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Maximum compressive strength occurred at (1.7%fiber) and it is nearer to the target strength.

S.No.	For Days	Compressive strength in N/mm²			
		Mix 1	Mix 2	Mix 3	Mix 4
1	3	6.37	6.62	7.03	7.18
2	7	12.44	12.65	13.13	13.48
3	28	24.37	24.68	25.34	25.65

Table 2: Results of Compressive Strength

B.Split tensile strength:

Split tensile strength test was conducted for the cylinders of 150mm dia and 300mm length.The obtained values are tabulated in Table-3.Compared to conventional concrete crack width is for this fiber reinforced concrete. Splitting of specimens into two pieces can be controlled completely with this fiber.

S.No.	For Days	Compressive strength in N/mm²			
		Mix 1	Mix 2	Mix 3	Mix 4
1	3	1.35	1.63	1.73	1.82
2	7	2.24	2.38	2.46	2.58
3	28	3.16	3.26	3.41	3.52

Table 3: Results of Split Tensile Strength

C.Flexural strength:

Flexural strength test was conducted for the beams of 700mm length,150mm wide and 150mm depth. The obtained values are tabulated in Table-4.

V. CONCLUSION

Human hair waste can be effectively managed to be utilized in fiber reinforced concrete constructions.

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.

The human hair fiber concrete has the high compressive strength compared to the normal Concrete.

Better split tensile strength was achieved with the addition of the human hair in concrete. The strength has increased. When compared to that of the conventional concrete specimen. It is well observed that the maximum increase is noticed in the addition of 1.7% hair fiber, by weight of concrete, in all the mixes.

Crack formation and propagation are very much reduced showing that FRC can have its applications in seismic resistant constructions.

The addition of human hairs to the concrete not only modifies various properties of concrete like tensile strength, compressive strength but also enhances the binding properties, micro cracking control and also increases spalling resistance. The crack width is reduced to a greater extent.

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