

A Concept of Improving Strength of Concrete using Human Hair as Fiber Reinforcement

^[1]Achal Agrawal, ^[2]Abhishek Shrivastava, ^[3]Siddharth Pastariya, ^[4]Anant Bhardwaj

^[1,2,3,4]Lecturer , Civil Engineering Department, SAIT, Indore, MP, India

ABSTRACT :- Fiber reinforced concrete provides good flexural strength with less crack developments. Since concrete is weak in tension. So an attempt has been made to achieve improved strength results using hair as fiber in conventional concrete. Human hair are strong in tension, non-degradable and is available in abundance. Present studies have confirmed 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 fiber as 0% ,1%,2%,3%,4% and 5% by weight of cement. For every combination of proportions of concrete cubes and beams were tested for their compressive and flexural strength. By testing of concrete cubes with human hair as fiber cement concrete an improved strength is obtained.

KEYWORDS: Fiber Reinforced Concrete, Hair Fiber, Compressive Strength, Flexural Strength.

I. INTRODUCTION

Fibre Reinforced Concrete (FRC) contains fibrous materials that causes strength improvement of concrete. FRC is a mixture of cement, sand, aggregates and fibrous materials that are mixed with concrete in scattered manner or randomly oriented. Fibres may be of steel, glass, horsehair, human hair or synthetics. Fibres have been used in ancient time, it is not new thing. Horsehair were used in mortar to improve its inherent properties. FRC reduces crack development. Studies have been done on FRC that have proven it improves compressive as well as flexural strength of concrete. Human hair are good in tension, so these can prove to be useful in concrete as reinforcing material.

Advantages of FRC:-

1. FRC is used in civil engineering structures where corrosion is to be avoid at the maximum.
2. FRC is better suited to optimize cavitations/erosion damage in structures such as sluice-ways, bridge piers where high velocity flows are encountered.
3. Fibres decreases internal forces by blocking microscopic cracks from forming within the concrete.
4. It can provide saving in weight of concrete as thin FRC section can provide same strength as relatively thick plain cement concrete section.
5. It can be useful in quake prone areas to reduce human casualties.
6. Human hair as fibre has high tensile strength which is nearly equals that of a thin copper wire.

Disadvantages of FRC:-

1. The main disadvantage of FRC is its fabrication, which is difficult.
2. It involves more labour which makes it costlier as compare to plain cement concrete but these disadvantages nullify as it has much better advantages

II. METHODOLOGY

This research is done with comparison of two strength parameter of concrete. Compressive strength and flexural strength of human hair are added to the plain cement concrete in different % as 0,1,2,3,4 & 5 by weight of cement and is compared for 7 ,14 & 28 days curing period.

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Compressive strength :-

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 have been used. We have taken 150 mm size cast iron cubes. A mix of M20 grade i.e. 1:1.5:3.

If,

P= Maximum load at Failure

A= Contact area under loading

$$\sigma = P/A$$

Flexural Strength:-

Tensile strength measurement is commonly done by flexural test. Concrete is not designed for tension but to know about cracks formation at a load its knowledge become important. To measure flexural strength of concrete, beams are casted and tested in flexural testing machine. Beam may be of size 150mm*150mm*700mm & 100mm*100mm*500mm. We use beams of size 150mm*150mm*700mm for this. Beam moulds kept ready before mixing concrete so as to assume there is no loss of water or slurry. Two beams for each % variation is casted and tested for 7 days , 14 days & 28days curing period & corresponding flexural strength is calculated.

We know that ,

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

Where,

M = Moment of Resistance,

I = Moment of Inertia about neutral axis,

σ_b = Bending stress,

y = Extreme fibre distance from neutral axis, W = Maximum load at which beam fails,

b = width of the beam,

d = depth of the beam,

On solving this bending stress can be written as :-

$$\sigma_b = \frac{3Wl}{4bd^2} .$$

III. RESULTS & DISCUSSION

Results are briefly tabulated and are shown in table 1 to 6. They are also shown in the bar chart form, from chart 1 to 6.

Compressive strength:-

Table no. 1 Compressive Strength(N/mm²) at 7 days Curing Period

SN	Mix	% Hair	Avg. Compressive Strength
1	M-20	0	14.46
2		1	14.53
3		2	14.77
4		3	14.85
5		4	15.08
6		5	15.37

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Table no.2 Compressive Strength(N/mm²) at 14 days Curing Period

SN	Mix	% Hair	Avg. Compressive Strength
1	M-20	0	17.50
2		1	17.54
3		2	17.85
4		3	17.99
5		4	18.36
6		5	18.88

Table no. 3 Compressive Strength(N/mm²) at 28 days Curing Period

SN	Mix	% Hair	Avg. Compressive Strength
1	M-20	0	20.80
2		1	20.96
3		2	21.37
4		3	21.67
5		4	22.15
6		5	22.71

Charts:-

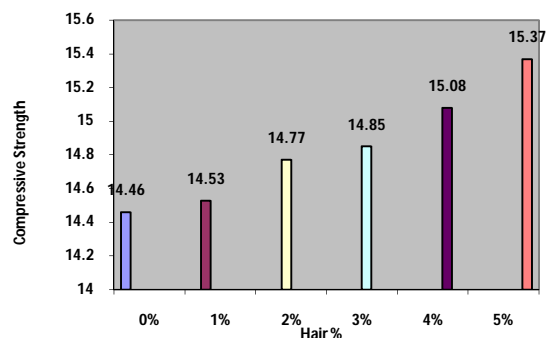


Chart 1. Compressive Strength (N/mm²) at 7 days Curing Period

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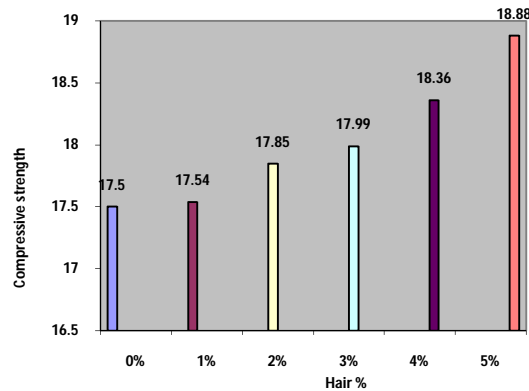
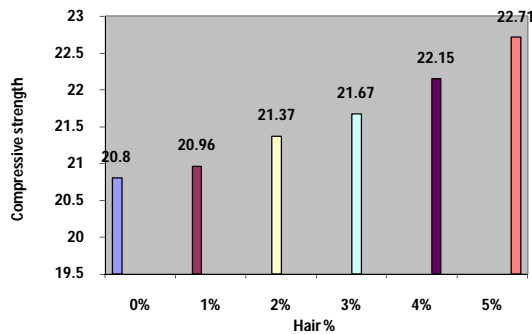


Chart 2. Compressive Strength (N/mm²) at 14 days Curing Period



Charts 3. Compressive Strength (N/mm²) at 28 days Curing Period

Flexural strength :-

Table no. 4 Flexural Strength(N/mm²) at 7 days Curing Period

SN	Mix	% Hair	Average Flexural strength
1	M-20	0 %	3.52
2		1%	3.58
3		2%	3.60
4		3%	3.64
5		4%	3.68
6		5%	3.76

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Table no. 5 Flexural Strength(N/mm²) at 14 days Curing Period

SN	Mix	% Hair	Average Flexural strength
1	M-20	0 %	4.30
2		1%	4.38
3		2%	4.39
4		3%	4.42
5		4%	4.47
6		5%	4.72

Table no. 6 Flexural Strength(N/mm²) at 28 days Curing Period

SN	Mix	% Hair	Average Flexural strength
1	M-20	0 %	5.19
2		1%	5.27
3		2%	5.34
4		3%	5.40
5		4%	5.44
6		5%	5.53

Charts:-

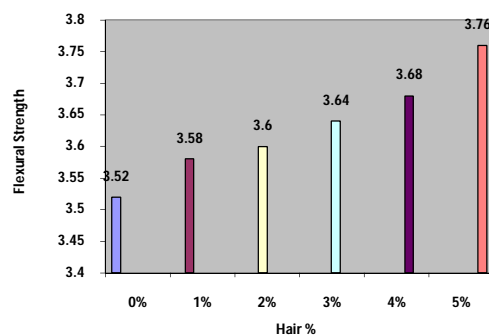


Chart 4. Flexural Strength (N/mm²) at 7 days Curing Period

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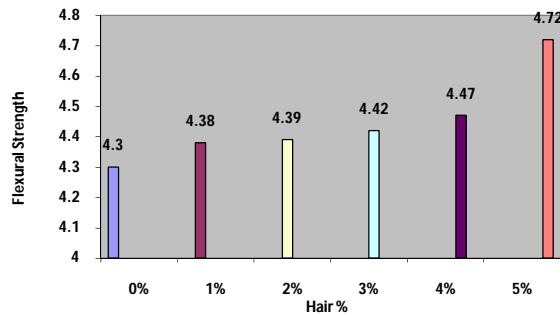


Chart 5. Flexural Strength (N/mm²) at 14 days Curing Period

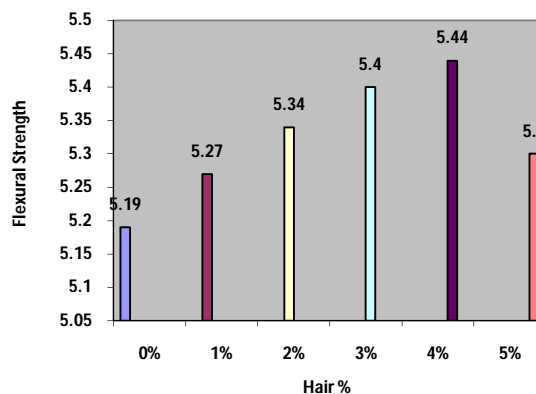


Chart 6. Flexural Strength (N/mm²) at 28 days Curing Period

On increasing % addition of human hair to the concrete the compressive & flexural strength goes on increasing and optimum strength is achieved when 5% hair are mixed.

IV. Conclusion

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

- When 5% hair were added to the mix, then maximum compressive and flexural strength were noted.
- Compressive strength increased more than Flexural strength when compared with conventional concrete.
- For 7 days curing period 6.29% compressive and 6.82% flexural strength increment was marked when compared with conventional mix.
- For 14 days it was 7.89% and 9.7% increment in compressive and flexural strength respectively when compared with conventional concrete.
- For 28 days a maximum of 9.18% and 6.55% increment in compressive and flexural strength respectively was achieved when compared with conventional concrete.
- It was noted that a maximum of improvement in strength of concrete can be achieved by adding human hair as fiber reinforcement in concrete mix.
- its has been noted that on an average the increment in the compressive strength of FRC is about 9% & that of flexural strength is 6.50% when compared with Plain cement concrete (PCC).

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