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HUMAN HAIR FIBER REINFORCED CONCRETE

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1 Abstract: Since the ancient times, many researches and advancements were carried to enhance the physical and mechanical properties of concrete. 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 fibre reinforcement material.

A Fibre is a small piece of reinforcing material possessing certain characteristics properties. Addition of fibres to concrete influences its mechanical properties which significantly depend on the type and percentage of fibre. The properties of fibre reinforced concrete is influenced mainly by the physical and mechanical properties of the fibre.

A good fibre should have good adhesion within the matrix and adaptable elasticity modulus. It must be compatible with the binder, which shouldn't be attacked or destroyed in the long term. It should be short, fine and flexible to permit mixing, transporting and placing and also strong enough to withstand the mixing process.

The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibres) termed as volume fraction (Vf). Vf typically ranges from 0.1 to 3%. Also it can be taken as percentage by weight of cement that is used in preparing concrete. The increase in the volume of fibres, increase approximately linearly, the tensile strength and toughness of the composite. But use of higher percentage of fibre is likely to cause segregation and harshness of concrete and mortar.

One of the differences between conventional reinforcement and fibre reinforcement is that in conventional reinforcement, bars are oriented in the direction desired while fibres are randomly oriented. It was observed that the fibres aligned parallel to the applied load offered more tensile strength and toughness than randomly distributed or perpendicular fibres.

The modulus of elasticity of matrix must be much lower than that of fibre for efficient stress transfer. The Interfacial bond between the matrix and the fibre

also determine the effectiveness of stress transfer, from the matrix to the fibre. A good bond is essential for improving tensile strength of the composites.

Biological fibres have recently become eye-catching to researchers, engineers and scientists as an alternative reinforcement for FRP (fiber reinforced polymer) composites, due to their low cost, fairly good mechanical poperties and high aspect strength. One of the immaculate biological fibers is the human hair, on the whole, three to four tons of human hair fibers are wasted in India annually; hence they pose an environmental challenge.

In order to find commercial application the wasted human hair is nowadays finding its use in the field of science. Human hair is basically a nano-composite biological fiber with well characterized microstructures. Different techniques and technologies have been employed to study the different characteristics of the human hair to prove it a biological composite fiber

. The main component of hair is keratin which is rough, insoluble and incredibly strong. An important aspect is that a single strand of hair can withstand the load of 100-150 grams. Hair is elastic and it is capable of regaining its original position on removal of the deformation load. Therefore, the present paper reports the current scenario of human hair as biological composite fiber.

Fibre-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres includes steel fibres, glass fibers, synthetic fibers and natural fibers – each of which lends varying properties to the concrete.

In addition, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities. Fibres are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion, and shatter–resistance in concrete.

Present work has been undertaken to study the effect of human hair on plain cement concrete of M-30 grade on the basis of its mechanical properties which include compressive strength and also to reduce environmental problems.

Also addition of human hair fibres enhances the binding properties, micro cracking control imparts ductility and also increases spalling resistance. Fibres are

usually used in concrete to control plastic shrinkage and dry shrinkage cracking and also to lower the permeability of concrete. Also, very fine hair fibres can be used for the partial replacement of cement in concrete.

By testing we found that there is an increment in the various properties and strength of concrete by the addition of human hair as fibre reinforcement.

Experiments were conducted on Concrete cubes, beams and cylinders of standard sizes with addition of various percentages of Human Hair fibre i.e., 1%, 2% and 3% by weight of cement and results were compared with those of plain cement concrete of M-30 grade tested for their mechanical properties.

11.MATERIALS USED

The binding materials used in concrete are Portland pozzolana cement.

This cement is of 53 grades conforming to IS 456-2000 and is having desired properties.M30 grade designation is used.

The coarse aggregate for the works should be river gravel or crushed stone. Angular shape aggregate of size is 20mm and below.

Fine aggregate is added to concrete to assist workability and to bring uniformity in mixture.

Human Hair as a Fibre is used. Hair fibre in aspect ratio 0.25 is used

80% of human hair is formed by a protein known as keratin, with a high grade of sulfur – coming from the amino acid cysteine – which is the characteristic to distinguish it from other proteins. Keratin is a laminated complex formed by different structures, which gives the hair strength, flexibility, durability, and functionality.

The main factor to be considered in the human hair is the high amount of the amino acid cysteine, which may be degraded and afterwards may be re-oxidated under a disulphidic bounding form. The physical proprieties of hair involve: resistance to stretching, elasticity and hydrophilic power.

111 .EXPERIMENTAL METHODS

3.1 TESTS ON FRESH CONCRETE

3.1.1 COMPACTION FACTOR TEST: Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 - 1959. The apparatus used is Compacting factor apparatus.

RESULT:

Compaction factor for PPC=0.823

Compaction factor for concrete, by the addition of Human Hair,=0.9

3.1.2 SLUMP TEST: Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199 - 1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod.

RESULT:

Slump value for PPC

Specimen	**Trial 1**	**Trial 2**	**Trial 3**	**Mean (cm)**
Slump Value	11	10.9	10.66	10.85

TAB 8.1:SLUMP VALUE FOR PORTLAND CONCRETE

Slump value= 64%

Slump value ofConcrete, by the addition of Human Hair:

Specimen	**Trial 1**	**Trial 2**	**Trial 3**	**Mean (cm)**
Slump Value	9.8	9.1	9.3	9.4

TAB 8.2:SLUMP VALUE FOR ADDITION OF CONCRETE

slump value=68%

3.2 TEST ON HARDENED CONCRETE

3.2.1 COMPRESSIVE STRENGTH OF CONCRETE: The compressive strength of concrete is defined as the load which causes the failure of specimen, per unit area of cross-section in uniaxial compression under given rate of loading. The strength of concrete is expressed as N/mm^2.

For structural design the compressive strength is taken as the criterion of quality of concrete and working stress are prescribed as per codes in terms of percentages of the compressive strength as determined by standard tests.

For concrete without admixture for M_{30} grade was find out for 7 days compressive strength (3- cubes),14 days compressive strength (3- cubes) and 28 days compressive strength (3- cubes)

RESULTS :

COMPRESSIVE Compressive strength	Ordinary	1%	2%	3%
7 days (N/mm^2)	19.64	19.64	20.8	17.225

Table3.1 COMPRESSIVE STRENGTH FOR 7 DAYS

Compressive strength	Ordinary	**1%**	**2%**	**3%**
14days (N/mm^2)	27.198	32.4	28.8	23.85

Table:3.2 COMPRESSIVE STRENGTH FOR 14 DAYS

Compressive strength	Ordinary	1%	2%	3%
28 days (N/mm^2)	30.22	36	32	26.5

Table:11.3 COMPRESSIVE STRENGTH FOR 28 DAYS

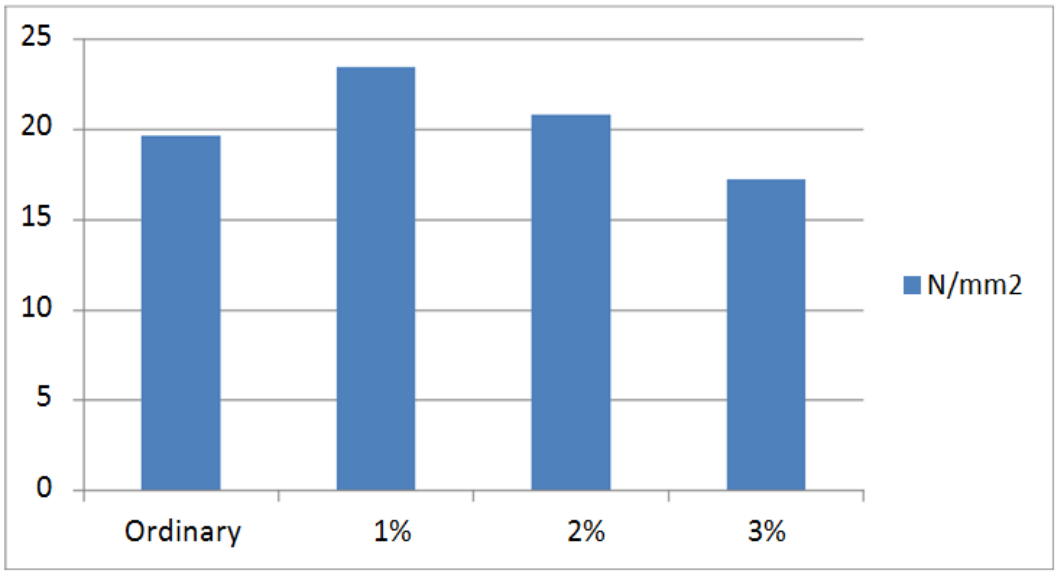

Fig3.1 BAR CHART FOR 7 DAYS COMPRESSIVE STRENGTH

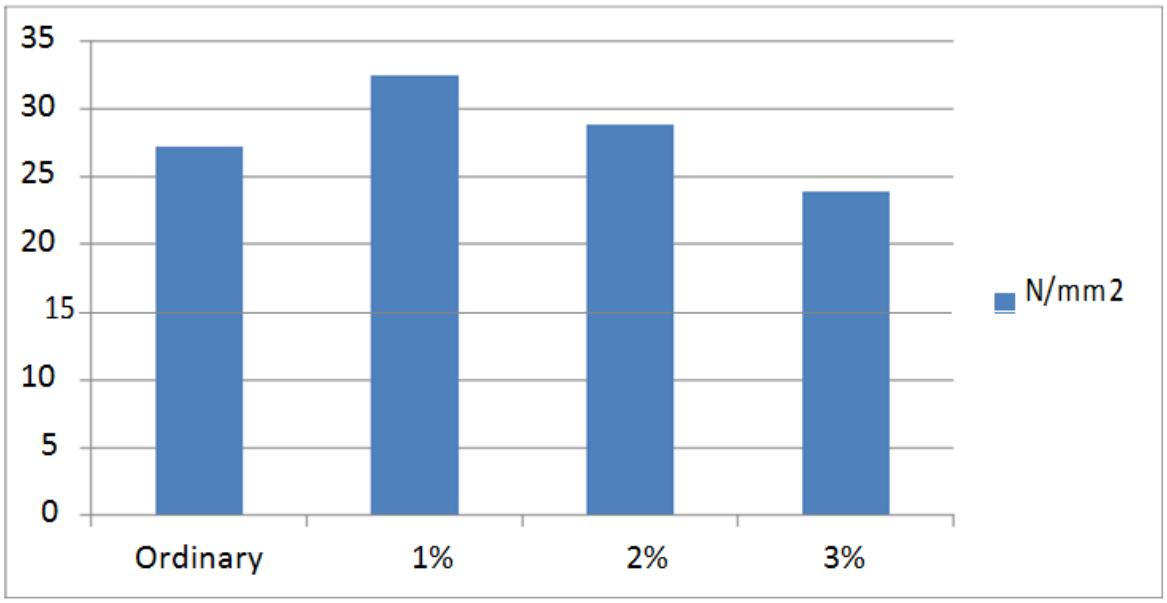

Fig:3.2 BAR CHART FOR 14 DAYS COMPRESSIVE STRENGTH

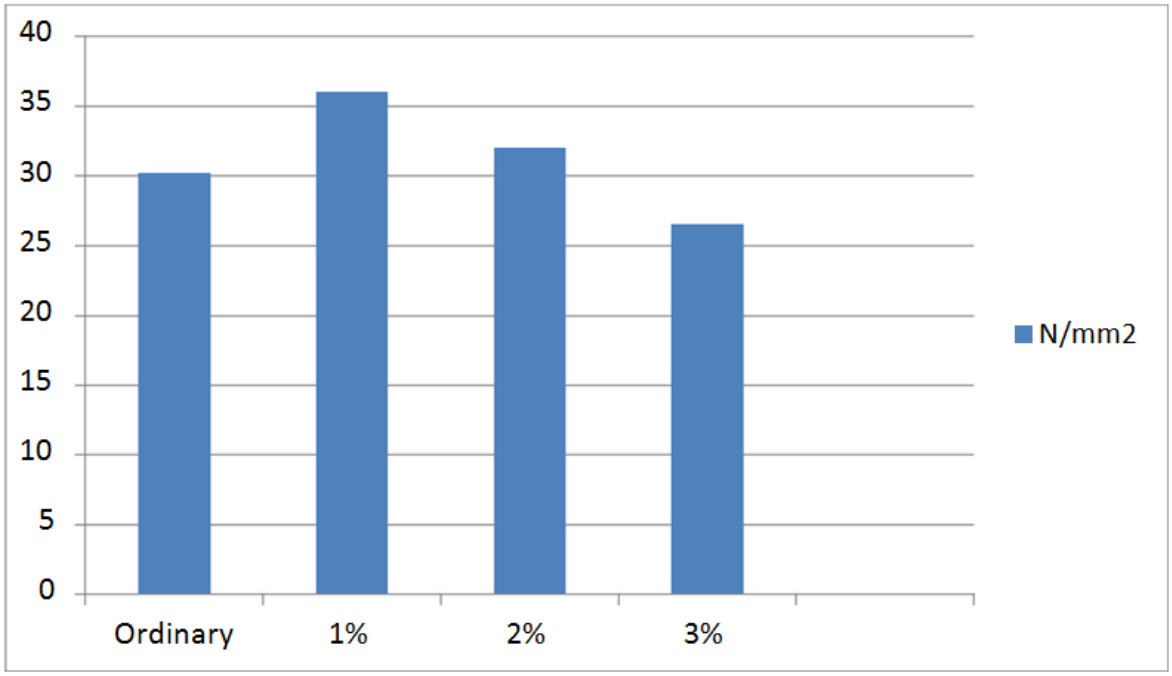

Fig:3.3 BAR CHART FOR 28 DAYS COMPRESSIVE STRENGTH

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3.2.2 FLEXURAL STRENGTH TEST : The concrete strength used in the design of concrete pavements is based on AASHTO Test Method T-97 or ASTM C78, Flexural Strength of Concrete using a Simple Beam with Third-Point Loading.

These flexural tests (also called Modulus of Rupture tests or Third-Point Loading tests) are performed using concrete beams that have been cast and cured in the field, to mimic field conditions.

For AASHTO thickness design, it is important that the third point loading 28 day flexural strength be used use in the AASHTO equation. If the strength values are measured using some othertest method, it must be converted to the 28-day third-point strength.

RESULTS :

Flexural strength	Ordinary	1%	2%	3%
7 days(N/mm^2)	3.51	4.68	3.12	2.145

Table:3.4 FLEXURAL STRENGTH FOR 7 DAYS

Flexural strength	Ordinary	1%	2%	3%
14days(N/mm^2)	4.86	6.48	4.32	2.97

Table:3.5 FLEXURAL STRENGTH FOR 14 DAYS

Flexural strength	Ordinary	1%	2%	3%
28				

days(N/mm^2)	5.4	7.2	4.8	3.3

Table:11.6 FLEXURAL STRENGTH FOR 28 DAYS

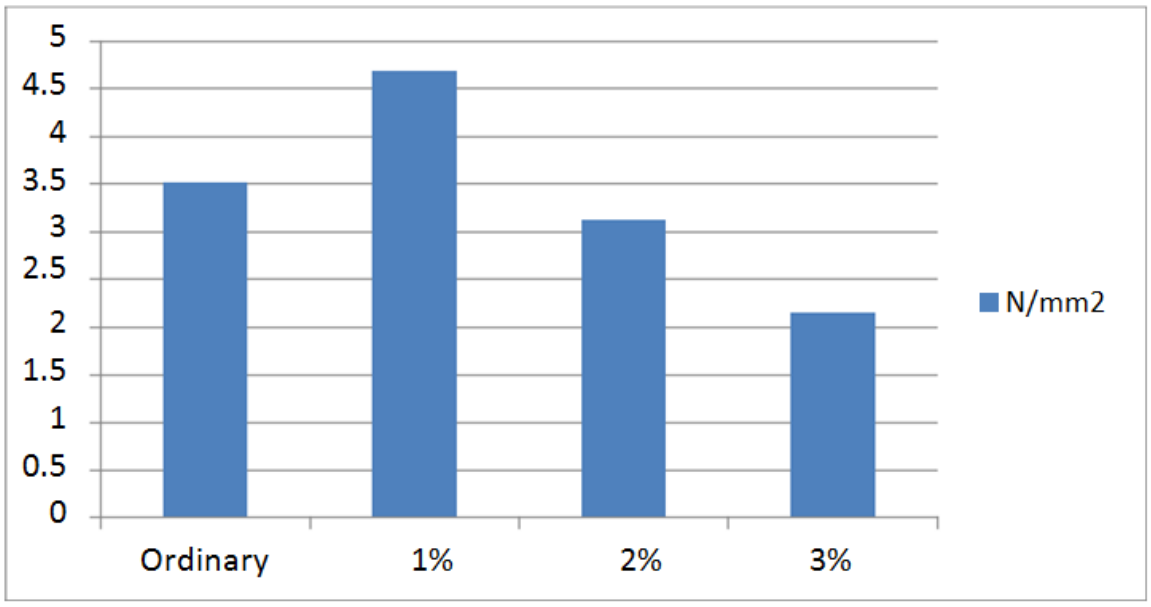

Fig:3.4 BAR CHART FOR 7 DAYS FLEXURAL STRENGTH

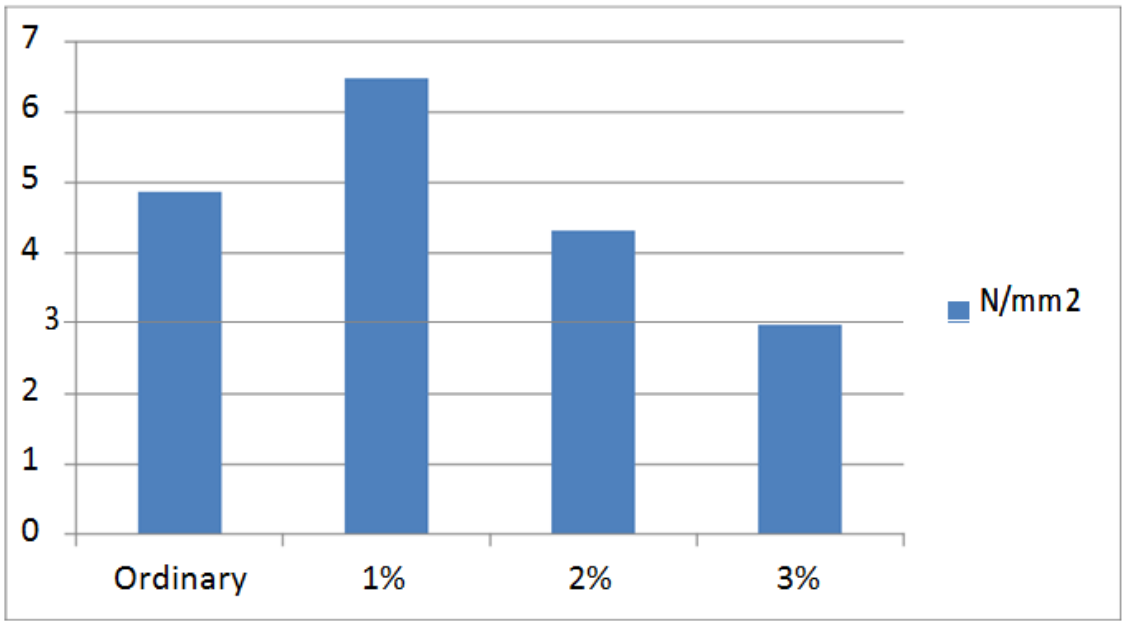

Fig:3.5 BAR CHART FOR 14 DAYS FLEXURAL STRENGTH

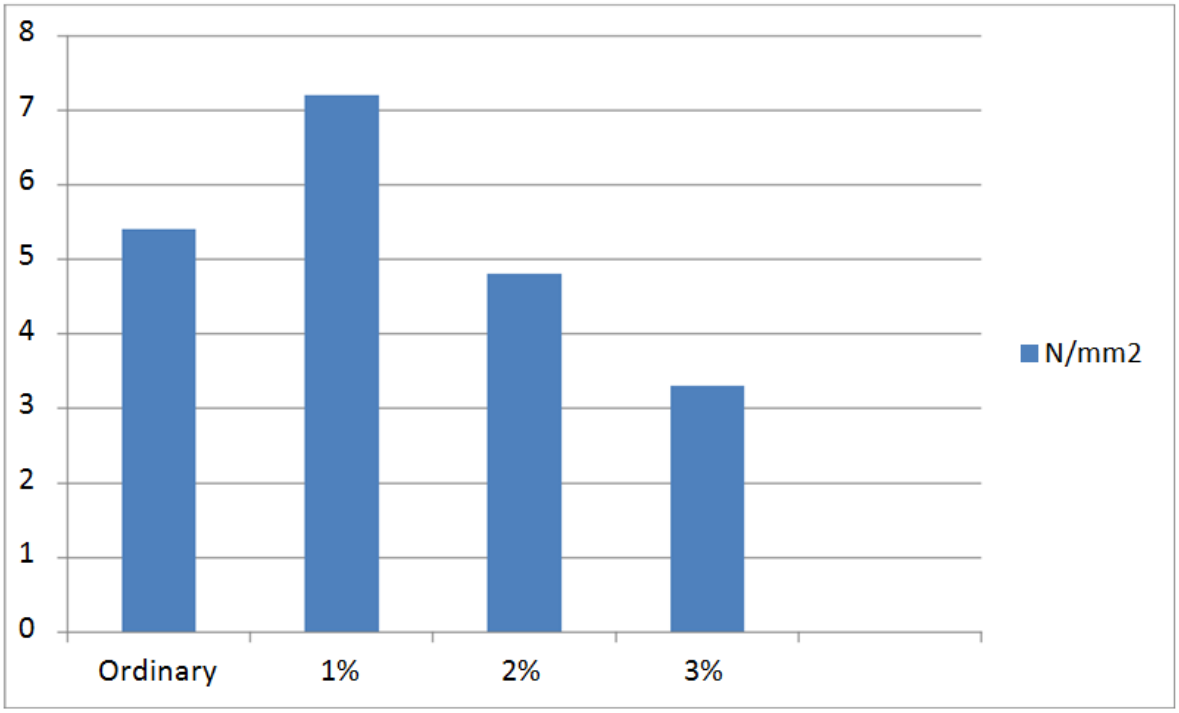

Fig:3.6 BAR CHART FOR 28 DAYS FLEXURAL STRENGTH

3.2.3 SPLIT TENSILE STRENGTH TEST: Since there is no direct method for finding the tensile strength of concrete indirect method is adopted.

In this method the same compression testing machine as used for finding the compressive strength is used. Unlike compression test, concrete cylinders of standard size 150 x 300 mm as specified by Indian standard are used for testing.

RESULTS :

Split tensile strength	Ordinary	1%	2%	3%
7 days (N/mm^2)	2.204	2.48	1.469	1.012

Table:3.7 SPLIT TENSILE STRENGTH FOR 7 DAYS

Split tensile strength	Ordinary	1%	2%	3%
14 days (N/mm^2)	3.051	3.437	2.034	1.40

Table:3.8 SPLIT TENSILE STRENGTH FOR 14 DAYS

Split tensile strength	Ordinary	1%	2%	3%
28days (N/mm^2)	3.39	3.819	2.26	1.556

Table:3.9 SPLIT TENSILE STRENGTH FOR 28 DAYS

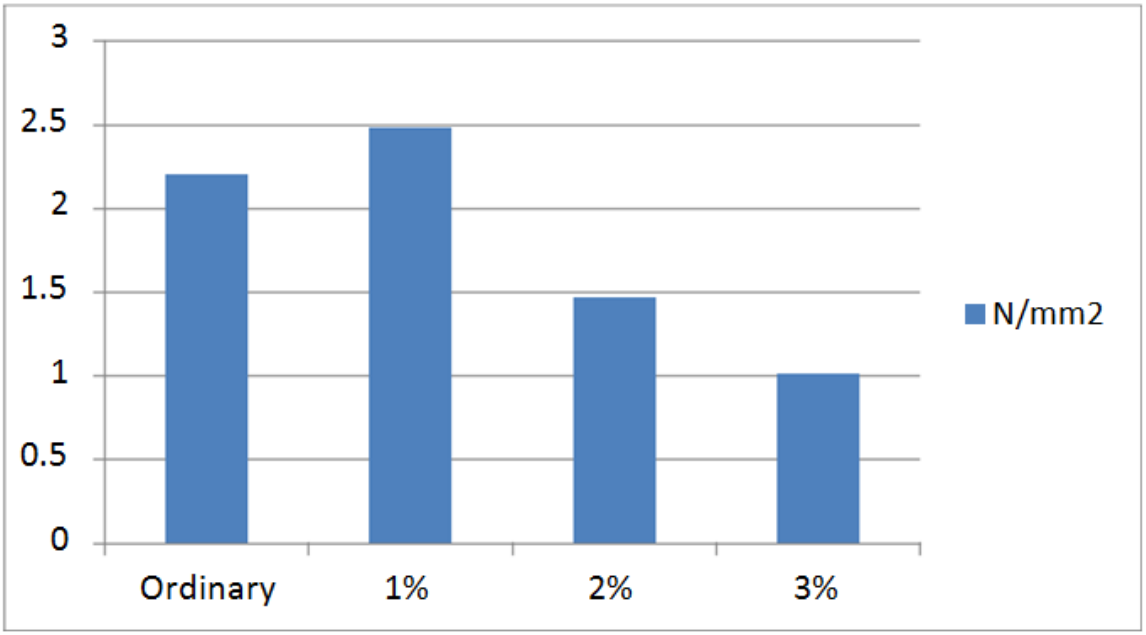

Fig:3.7 BAR CHART FOR 7 DAYS SPLIT TENSILE STRENGTH

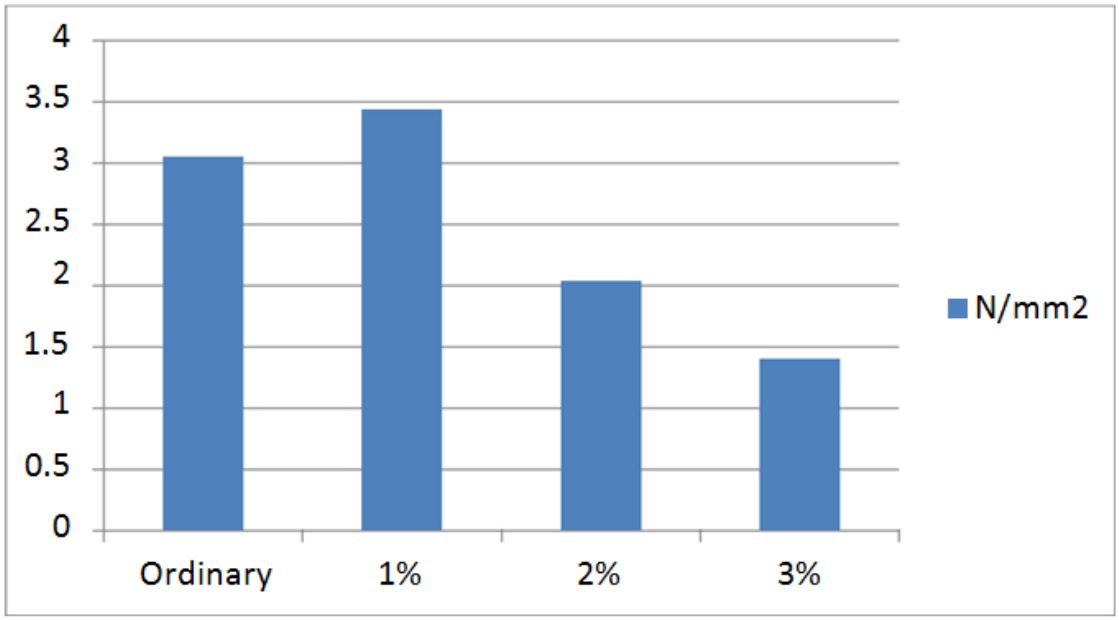

Fig:3.8 BAR CHART FOR 14 DAYS SPLIT TENSILE STRENGTH

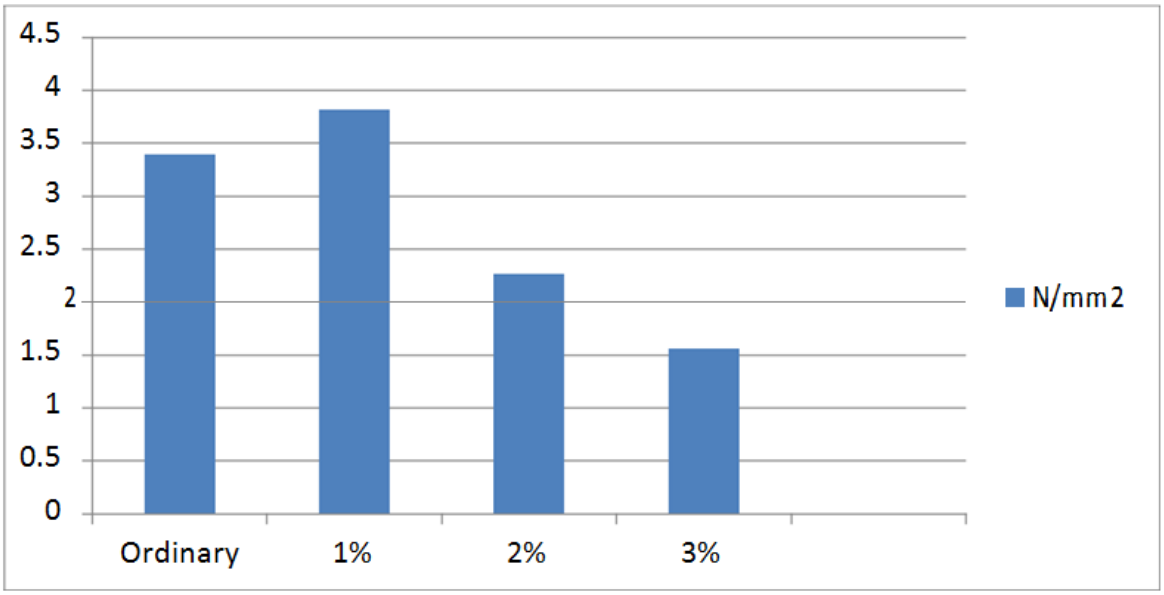

Fig:3.9 BAR CHART FOR 28 DAYS SPLIT TENSILE STRENGTH

4. CONCLUSION

Better strength will get while using1%-2%of human hair. It will resist shrinkage and crack. It will affect the workability during 3%. . This study proves that adding cement and human hair greatly increase the strength of the mixture thus making it a good material for the construction of road pavement. There is an increment in the various properties and strength of concrete by the addition of human hair as fibre reinforcement.