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BEHAVIOR OF CONCRETE WITH PLASTIC WASTE AND NATURAL FIBERS

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ABSTRACT

Concrete is by far the most widely used construction material today. To make good concrete now variety of innovative materials such as fibres, admixtures and construction ,pozzolanas and different concrete making techniques are adopted in present day construction.

In recent years, intensive research has resulted in advances and innovation in the technology of fibres such as glass, polypropylene, plastic aggregate and hair . and more basic knowledge has been gained on the behaviour of cement concrete containing these fibres. Concrete containing hydraulic cement, water, aggregate, and discontinuous discrete fibres is called fibre-reinforced concrete. The incorporation of short discrete fibres (steel, polypropylene, glass, plastic agg. And hair) can lead to usefull improvements in the mechanical behaviour of tension weak concrete. Concrete is the most widely used man made construction material in the world and its second only to water as the most utilized substance in the planet. Seeking aggregates for concrete and to dispose of the waste from various commodities is the present concern.

In the present study the recycled plastics were used to prepare the coarse aggregates thereby providing a sustainable option to deal with the plastic waste . There are many recycling plants across the world, but as plastics are recycled they lose their strength with the number of recycling. So these plastics will end up as earth fill. In this circumstance instead of recycling it repeatedly, if it is utilized to prepare aggregates for concrete, it will be a boon to the construction industry. Most of the failures in concrete structures occur due to the failure of concrete by crushing of aggregates. PCAs which have low crushing values will not be crushed as easily as the stone aggregates. These aggregates are also lighter in weight compared to stone aggregates. Since a complete substitution for NCA was not found feasible, a partial substitution with various percentage of PCA was done. Both volumetric and grade substitution was employed in this investigation.

Human hair has about 65-95% of its weight in proteins, more 32% of water, lipid pigments and other components .when dry, the hair thread may stretch 20-30% of its length; and, in contact with water, this may reach up to 50%. In contact with ammonia it becomes more elastic. Due to nano cross-section of hair and its proper tensile strength this project investigates its application to reduce the shrinkage of concrete mixtures. For this purpose, human hair fibers were used in 0.4 and 0.8 and 1.2 weight percent and the length of the fibers in each case varied between 15 and 60 millimeter and the samples were made of dimensions of 40×40×160 millimeters. Compressive strength, tensile test on beams and split tensile strength is carried out for concrete and variation in results as per variation in material is found out.

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Keywords : fibre-reinforced concrete , human hair , natural fibers, plastic coarse aggregate, , plastic waste

I. INTRODUCTION

The use of plastic is increasing day by day, although steps were taken to reduce its consumption .By using these plastic wastes in concrete will lead to sustain the concrete design and protect the environment. Development of concrete with non-conventional aggregate such as plastic bags, PET Bottles and waste LDPE were used in concrete to improve the properties of the concrete and reduce cost. The plastic aggregate are taken in various proportion such as 0%,4%,8%,12%,16%,20%and 24%also add hair in proportion of 0.2%,0.4% ,0.6%by weight of cement. By adding this proportion increase the strength of concrete after 7and 28 days of curing of concrete

II. OBJECTIVE

Our main objective to conduct this project will be to test on M20 grade of concrete carried out with conventional and varying percentages of plastic aggregate and hair.Initially trial was being conducted for 7 and 28 days to check whether proportion of materials decided is sufficient to meet our desirable results or not. The mix proportion used for testing will be 1:1:2 and varying percentage of PCA will be 4%,8%,12%,16% and 20%of weight aggregate also add hair 0.2%,0.4% of weight of cement.

III. PLASTIC COARSE AGGREGATE

Properties According to the Indian standard specifications the property of aggregates such as specific gravity, aggregate crushing value and density were determined . From Table I comparing the properties of aggregate for both NCA and PCA it is observed that the specific gravity and density for PCA is much lower than NCA which offers a light weight concrete. A lower crushing value indicates the complexity with which a PCA concrete could be crushed under compressive stresses.

Fig. 1: Plastic aggregate

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IV. CASTING AND TESTING OF SPECIMEN

The 6 concrete cubes each were prepared for 0%, 4%,8%, 12%,16% and 20% by weight of aggregate for7 days and 28 days.

Table 1 : Workability Test of Fresh Concrete

% of conventional	Water Cement Ratio (%)	Workability by Slump (mm)
0	0.40	100

4.1 Test Conducted on Hardened Concrete

In present study compression test on cube, flexural test on beams, split cylinder test, were carried out. The experimental set up for various tests are described below.

4.2 Compressive Strength Test

The test carried out on the cube specimen of dimension 150mmX 150mm X 150mm. Cast iron Moulds are used to cast the cubes having leak proof metal base plate. The joints between the moulds are thinly coated with the oil to prevent adhesion of concrete to the mould surface.

4.3 Curing:

- After molding the test specimens are stored on the site at a place free from Vibration under damp matting, sacks or other similar materials for 24+_0.5 hours from the time of the addition of water to the other ingredients.
- The temperature of the place of the storage should be within the range of 22^0c to 32 ^{0} C. After a period of 24 hours, they should be marked for later identification removed from the moulds, stored in clean potable water at a temperature of 24 ^{0} c to30^0 C until they are transported to the testing laboratory.

4.4 Testing:

After the required curing (i.e.7,28 days etc) , the specimens are tested under the compression testing machine. The load should be applied gradually till the specimens fails. The compressive Strength is given by the load at failure divided by the cross sectional area of the specimen. The testing shall be done on at least three specimens at each selected age.

4.5.5 Flexural Test on Beam

Standard beam of size 150 x 150 x 500 mm were supported symmetrically over a span of 350 mm and subjected two points loading. In flexure test, the beam specimen was placed in the machine in such a manner that the load was applied to the upper most surface as cast in the mould. All beams were tested under two point loading in Universal Testing Machine of 50 tone capacity. The load was increased until the specimen failed and the failure load was recorded.

The **centre-point flexural strength** test to determine their concrete strength (see Figure 3.6.3). Centre-point loading forces the beam to fail directly under the centre of the loading. This may or may not be the weakest point in the beam. In third point loading, the entire middle one-third of the beam is stressed uniformly and thus the beam fails at its weakest point in the middle one-third of the beam. By forcing the beam to fail at the centre, the centre-point flexural test results are somewhat higher than the third-point test results. Typically, the centre

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point results are about 15% greater. Though this relationship is not exact, it does provide a reasonable estimate of the concrete's average strength.

Center point load was applied through loading system as shown in fig. The load was applied up to failure. The flexural strength was determined by the formula,

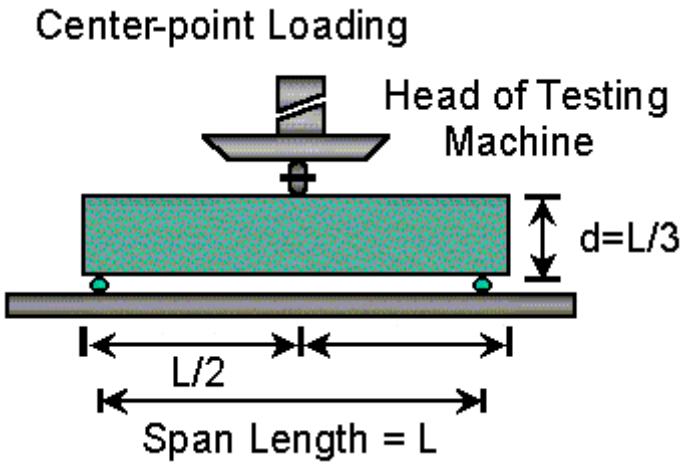

Fig. 2 Centre Point Loading Setup In Flexural Test

$$f_t = \frac{3PL}{2Bd^2}$$

Where,

f_t = Flexural strength(Mpa)

P = central point through two point Loading System (KN)

L = Span of beam (mm)

b = Width of beam (mm)

d= Depth of beam (mm)

The total number of specimen casted were 120 and same were tested for different test as discussed in article.

V. RESULTS AND DISCUSSION

5.1.1 Compressive Strength Test

Table 2: Compressive Strength Test

Sr no	PCA (%)	HAIR (%)	7DAY				28DAY			
			S-1	S-2	S-3	Mean	S-1	S-2	S-3	mean
1	0	0	21.24	20.53	20.87	20.88	29.55	29.77	29.12	29.48
2	4	0	22.50	23.03	22.66	22.73	30.67	30.85	30.79	30.77
3	8	0	18.51	22.67	21.33	20.83	27.03	26.70	26.92	26.88
4	12	0	21.96	22.34	22.61	22.30	24.19	23.57	24.03	23.93
5	16	0	17.24	16.40	16.57	16.73	23.55	24.44	24.39	24.12
6	20	0	14.58	15.12	15.01	14.90	16.00	16.88	17.00	16.62

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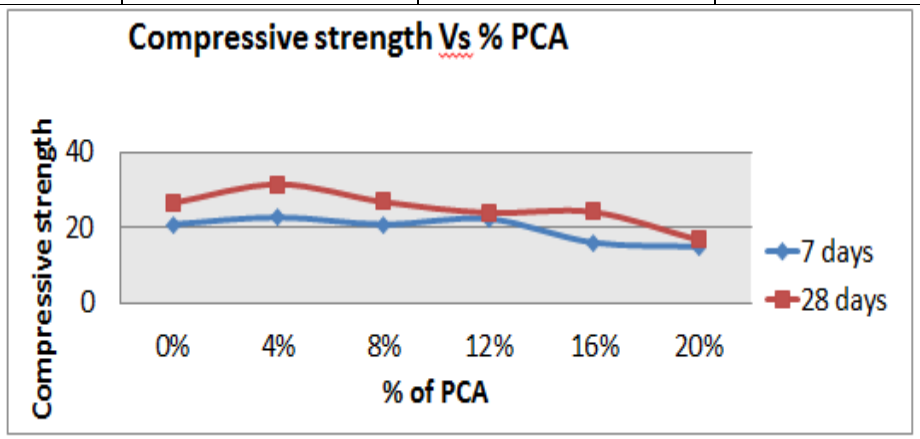
7	4	0.3	22.68	23.25	23.02	22.98	31.79	32.32	32.10	32.07
8	8	0.6	21.33	20.80	21.49	21.20	27.57	27.54	27.71	27.60
9	12	0.9	21.34	21.44	21.62	21.46	24.45	23.78	24.00	24.07
10	16	1.2	19.58	17.78	18.69	18.68	20.67	20.46	19.59	20.24
11	20	1.5	17.13	16.90	16.45	16.82	19.13	17.34	18.24	18.23

5.1.2 Compressive Strength Graph and Table

Table 3: Compressive Strength Test For PCA

SR NO.	PCA(%)	7 DAYS	28 DAYS
1	0	20.88	29.48
2	4	22.73	30.77
3	8	20.83	26.88
4	12	22.30	23.93
5	16	16.73	24.12
6	20	14.90	16.62



Graph 1: Compressive Strength Graph For PCA

5.1.3 Compressive Strength for PCA + Natural Fiber:-

Table 4: Compressive Strength For PCA + HAIR

SR NO.	PCA (%)	HAIR (%)	7 DAYS	28 DAYS
1	0	0	20.88	29.48
2	4	0.3	22.98	32.07
3	8	0.6	21.20	27.60
4	12	0.9	21.46	24.07
5	16	1.2	18.68	20.24
6	20	1.5	16.82	18.23

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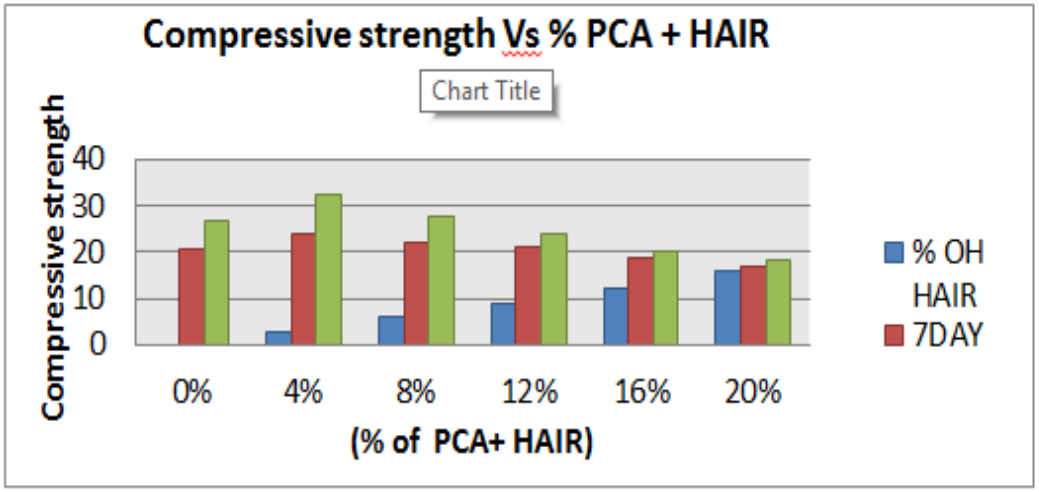

Graph 2 Compressive Strength Graph For PCA + HAIR

5.2.1 Flexural Strength Test:

Table 5: Flexural Strength Test:

SR NO	PCA (%)	HAIR (%)	7DAY				28DAY			
			S-1	S-2	S-3	MEAN	S-1	S-2	S-3	MEAN
1	0	0	19.10	16.5	16.2	16.63	18.2	19.5	21.5	19.70
2	4	0	15.20	17.90	16.80	20.85	20.50	21.30	20.00	21.50
3	8	0	20.05	21.35	20.90	21.55	23.70	22.80	23.90	23.45
4	12	0	20.30	22.25	22.10	20.76	22.30	23.40	22.90	22.86
5	16	0	20.85	21.25	20.30	20.08	20.80	20.00	19.75	20.18
6	20	0	20.40	19.85	19.65	19.67	20.45	21.00	19.30	20.25
7	4	0.3	18.30	17.85	18.70	18.28	22.10	21.30	22.05	21.81
8	8	0.6	20.95	21.45	21.30	21.23	21.55	23.70	24.80	23.35
9	12	0.9	21.30	20.30	19.90	20.50	22.20	23.40	24.50	23.36
10	16	1.2	20.90	21.05	21.85	21.26	22.35	22.90	21.90	22.38
11	20	1.5	20.40	21.20	19.90	20.50	22.20	23.25	21.20	22.21

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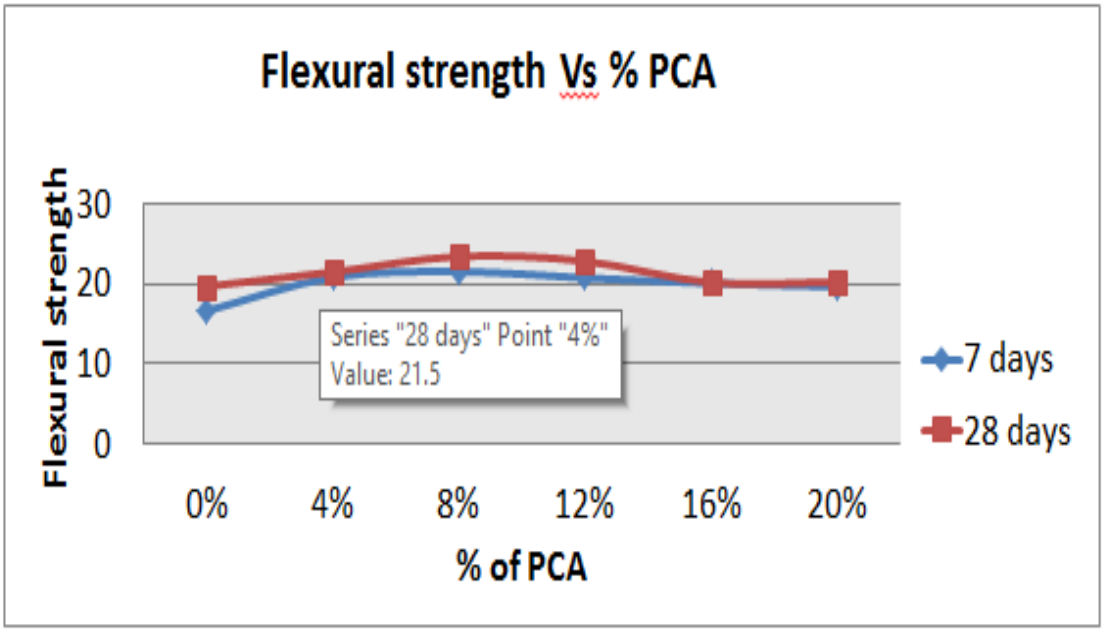
5.2.2 Flexural Strength Table and Graph for PCA:

Table 6: Flexural Strength for PCA

SR NO.	PCA(%)	7 DAYS	28 DAYS
1	0	16.63	19.70
2	4	20.85	21.50
3	8	21.55	23.45
4	12	20.76	22.86
5	16	20.08	20.18
6	20	19.67	20.25



Graph 3: Flexural Strength Graph For PCA

5.2.3 Flexural Strength Table and Graph for PCA + Natural Fiber

Table 7: Flexural Strength For PCA +HAIR

SR NO.	PCA(%)	HAIR(%)	7 DAYS	28 DAYS
1	0	0	16.63	19.73
2	4	3	18.28	21.81
3	8	6	21.23	23.35
4	12	9	20.50	23.36
5	16	12	21.26	22.38
6	20	15	20.50	22.21

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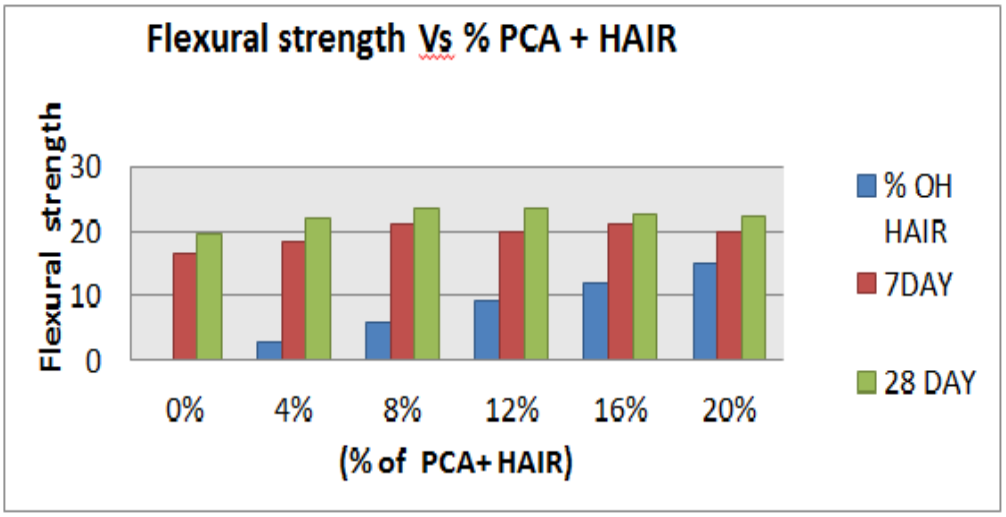

Graph No 04 Flexural Strength Graph

5.3.1 SPILT TENSILE TEST

Table 8: Spilt Tensile Test

SR NO	PCA (%)	HAIR (%)	7DAY				28DAY			
			S-1	S-2	S-3	MEAN	S-1	S-2	S-3	MEAN
1	0	0	0.49	0.52	0.51	0.50	0.63	0.65	0.64	0.64
2	4	0	0.50	0.54	0.52	0.52	0.66	0.67	0.66	0.66
3	8	0	0.51	0.55	0.54	0.53	0.87	0.82	0.85	0.84
4	12	0	0.62	0.60	0.55	0.59	0.74	0.71	0.72	0.72
5	16	0	0.57	0.59	0.53	0.56	0.66	0.71	0.71	0.69
6	20	0	0.50	0.48	0.51	0.49	0.68	0.66	0.69	0.67
7	4	3	0.62	0.60	0.61	0.61	0.92	0.85	0.83	0.86
8	8	6	0.55	0.53	0.54	0.54	0.76	0.87	0.83	0.82
9	12	9	0.53	0.55	0.52	0.53	0.71	0.69	0.78	0.72
10	16	12	0.50	0.55	0.52	0.52	0.67	0.66	0.66	0.66
11	20	15	0.47	0.53	0.50	0.50	0.62	0.61	0.60	0.61

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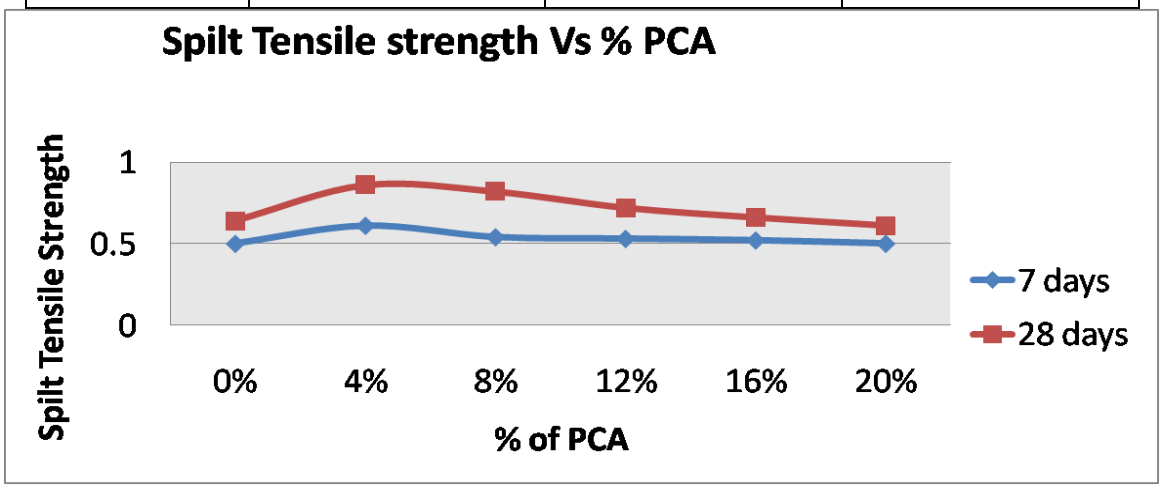
5.3.2 Spilt Tensile Table for PCA:

Table 9: Spilt Tensile Test for PCA

SR NO.	PCA(%)	7 DAYS	28 DAYS
1	0	0.50	0.64
2	4	0.52	0.66
3	8	0.53	0.84
4	12	0.59	0.72
5	16	0.56	0.69
6	20	0.49	0.67



Graph No 05 Spilt Tensile Test for PCA

5.3.3 SPILT TENSILE TABLE FOR PCA + Natural Fiber

Table 10: Spilt Tensile Test for PCA+ HAIR

SR NO.	HAIR(%)	PCA(%)	7 DAYS	28 DAYS
1	0	0	0.50	0.64
2	3	4	0.61	0.86
3	6	8	0.54	0.82
4	9	12	0.53	0.72
5	12	16	0.52	0.66
6	15	20	0.50	0.61

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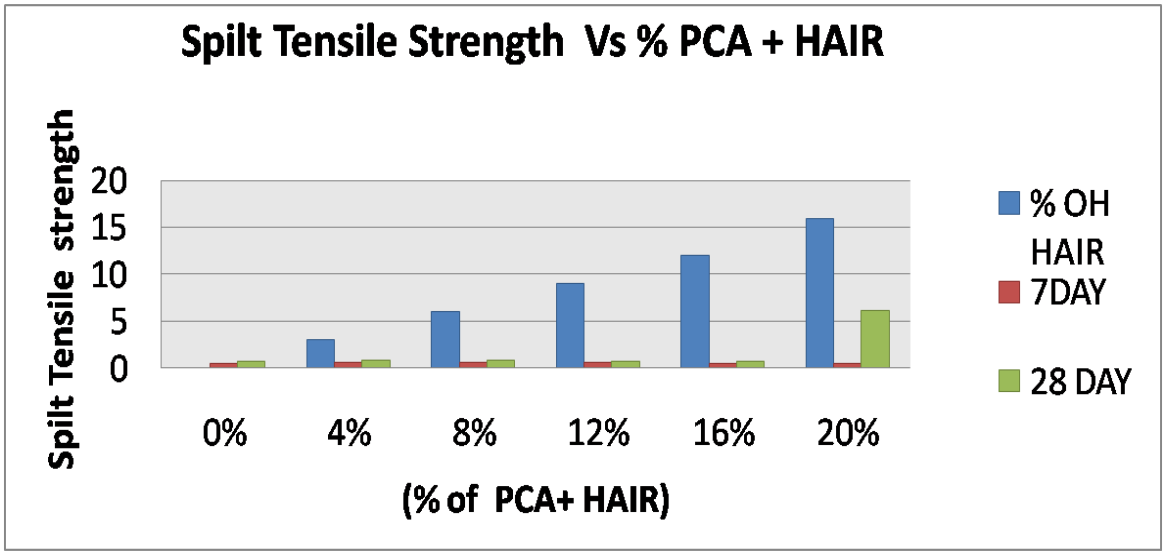

Graph No 06 Spilt Tensile Test for PCA+HAIR

5.4 Costing of materials: (for unit quantity)

Table 11: Material rate per unit quantity

Sr. no.	**Material**	**Rate in Rs.**	**Per**
1	Cement	270	Bag
2	Aggregate	1300	m^3
3	Sand	800	m^3
4	PCA	17	Kg
5	Natural Fiber (hair)	200	Kg

5.5 Rate analysis for PCC (with and without natural fiber for 1 m^3 quantity):

Table 12: Rate analysis

Sr. No.	**PCA %**	**Hair %**	**Amount in Rs.**
1	0	0	4670
2	4	0	4682.16
3	8	0	4693.76
4	12	0	4707
5	16	0	4718
6	20	0	4730.04
7	4	0.3	4820.16
8	8	0.6	4960.76
9	12	0.9	5111.05
10	16	0.12	5255

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