Experimental Investigation on Variation in Compressive Strength & Mechanical Properties of Composite Concrete - A Review

Mr. R.S. Chaudhari[1], Dr.P.P.Bhangale[2]
[1]*Assistant Professor, PCCOE, Nigdi, Pune*
[2]*HOD, Civil Engineering Department, SSGB COE&T, Bhusawal*

***Abstract*- The fiber reinforced concrete is one of the important topics as it is a means to replace conventional concrete ingredients by considering new ideas and materials. In the first attempt, we tried to replace the cement by some percentage of human hairs & coarse aggregate by Polypropylene (PP). The length of the human hair used in this experiment varied from 3 cm to 6 cm and the first class polypropylene were used. The idea behind this selection is to use such a material which is harmful to the nature and also non degradable. The various combinations of percentages used in this study are 1) 4%hair +0%PP 2) 4%hair +1%PP 3) 4%hair +2%PP 4) 4%hair +3%PP. For testing all those proportions, M-25 grade Concrete was considerded as a base concrete. The compressive strength of the specimens were tested & it was observed that the Compressive strength of the composite concrete was maximum at combination 4%hair +2%PP and then it started reducing.Total 60 specimens were casted for this work. In the second experiment, the effect of bentonite, sugarcane molasses, jaggery and polyvinyl acetate on strength properties of concrete was studied. The experimentation has been carried out to assess the strength properties of concrete using these materials in concrete composition. Based on the literature, the main reason of usage of these materials is due to the binding property possessed by them. Three different percentages of polyvinyl acetate were chosen in the experimentation as 0.1%, 0.2% and 0.3% respectively and keeping proportion of bentonite, sugarcane molasses and jaggery constant at 30%, 0.1% and 0.1% respectively by weight of cement. Cement was only replaced bentonite. Sugarcane molasses, jaggery and polyvinyl acetate were only added without replacing cement. However, the values of strength observed were at lower side initially, later gain in strength was observed. At 0.2% PVA composite proportion maximum strength was observed. The test results show some marginal strength variation at all proportions. For this experimentation total 30 cubes and 30 cylinders were tested.**

***Index Terms*-Binders, Compressive strength, Human hairs, PP, Tensile strength**

I. INTRODUCTION

Human hairs and pure Polypropylene fiber were mixed in various proportions in the M-25 grade concrete. Some percentage of cement was replaced by the weight of hair. The specimens were casted for the various proportions and were tested after 7 and 28 days. The results obtained were compared with the conventional M-25 grade Concrete. Some other materials can be substituted in concrete without hampering the strength and durability of the concrete like, Bentonite was found to be useful because of its blending ability and having some properties similar to cement. In addition to this, bentonite is a naturally occurring material recovered from the precipitates of volcanic eruptions so it does not emit any greenhouse gases and is environment friendly. On the other hand sugarcane molasses and jaggery tend to make significant variation in the strength of concrete even in very small percentages. Polyvinyl acetate isn't a naturally occurring adhesive and no records of its usage in concrete have been found so the effect of addition of polyvinyl acetate in concrete is to be observed.The details of the strength obtained are discussed in this paper.

II. THE MIX DESIGN

The details of mix design & material used in the experiments are discussed as under,

The mix design for M25 grade concrete is calculated Using IS 456:2000, IS 10262:2009 etc

Quantity of materials for Composite concrete for experiment no 1 is given in the following table.

Proportions	4%+ 0%	4%+1%	4%+ 2%	4%+3%
Water (Kg)	4.218	4.218	4.218	4.218
Cement (Kg)	8.998	8.998	8.998	8.998
FA (Kg)	12.878	12.878	12.878	12.878
CA (Kg)	25.848	25.589	25.331	25.072

Table No. 1 Quantity of materials for various praportion for Experiment No 1(4% replacement of cement & 0%of PP)

Testing:-

The curing was started after 24 hours of casting the specimen for a period of 7 to 28 days. The specimens were subjected to compression, split tensile and flexural test under universal testing machine and flexural testing machine respectively.

III.MATERIALS USED AS FIBRE

Following are the materials used in the conventional concrete for the both the experiments.

Experiment No 1	
Polypropylene	
Human Hair	
Experiment No 2	
Bentonite	
Jaggery	
Sugarcane Molasses	
Polyvinyl acetate	

Table No 2 Materials used for casting the composite concrete.

IV. MATERIAL USED AS A BINDER

*Bentonite***:-**Bentonite possesses an ability to absorb moisture when it is wet and expands as much as several times its dry mass. This property of expanding makes it useful as a sealant and as low permeability barriers. The ionic surface of bentonite has a useful property in makin:g a sticky coating resulting in strong binding

*Jaggery:-*The jaggery contains approximately 60-85% sucrose, 5-15% glucose and fructose.Along with 0.4% of protein, 0.1 g of fatand 0.6 to 1.0g of minerals (8 mg of calcium, 4 mg of phosphorus and 11.4 mg of iron). It is also found to contain traces of vitamins and aminoacids. Hydrolysis breaks the glycosidic bond converting sucrose into glucose and fructose. This conversion imparts adhesion i.e. interlocking capability which is predominantly dependent on the viscosity and ion exchange property. According to literature, jaggery was used as a building material in addition with cement for joining bricks.

*Sugarcane Molasses:-*Molasses is a by-product obtained from the sugar refining process. Molasses can also be obtained from the paper industries. India and Brazil are the largest sugarcane cultivating countries. Molasses is thick syrup with around 40-50% of total reducing sugar, rich in minerals like potassium, calcium, iron etc. There is about 4% yield of molasses for every ton of sugarcane processed. In construction industry, molasses can be used as a minor component of mortar for brickwork and as a binder.

*Polyvinyl acetate:-*Polyvinyl acetate (PVA) is a synthetic glue. It is made by polymerisation of vinyl acetate monomer. It is used in binding due to its strong flexible bond and alkaline nature. Its alkalinity makes it suitable for usage in concrete as it won't corrode the reinforcement.

V. RESULTS OBTAINED

Following table and graphs shows the effect on compressive strength, splint tensile strength & flextural strength in the composite concrete

Experiment No 1-

Conventional concrete (MPa)	4%+ 0%	4%+1%	4%+ 2%	4%+3%
17.09	17.99	18.95	20.03	19.25

Table No 3 Compressive strength at the 7 days.

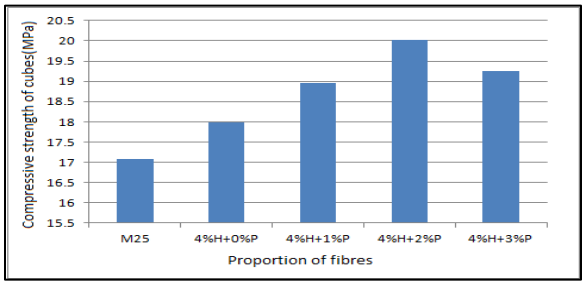

Fig No. 1 Compressive strength after 7 days.

Conventional concrete (MPa)	4%+ 0%	4%+1%	4%+ 2%	4%+3%
33.80	33.02	33.92	34.86	32.97

Table No 4 Compressive strength at the 28 days.

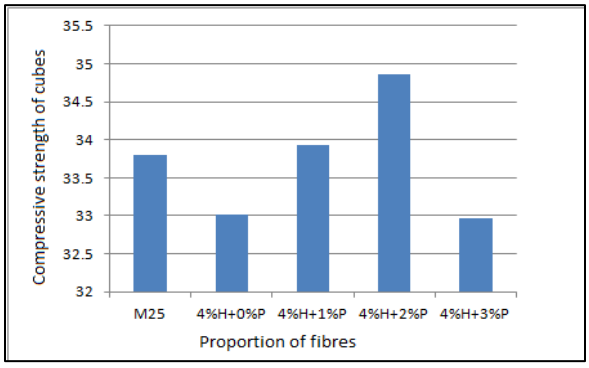

Fig No. 2:- Compressive strength after 28 days

Conventional concrete (MPa)	4%+ 0%	4%+1%	4%+ 2%	4%+3%
2.88	2.85	2.89	3.30	2.75

Table No 5 Split Tensile strength after 7 days.

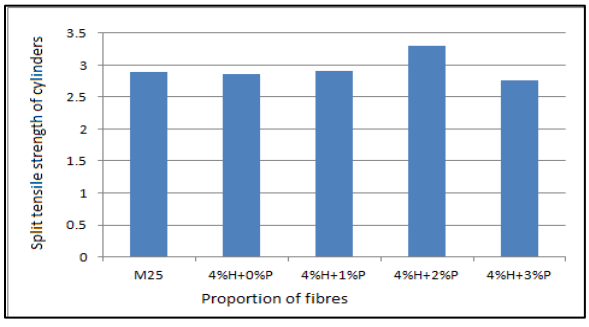

Fig No. 3:- split Tensile strength after 7 days.

Conventional concrete (MPa)	4%+ 0%	4%+1%	4%+ 2%	4%+3%
4.00	3.75	4.08	4.58	3.50

Table No 6 Split Tensile strength after 28 days

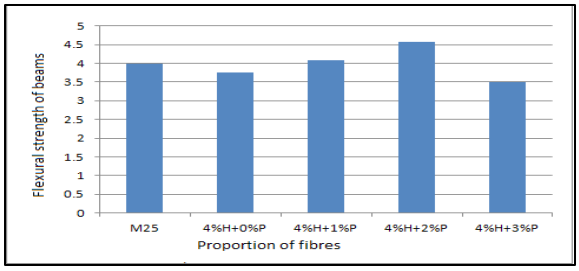

Fig No. 4 Split Tensile strength after 28 days

Experiment No 2-

Following table No 7 shows variation in compressive strength & tensile strength when binders are used in concrete for various proportions.

Type of Concrete	Compressive Strength (MPa)	
	7 days	28 days
Base[30%Be(Replacement)+0.1%J+0.1%SM]	12.26	20.30
Conventional (M20)	15.18	24.65
0.1%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.1% PVA]	11.59	18.89
0.2%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.2% PVA]	12.31	21.49
0.3%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.3% PVA]	11.02	18.89

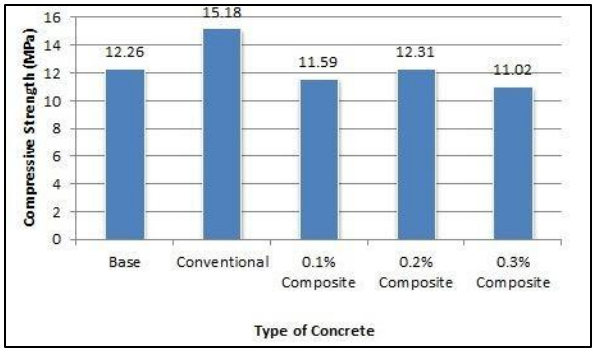

Fig No 5. Variation in compressive strength (7 days)

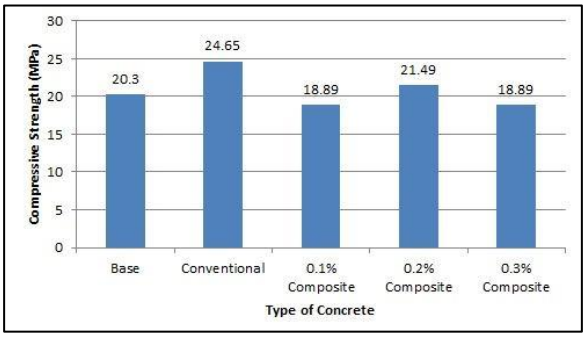

Fig No 6. Variation in compressive strength (28 days)

Following Table No 8 shows the split tensile strength of concrete.

Type of Concrete	Split Tensile Strength (MPa)	
	7 days	28 days
Base[30%Be(Replacement)+0.1%J+0.1%SM]	1.34	1.60
Conventional (M20)	1.53	2.48
0.1%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.1% PVA]	1.26	1.29
0.2%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.2% PVA]	1.03	1.33
0.3%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.3% PVA]	1.00	1.10

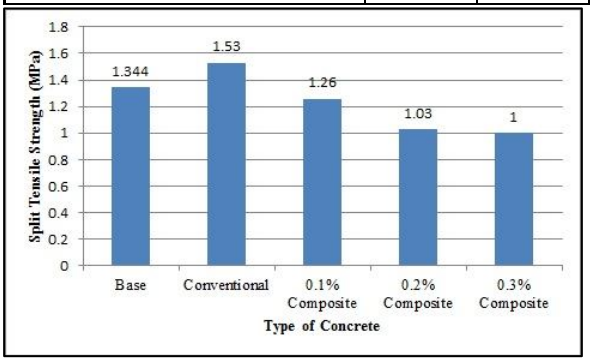

Fig No 7. Split Tensile Strength (7 days)

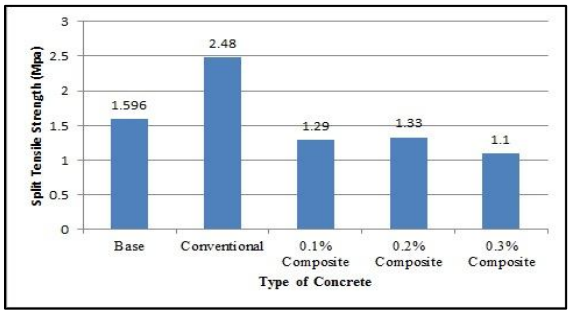

Fig No 8. Split Tensile Strength (28 days)

Images during testing,

Item	Image
Concrete Cube	
Concrete Cylinder	
Concrete beam	

Table No 9 Testing of cube, cylinder & beam.

VI. CONCLUSION & FINDINGS

Following points are concluded for the experiment no 1 which is based on the addition of PP & Human hairs in the conventional concrete,

1.The maximum strength of conventional concrete cubes for 7 days and 28 days were 17.09 MPa and 33.80 MPa respectively, whereas the maximum strength of composite concrete were found at the combination of 4% hair and 2% P.P fibre and the corresponding strength were 20.03 MPa and 34.86 MPa respectively. Hence the maximum increase is found to be 17.21% and 3.11% respectively.

2.The maximum strength of conventional cylinders for 28 days were found to be 2.88 MPa,whereas for the above mentioned combination of fibers it was found to be 3.30MPa hence giving an increase of 14.62% increase.

3. The maximum strength of conventional beams for 28 days were found to be 4 MPa , whereas for the above mentioned combination of fibres it is obtained as 4.58 MPa hence giving an increase of 14.58%.

Following points are concluded based experiment no 2 which is based on the addition of various binders in the conventional concrete,

- Workability of composite concrete was less than conventional concrete.

- Setting time of composite concrete was more than conventional concrete.
- This type of composite mixture can be useful in reducing early setting of cement in hot weather concreting.
- Segregation and bleeding of composite concrete was very less due to admixtures.

Finally it is observed that the compressive strength, tensile strength & flexural strength is increased upto a certain limit and the decreases.

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