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Experimental Study on Mechanical Properties of Concrete by Addition of Polyethylene Terephthalate (PET) Fiber Coated with Bagasse Ash

Rahul Chopra[1], Sameer Malhotra[2]

[1]Research Scholar. Civil Engineering Department & GVIET Banur Pb
[2]Head of Department, Civil Engineering Department & GVIET Banur Pb

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Abstract - *The main reason behind carrying out this research was to check the strength of concrete when introduced with Baggase Ash coated PET (Polyethylene Terephthalate) fiber of concrete and to verify the increase in bonding strength of concrete. Therefore, this will reduce the plastic waste in environment and in turn it will decrease the hazardous effects into Eco friendly system. The study was made on M40 grade design. The objective of the study was to check the mechanical properties, using coated fiber percentages compared with the conventional concrete, hence determined the compressive strength, and spilt tensile strength and Flexural strength of concrete. This investigation as carried out by using several tests, which include Compressive strength, spilt tensile strength and Flexural strength. The Baggase Ash coated PET fibers were replaced with weight of cement in different percentages that is 0.5%, 1%, 1.5% and 2%. Fibers were coated with Bagasse Ash. Bagasse Ash is a waste product of Sugarcane miles. Bagasse Ash usually increases the bonding strength in concrete. The 15 % to 20 % quantity of bagasse ash was partially replaced with cement, this process ultimately increase the strength of specimen from 10% to 20%. Bagasse Ash reduces the demand of cement.*

Key Words: PET Fiber, Bagasse ash, Epoxy binder, Compressive strength, spilt tensile strength, Flexural strength.

1. INTRODUCTION

In the present era, the construction activities are increasing day by day. The main constituent used in the production of concrete is cement. Production of cement releases a lot of CO_2 as a potent gas. After that, during preparation of concrete again greenhouse gases are released which lead to increase in the temperature. In this study a research is being conducted to replace the cement with plastic waste in different percentages to cut back the impact on environment. The use of replacement of cement with fiber gives identical strength in concrete. Then simply use the plastic fibers in concrete. The replacement of cement with PET fiber is cut back the price and save the money.

The plastic waste is another massive drawback to dispose. The plastic demand in market are going to be high and disposing of land isn't on the market thus reprocess or recycle the plastic waste .the maximum plastic waste is use in construction and dispose .

The polythene (PET) waste bottles are might simply be acquired from the atmosphere with virtually no value is chopped and additional into standard concrete to look at the strength behaviour of assorted specimens.

The plastic wastes the foremost common wastes is resin polythene terphthalate (PET) that obtained in various abundance from plastic bottles used as containers of sentimental drinks and water. The event of recent construction materials exploitation Recycled PET fibres is important to every the development &PET exercise industries. PET bottles fibres into the concrete it provides with high plasticity and high strength but reduce the workability as a results of PET fibres has really weak bond with cement paste .So for exploitation this fibres we wish to use a chemical admixture form of a brilliant softener that improve the workability of concrete. The compressive characteristics of concrete is full of including of plastic bottles fibres and by addition of 1.5% of plastic in concrete enhances and causes concerning Sixteen temperament issue form increase in strength 28 days activity.

As plastic itself is bio-degradable and its increase in use is creating a major problem that is availability of very less area of disposal. With various waste production fractions, because of the high amount by-product plastic waste earns special attention on account of non-biodegradable character generating a lot of problems in the environment. While only India annually produce approximately 40 million tons of solid waste, and this rate is increasing at (1.5 to 2) % annually. The total amount as indicated above only 12.3 % is generating from waste water bottles. The plastic waste bottles must not be disposed of by dumping or burning, as they produce unrestrained fire or contaminate to the soil and vegetation.

Bagasse ah is a material which is left out after burning sugarcane bagasse, which is already creating problems in disposal. In the present study epoxy binder was used for coating of PET fiber. The ash was passed through the sieve size 15o micron. The baggase ash shows improve in binding properties of concrete. The 15 to 20 % of bagasse ash partial replacement with cement they increase the strength 10 to 20 %. Bagasse ash reduces demand of cement.

1.2 PET Fiber

Polyethalate Terephthalate (PET) bottles are mostly use in soft drink and mineral water .the demand of these bottles is increase these days and they mostly increase the plastic waste in environment. These bottles can be reused in terms of PET fiber as replacement of cement .hence the reducing the cost of construction and reduce the plastic waste. The use of coated PET fiber in concrete improve the strength of concrete and improve the bonding strength .they reduce the crack in concrete.

In present conditions concrete conquered and used most broadly as a construction material due its high hardened characteristics low cost and long life serviceability but the only big issue with concrete is less tensile strength characteristics. To improve the tensile characteristics of concrete an addition of fiber will enhance theses characteristic. Various research studied are conducted that are used fiber in the concrete. By using waste water bottles into control concrete improves tensile characteristics and also help to improve ductility but the properties of fresh concrete such as workability will be reduce. To enhance the workability we will use super plasticizer chemical admixture in the concrete.\

Figure 1 *PET Fibres size 50mm*2mm*

1.3 Bagasse Ash

Sugarcane pulp ash could be a by-product of sugar industrial unit found once fiery sugarcane pulp that found once the drawing out of total economical sugar as of sugarcane. The dumping of this material is already a big challenge, inflicting environmental issues round the sugar factories. On the opposite hand, the boost in construction activities within the country created shortage in most of concrete creating materials particularly cement, leading to a rise in worth.

Sugarcane is almost amongst the main crops developed up in over one hundred ten countries the total production rate is approximately about 1500 million tons. In India solely, sugarcane manufacturing is over three hundred million tons/year, which cause regarding ten million heaps of sugarcane pulp ash as associate un-utilized waste. Once the removal of all efficient sugar as of sugarcane, regarding (40-46) % fibrous residue is acquired, that is recycled within the same trade as fuel in boilers for warmth generation leaving eight-10 sea ash as waste, called sugarcane pulp ash (SCBA).

Fig 4 *Bagasse Ash*

1.4 Methodology

The flow chart of work done project illustrated in Figure 5.

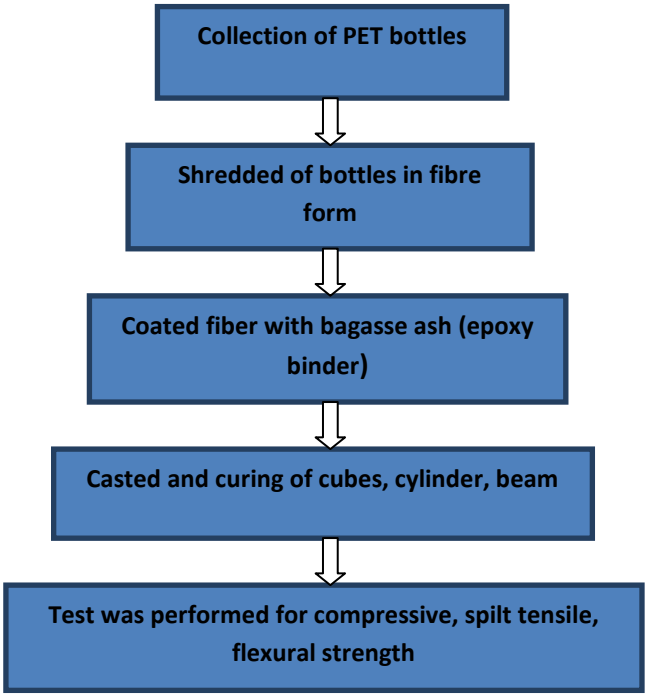

Fig. 6 *Methodology of the project work*

2. EXPERIMENTAL PROGRAM

2.1 Material

2.1.1 Cement

Ordinary Portland cement (OPC) of ACC (Associated Cement Companies) 43 Grade from a same lot was used for the study. Cement was carefully stored to prevent it from moisture. In table 1 the physical properties of the cement are given below.

Table 1 Physical and chemical Properties of Cement

Physical Properties	
Fineness (90 μ sieve)	5 %
Specific gravity	3.15
Soundness	1 mm
Standard consistency	29 %

2.1.2 Fine Aggregates

River sand taken from local quarry conforming to IS 383:1970. Table 2 shown Physical properties of F.A.

Table 2 Physical properties of Fine Aggregate

Formula	$(C_{10}H_8O_4)_n$
Density	1.38 g/mm^3
Molar mass	Vary according to structure
Melting point	Generally less than 260^{0}C but may range between 254^{0}C to 256^{0}C
Boiling point	350^{0}C
Solubility in water	Practically insoluble
Refractive Index	1.56

Table 3 Chemical properties of PET

Characteristics	Result obtained
Fineness modulus	2.74
Specific gravity	2.65
Bulk density (Kg/m3)	1675

2.1.3 Coarse Aggregate

In surrounding locally available crushed stone aggregate was used for the concrete mixes. Homogenous aggregates or aggregates from same quarry were used. The aggregates which pass though the 20 micron sieve and retained on 10 micron sieve were used in the casting of samples. Maximum size of coarse aggregates 20mm and Minimum size 10mm.

2.1.4 Super plasticizer

Conplast SP430 (G) as a super plasticizer.ConplastSP430G8 is based on Sulphonated Naphthalene Polymers and is supplied as a brown liquid instantly dispersible in water.

Specially formulated SP430G8 was formulated to reduce water up to 25% without compromising workability and reduced permeability.

2.1.5 Water

Portable water used for all the mixes from domestic water (Tap water) supplied in the concrete laboratory by the institute. The water was clean and free from oil, acids, alkalis, salts and alternative substances harmful to concrete. Same water was used for curing additionally.

2.1.6 PET Fibe

Plastic waste bottles fiber use in these study .the fibres is manually cut in size of 50mm*2mm and plastic fibres coated with bagasse ash with help of Epoxy Binders. The ratio of coated fiber is 1:1.5. After the coating fibres dry 1 to 2 days.

Figure 7 *Bagasse Ash Coated Fiber*

2.1.7 Bagasse Ash

The bagasse ash is use near sugar mills Morinda Road Punjab Mohali. Colour of ash is Blackish and Specific Gravity is -1.13g/cc.

Table 4 chemical composition of Bagasse Ash

S.No.	Compound of Bagasse Ash	Mass
1	Sculpture Tri Oxide(SO_3)	0.56
2	Loss of Ignition	0.75
3	Magnesium Oxide(Mg)	0.82
4	Calcium Oxide(Cano)	1.952
5	Alumina oxide (AI203)+Iron Oxide(Fe_2O_3)	29.181
6	Silica dioxide(SiO_2)	66.89

2.1.8 Epoxy Adhesive

Epoxy adhesive of Copy brand was used to coat Bagasse Ash on PET fibers. The ratio of mixing was fixed at 1:1.5.

2.2 Mix proportion of plastic fibres

The material requirement was calculated by taking different percentages of PET fiber (0.5, 1, 1.5 and 2) % as replacement of cement.

Cubes, Beams, and Cylinder were casted for the ratio mentioned in table 7 these sample was then kept for curing for 14 and 28 days. Total 90 number of sample ware casted. Each specimen were casted a three sample and vibration or compaction done after the casting. The specimen was removed from mould after 24 hours of casting. These samples were then kept for curing for 14 and 28 days. After 14 and 28 days test for compressive strength, spilt tensile strength, flexural strength. The specimen ware tested in compressive testing machine and flexural testing machine. After testing each sample was calculated average value.

2.3 Experimental Plan

In this project studies the Bagasse Ash coated fiber with replacement of OPC 43 grade Cement. The replacement percent by weight of cement content derived from the mix proportioned shown in Table 5.

2.3.1 Mixing

Collected the raw material near campus and manual mixing of coated fibers into concrete. Concrete mix prepare a percentage of (0.5, 1, 1.5, and 2) % coated fiber replacement with weight of cement.

Figure 8 *Preparation of concrete mix with Bagasse Ash coated PET fiber*

3.4 Experiment procedure

3.4.1 Compressive Strength

Cubes specimen forecasting for 150*150*150. Each specimen has casted a three sample for testing and total of 30 sample were casted. After testing calculated the average value of specimens. Compressive Strength find out in Compressive Testing Machine after curing period of 14 and 28 days. Cubes were dry 30 to 60 mint after curing.

Compressive Strength Calculated by
Compressive strength = P/A N/mm^2
P = load on specimen
A = Area of cubes mm^2

The testing were done in compressive testing machine and result are shown in Table 6 Compressive strength of using coated fiber were compare with conventional concrete and calculated.

Table 6 Result of tested cubes specimen of 14 days cubes

Compressive strength of 14 days cube N/mm^2				
Fiber %	S_1	S_2	S_3	strength (N/mm^2)
0	36.82	33.36	36.61	35.60
0.5	35	37.82	36.86	36.56
1	41.69	39.23	36.77	39.23
1.5	41.87	43.79	37.62	41.09
2	39.59	39.31	43.83	40.91

When the compressive strength is compare with conventional concrete the strength is almost increase the table 6 shown the increase percentages of compressive strength. Compressive strength is maximum increase 1.5 % and 2 % replacement of coated fiber. But the maximum strength found in 1.5 % replacement of fiber. The compressive strength is 13.36 % increase as compression with the conventional concrete for 14 days of cubes.

Table 7 Result of tested cubes specimen of 28 days cubes

Compressive Strength of Concrete 28 days N/mm^2				
Fiber %	S_1	S_2	S_3	Strength (N/mm^2)
0	40.57	46.38	42.75	43.23
0.5	44.36	43.02	45.98	44.45
1	47.19	50.45	48.67	48.77
1.5	51.89	48.63	50.26	50.26
2	48.45	50.28	49.36	49.36

Table 7 shown the compressive strength of 28 days cubes after curing. Testing were done in compressive testing machine. Compressive strength is increase replacement of coated fiber with weight of cement. Coated fiber increase the bonding between the concrete mixes and reduces the cracks. When compressive strength of 28 days compare with conventional concrete compressive strength is increase 13.99 to 12.42 %.

3.4.2 Spilt Tensile strength

Spilt tensile strength calculated in compressive strength machine .Total 30 number sample of cylinder specimen casted for testing. Each specimen casted a three sample .after the testing average value of specimen size of cylinder specimen 300*150 mm. Spilt tensile strength calculated by:

Spilt tensile strength = 2PL/3.14LD (N/mm^2)
Now,
P = Load on specimen N/mm^2
L = Length of cylinder (300mm)
D = Diameter of cylinder (150mm)

Spilt tensile strength of 14 days calculated in Table 8. Table shown the sample (S_1, S2, S3 are sample of specimen) and calculated average value of given specimen.

Table 8 Result of tested cylinder specimen 14 days

Spilt tensile strength of 14 days (N/mm^2)				
Fiber %	**S_1**	**S_2**	**S3**	**Strength (N/mm^2)**
0	4.59	4.36	3.78	4.24
0.5	4.54	4.43	4.32	4.43
1	4.75	4.62	4.5	4.62
1.5	5.07	4.94	4.18	4.73
2	4.80	4.70	4.89	4.80

Spilt Tensile strength is calculated in Compressive Machine. Result of Spilt tensile strength of 14 days shown in table 8. Spilt tensile strength is maximum 1.5 % replacement of coated fiber and after the 2 % percentages replacement of coated fiber strength is decrease. Spilt tensile Strength of cylinder specimen for 28 days is shown in the Table 9.

Table 9 Spilt tensile strength of cylinder for 28 days

Compressive Strength of Concrete 28 days N/mm^2				
Fiber %	**S_1**	**S_2**	**S_3**	**Strength (N/mm^2)**
0	40.57	46.38	42.75	43.23
0.5	44.36	43.02	45.98	44.45
1	47.19	50.45	48.67	48.77
1.5	51.89	48.63	50.26	50.26
2	48.45	50.28	49.36	49.36

3.4.3 Flexural Strength

Flexural strength calculated in flexural texting machine. Total 30 specimens were casted for the testing. Each sample have casted a three sample .after testing average value calculated .the beam specimen is 500*100*100.
The flexural strength is calculated by:
The flexural strength when a >13.3 cm for 10 cm beam,
Fib (flexural strength) =Pa/bd2 N/mm2
The flexural strength when a < 13.3cm for 10 cm beam,
Fib= 3Pa/bd2

Where,
b = measured width of beam in cm
d = measured depth in cm of the beam at the point of failure.
a = distance of the crack from the nearer support in beam)
P= maximum load in Kg applied to the beam
Flexural strength is calculated in Flexural testing machine. Flexural strength of 14 and 28 days shown in tables 10 and 11. Flexural strength is increase with replacement of coated fiber. Flexural strength is 23.90 % increase compare with conventional concrete. Maximum strength is increase in 1.5 % replacement of coated fiber.

Flexural Strength of Concrete for 14 days N/mm²				
Fiber %	S_1	S_2	S_3	strength (N/mm²)
0	3.58	4.28	4.13	4.0
0.5	4.24	4.26	4.72	4.41
1	4.63	4.66	5.16	4.82
1.5	5.62	5.43	5.25	5.43
2	5.23	5.40	5.05	5.23

Table 10 *Flexural strength of specimen 14 days*

Table 11 Flexural strength of concrete for 28 days

Flexural Strength of Concrete for 28 days N/mm²				
Fiber %	S_1	S_2	S_3	Strength (N/mm²)
0	5.70	5.19	5.72	5.54
0.5	6.40	6.77	5.69	6.29
1	6.87	6.64	7.10	6.87
1.5	7.11	7.20	7.52	7.28
2	7.07	7.31	6.84	7.07

3. CONCLUSIONS

The following conclusion can be drawn from this research study:

1. When Bagasse ash coated PET fibres concrete was compared with the conventional concrete in terms of compressive strength, spilt tensile strength, and flexural strength of M40 grade for 14 and 28 days, it was observed that above properties of concrete were found more than conventional concrete.
2. An increase of 13.99 % was found in compressive strength after 28 days test results.
3. An increase of 16.51 % was found in spilt tensile strength after 28 days test results.
4. An increase of 23.90 % was found in flexural strength after 28 days test results
5. From the experimental investigation it has been found that the most optimum percentage of use of coated PET fiber replacement with cement is 1.5%.
6. The use of Bagasse Ash coated PET fibres increase the properties such as compressive strength, spilt tensile strength, Flexural strength in concrete and plastic waste can be used in the concrete .This will help in reducing the plastic waste and save the environment.
7. PET fibres are produce from waste plastic which is cheaply available and thus reduce cost of construction and reduce the emission of CO_2.

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