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EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE USING PLASTICS AS FIBER (PP) AND PARTIAL REPLACEMENT OF FINE AGGREGATE (PET)

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Abstract. Worldwide the research is currently being conducted concerning the use of Fiber and PET in the area of strengthening of the reinforced concrete members. The PET bottles are the remaining from the storage of cold beverages or drinks or even water. On the other side ultra high strength with high performance becomes the need of the hour in order to make the structure durable, sensitive to the environment and even economical sometimes. Composite material has been developing these days to satisfy the construction industry by producing concrete which are more flexible and durable. Disposing plastics in any form is the big challenge to the producers and users of plastic. Producing eco friendly plastics have not reach its height in today's scenario. Here is an attempt to dispose the same effectively by incorporating it in to the concrete as effective component. Crushed PET bottles has find its way in concrete when replaced for fine and coarse aggregates by its improvised strength. PET bottles ad fine aggregate and polypropylene fiber to enhance the tensile property of concrete has been made a try with M35 grade concrete in order to make it effective light weight and efficient concrete. The mechanical properties has been assessed and the performance of the concrete has been evaluated in this study.

Keywords: PET (Polyethylene Terephthalate) , Polypropylene fibers, Fine aggregate, Durable, Flexible replacement, Compressive strength, Split tensile strength, Flexural strength.

INTRODUCTION

Any plastic irrespective of its kind would take several years commonly (20-30 years) for decomposition. Many attempts have been made and under research for finding effective methods of disposal of plastics. Polymers like Polypropylene and Polyethylene terephthalate are the commonly used for manufacturing plastic products. Production of plastics being uncontrolled in today's era even after banning its usage, there is a need to find the effective disposal method.

One effective method identified is the usage of waste plastic in construction materials.Hence,is an attempt to replace the construction materials like fine aggregates by means of waste plastics especially the available abundant plastics like Polypropylene and Polyethylene terephthalate.

The main objectives of the project are

- To investigate the material properties constituted in concrete,
- To study the strength parameters of concrete using plastic wastes and fibers.
- To identify the optimum content of the plastic waste (PET) along with fiber (PP) to be added to concrete.

INGREDIENTS

Cement : Ordinary Portland Cement 53 grade (OPC)

Fine aggregate : M sand, Polyethylene Terephthalate (Recycled Plastic)

Coarse aggregate : Gravel or crushed stone

Fiber : Polypropylene Fiber (Aspect ratio 200)

Water : Ordinary potable water.

Admixture : Silica Fume

Polypropylene Fibres

Polypropylene fibers are the synthetic fiber which is from the by-product of petroleum, and for use in concrete and mortar to overcome shortcomings of concrete.

FIGURE 1 Polypropylene Fiber

Table 1 Water Absorption of Ingredients

Material	Water absorption in % after 24hrs
Polypropylene fibers	0.3
Polyethylene terephthalate	0.1
Fine Aggregate	1.2
Coarse Aggregate	1.38

Table 2 Properties of Polyethylene Terephthalate

Properties	Values
Density (gm/cm^3)	1.3 - 1.4
Coefficient of thermal expansion (x10^{-6}K-1)	20 - 80
Lower limit of working temperature (°C)	-40 to -60
Upper limit of working temperature (°C)	115 - 170

Table 3 Physical Characteristics of Polypropylene Fiber

Property	Value
Length (mm)	12
Diameter (mm)	0.034
Youngs Modulus (MPa)	2800
Melting point (C^0)	160
Burning point (C^0)	590

RESULTS AND DISCUSSION

Compressive Strength

For compressive strength, 15cm x 15cm x 15cm cubes has been tested. The cubes tested has been cured for 28 days in ordinary potable water under normal room temperature. For trail mix combination, three cubes were tested at the age of 28 days of curing using compression testing machine as shown in Figure 2 and the test results are shown in Tables 4 & 5.

FIGURE 2 Compressive Strength Test Setup

Table 4 Results of PET & Fiber Concrete under Compression

Mix Designation	Load (kN)	Compressive Strength @ 28 days (MPa)
M0P0	700.2	31.12
M1P10	666.22	29.61
M2P20	652.05	28.98
M3P30	667.35	29.66
M4P40	617.17	27.43

Table 5 Test results of Silica fume Concrete

Mix Designation	Load (kN)	Compressive Strength @ 28 days (MPa)
M0P0S15	702.38	31.217
M1P10S15	699.52	31.09
M2P20S15	701.28	31.168
M3P30S15	702.47	31.221
M4P40S15	701.78	31.19

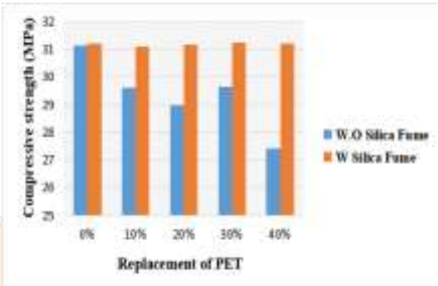

FIGURE 3 Compressive Strength at 28 days

Table 6 Percentage of Strength increased

Mix Designation	% of Strength Increased
M0P0 - M0P0S15	0.31%
M1P10 - M1P10S15	5%
M2P20 - M2P20S15	7.55%
M3P30 - M3P30S15	5.26%
M4P40 - M4P40S15	13.71%

Split Tensile Strength

Indirect tensile strength or Split tensile strength tests has been tested on cylindrical specimens of size 150 mm diameter and 300 mm length by curing it for 28 days in ordinary potable water using the compression testing machine as shown in Figure 4 and the test results are shown in Tables 7 & 8.

$$F_t = 2P / (3.14 \times (DL))$$

Where,

F_t - Split tensile strength of the specimen in (MPa)

P - Maximum load applied to the specimen (N)

D - Diameter of the specimen (mm)

L - Length of the specimen (mm)

FIGURE 4 Tensile Strength Test Setup

Table 7 Strength results of PET & Fiber Concrete under Tension

Mix Designation	Load (kN)	Tensile Strength @ 28 days (MPa)
M0P0	269.88	3.82
M1P10	193.58	2.74
M2P20	170.97	2.42
M3P30	149.07	2.11
M4P40	139.89	1.98

Table 8 Test results of Silica Fume Concrete

Mix Designation	Load (kN)	Tensile Strength @ 28 days (MPa)
M0P0S15	272.71	3.86
M1P10S15	198.52	2.81
M2P20S15	176.77	2.502
M3P30S15	154.72	2.19
M4P40S15	141.37	2.001

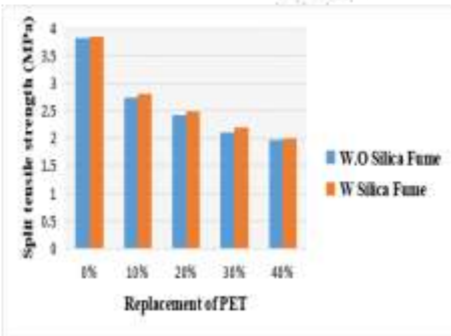

FIGURE 5 Split Tensile Strength Results

Table 9 Percentage of Strength Increase

Mix Designation	% of Strength Increased
M0P0 - M0P0S15	1.05%
M1P10 - M1P10S15	3%
M2P20 - M2P20S15	3.39%
M3P30 - M3P30S15	3.79%
M4P40 - M4P40S15	1.06%

FLEXURAL STRENGTH

Concrete prisms of size 100mm x 100mm x 500 mm has been used to determine the flexural strength of concrete being weak in tension. The test set up includes central point loading or called third point loading. The specimen are placed as shown in figure 6 in the testing machine which is of reliable type and has sufficient capacity to test . The results found are represented in the Tables 10 & 11.

$$\text{Flexural strength} = (P \times L) / (B \times D^2)$$

Where,

P - Load applied to the specimen (KN)

L - Length of the specimen (mm)

B - Breadth of the specimen (mm)

D - Depth of the specimen (mm)

FIGURE 6 Test Setup for Flexural Loading

Table 10 Strength Results of PET & Fiber concrete under Flexure

Mix Designation	Load (kN)	Flexural Strength (MPa) @ 28 days
M0P0	10.98	5.49
M1P10	9.04	4.52
M2P20	8.84	4.42
M3P30	9.94	4.97
M4P40	8.92	4.46

Table 11 Test results of Silica fume Concrete

Mix Designation	Load (kN)	Flexural Strength (MPa) @ 28 days
M0P0S15	11.06	5.529
M1P10S15	10.84	5.42
M2P20S15	10.54	5.27
M3P30S15	10.18	5.09
M4P40S15	9.46	4.73

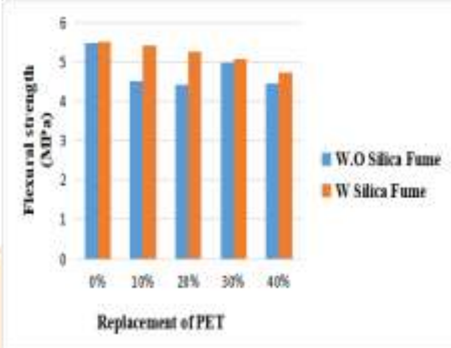

FIGURE 7 Flexural Strength at 28 days

Table 12 Percentage of Strength Increase

Mix Designation	% of Strength Increase
M0P0 - M0P0S15	0.71%
M1P10 - M1P10S15	18%
M2P20 - M2P20S15	16.68%
M3P30 - M3P30S15	2.38%
M4P40 - M4P40S15	5.87%

CONCLUSION

1. Comparing the compressive strength test results of conventional concrete ,fiber induced concrete and silica fume concrete, it was evident that the compressive strength increases to 31.221MPa for silica fume concrete whereas the test results of conventional and fiber concrete are found to be 31.12 and 29.66 MPa respectively.

2. Similarly the split tensile strength of adding PET as coarse aggregate and PPA as fiber in concrete shows the indirect ensile strength of 2.74MPa and 3.82 MPa respectively whereas the silica fume as admixture in concrete increases the strength to 3.86 MPa. The reason behind the strength improvement is all because of densified silica fume which fills the minute pores of concrete and makes the concrete more dense.

3. The flexural strength of PET concrete and fiber added concrete are 4.97 MPa and 5.49 MPa whereas for silica fume added concrete it was 5.529 MPa. It shows that the concrete added with admixtures would increase the flexural strength which in turn improves the overall property of the concrete.

4. At the outset Silica Fume added concrete along with fibers proves to be in more need for improving the mechanical properties of concrete and thus making the concrete to be highly stable and durable. Hence the waste plastics along with the admixtures can be used effectively in concrete in order to produce efficient and economical concrete.

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