

# 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 high strength and high performance concrete is 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.

## I. 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 objective of the project is

- To investigate the material properties used in concrete,
- To study the mechanical properties of concrete using plastic wastes and fibers.

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To identify the optimum content of the plastic waste (PET) along with fiber (PP) to be added to concrete.

## II. INGREDIENTS

- Cement : Ordinary Portland Cement 53 grade (OPC)
- Fine aggregate : M sand, Polyethylene Terephthalate (Recycled Plastic)
- Course aggregate : Gravel or crushed stone
- Fiber : Polypropylene Fiber 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 % at 24hrs
Polypropylene fibers	0.3
Polyethylene terephthalate	0.1
Fine Aggregate	1.2
Coarse Aggregate	1.38

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Vol. 9, Issue 3, March 2020

TABLE 2: PROPERTIES OF POLYETHYLENE TEREPHTHALATE

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

TABLE 3 : PROPERTIES OF POLYPROPYLENE FIBER

Property	Value
Length (mm)	12
Diameter (mm)	0.034
Modulus of elasticity(MPa)	2800
Melting point (C <sup>0</sup> )	160
Burning point (C <sup>0</sup> )	590

### III. RESULTS AND DISCUSSION

#### A. COMPRESSIVE STRENGTH

For compressive strength, 15cm x 15cm x 15cm cubes were used. All the cubes were tested in a saturated condition, after wiping out the surface moisture. For trail mix combination, three cubes were tested at the age of 28 days of curing using the AIMIL compression testing machine of 3000 KN capacity as per BIS: 516-1959 and the test values are shown in Table 4 & 5.

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**Figure 2 :** Compression Strength Test Setup

**TABLE 4 :** COMPRESSIVE STRENGTH RESULTS OF PET & FIBER CONCRETE

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)
M0POS15	702.38	31.217
M1P10S15	699.52	31.09
M2P20S15	701.28	31.168
M3P30S15	702.47	31.221
M4P40S15	701.78	31.19

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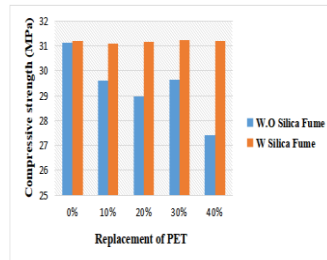


Figure 3: Compressive Strength At 28 Days

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%

## B.SPLIT TENSILE STRENGTH

Split tensile strength tests were carried out on cylindrical specimens of size 150 mm diameter and 300 mm length at the age of 28 days curing, using the AIMIL compression testing machine of 3000 KN capacity as per BIS: 5816-1970 and the test values are shown in Table 7 & 8.

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

Where,

$F_t$  - Split tensile strength of the specimen in MPa

$P$  - Maximum load in N applied to the specimen

$D$  - Measured diameter of the specimen in mm

$L$  - Measured length of the specimen in mm

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Vol. 9, Issue 3, March 2020



Figure 4: Tensile Strength test setup

TABLE 7: TENSILE STRENGTH RESULTS OF PET & FIBER CONCRETE

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

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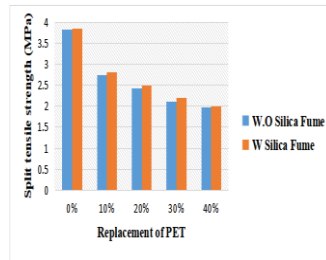


Figure 5: Tensile Strength at 28 days

TABLE 7 : PERCENTAGE OF STRENGTH INCREASED

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

## C.FLEXURAL STRENGTH

Concrete is relatively strong in compression and weak in tension. Direct measurement of the tensile strength of concrete is difficult. Concrete beams of size 100mm x 100mm x 500 mm are found to be dependable to measure flexural strength with central point loading or third point loading. The testing machine is of the reliable type which has sufficient capacity to test and capable of applying the load at the rate specified and and the test values are shown in Table 10 & 11.

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

Where,

P - Load applied to the specimen in KN.

L - Length of the specimen in mm

B - Breadth of the specimen in mm

D - Depth of the specimen in mm

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Vol. 9, Issue 3, March 2020



**Figure 6** : Flexural Strength test setup

**TABLE 10** : FLEXURAL STRENGTH RESULTS OF PET & FIBER CONCRETE

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



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Vol. 9, Issue 3, March 2020

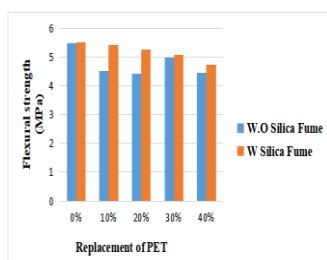


Figure 7 : Flexural Strength at 28 days

TABLE 12 : PERCENTAGE OF STRENGTH INCREASED

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

## IV. CONCLUSION

1. Compare to the test results of compressive strength of conventional ,fiber concrete and silica fume concrete, it is evident that the compressive strength proves to be 31.221 for silica fume concrete since the test results of conventional and fiber concrete are 31.12 and 29.66 respectively.
2. Similarly the split tensile strength of fiber concrete and silica fume concrete are 2.74 and 3.82. Out of which the 3.86 concrete result proves to be higher, all because of fiber and Silica fume.
3. The Flexural strength of SFC and fiber concrete are 5.529 and 4.97 whereas for conventional concrete it is found to be 5.49 which is 5.529 of the admixtures added concrete.
4. At the outset comparatively the SFC proves to be more need in mechanical properties of concrete. Hence the waste plastics along with the admixtures can be used effectively in concrete in order to produce efficient and economical concrete by adding silica fume and PET bottles.

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Vol. 9, Issue 3, March 2020

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