

Study And Investigation to Behavior of Using Waste PET Bottles Fibers in Concrete

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Abstract — Recent years have seen an uptick in research towards improving concrete's qualities through the incorporation of new materials. The most pressing problem in the world now is garbage disposal. Scientists need to think of new ways to recycle trash. The problem of plastic waste has emerged due to the fact that plastic is not biodegradable. One of the most common types of plastic waste is PET, or Polyethylene Terephthalate. Mineral and beverage water bottles are the most common buyers of these. This research details the use of PET bottle fibres obtained by slicing the bottles rather than subjecting them to a separate recycling process. Various mechanical parameters, including compressive strength, split tensile strength, flexural strength, ultimate load, stiffness, and maximum central deflection for different fibre proportions, should be reported from tests performed on concrete specimens. Superplasticizers and fibres made from recycled PET bottles fortify the specimens. This study will use a 0.8% superplasticizer to cement weight ratio and fibre to cement weight ratios of 0.25%, 0.5%, and 0.75%. Particularly interesting are the findings regarding the adhesive properties of PET to concrete; these findings open the door to the prospect of employing PET in networks or as flat or round bars for structural reinforcement.

Keywords: Polyethylene Terephthalate, Concrete, silica fume, Steel Fibre-Reinforced Concrete

I. INTRODUCTION

One of the most pressing issues facing society today and tomorrow will be finding effective ways to recycle different types of waste. We must do everything in our power to find a solution to this problem. The researchers must come up with creative, innovative, and ground-breaking ways to recycle the trash. Reusing waste products is becoming more important as landfill space becomes increasingly scarce and disposal costs continue to rise. Including such materials in concrete mixes is always of more interest to researchers. There is a decrease in the waste problem and the concrete becomes more economically viable as a result. Many structural uses for plastics have been documented in the literature. The construction and plastic recycling sectors stand to benefit greatly from the creation of these novel materials that make use of recovered plastics. It is only reasonable to conduct tests on these novel materials before putting them into use. Since plastics are so widely used, they add to the ever-increasing volume of solid waste. Polyethylene terephthalate, or PET, is the second most common type of plastic trash after polyethylene, which accounts for the most portion overall. The latter is obtained in big quantities from plastic water and beverage bottles.

A. Scope of study

Tests on concrete specimens reinforced with PET fibers that have been given a superplasticizer addition. the following fiber mixture ratios in concrete

- 1) 0 % by Weight of Cement.
- 2) 0.25 % by Weight of Cement.
- 3) 0.50 % by Weight of Cement.
- 4) 0.75 % by Weight of Cement.

Test using PET bottle fibers in steel-reinforced concrete beams with 0%, 0.5%, and 0.75% cement by weight.

II. OBJECTIVE OF THE STUDY

- 1) To examine the behavior of a specimen utilizing various PET bottle waste fiber quantities in concrete.
- 2) To determine the ultimate load and maximum deflection of a reinforced concrete beam specimen with various fiber-to-steel reinforcing ratios.
- 3) To determine the stiffness of an RCC beam with various fiber proportions.

III. METHODOLOGY

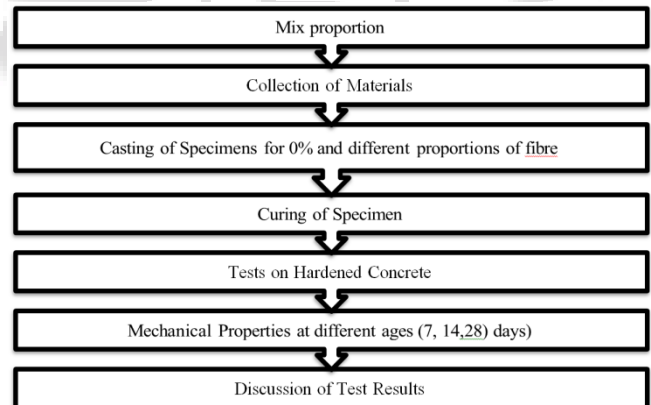


Fig. 1: Methodology

A. PET bottle fibres

The PET bottles used to make this fiber are leftovers. By dividing the bottle's top and bottom with a simple transverse cut, fibers can be obtained without the use of a costly recycling method. Circular fibres outperform lamellar ones because they guarantee superior adherence between concrete and fibres, even when subjected to extreme loads. The lamellar fibres tend to fall out. As seen in Figure 4.2, the fibres are in the correct form.

These circular fibers were created by perpendicularly cutting trash bottles along their longitudinal axes. The fibers are between 5&7 mm wide, with a ring diameter of roughly 10 cm. They are also between 0.6 and 0.8 mm thick.



Fig. 2: Used PET bottle fibers

Property	Value
Length of fibre	157.07mm
Width of fibre	6mm
Thickness of fibre	0.6mm
Aspect ratio of fibre	68.59
Tensile Strength of fibre	178.78 MPa
Elongation (12.5mm/min)	64.7%

Table I: Properties of PET bottle fibre

IV. RESULTS & DISCUSSION

In order to determine its compressive strength, concrete samples of 150*150*150 mm are utilised. The design calls for pouring the concrete into the mould shown in Figure 5.1 and then compacting it well to eliminate air pockets. After 24 hours, the moulds are removed and the test specimens are placed in water to cure, as illustrated in Fig. 5.2. The specimen's top must be completely level and smooth. After seven days of curing, the specimens are evaluated using a compression testing equipment, as shown in Figures 5.3 and 5.4. You can see the sample's degradation process in Fig. 5.5.



Fig. 3: the cube mould



Fig. 4: specimen curing



Fig. 5: machine for testing compression



Fig. 6: Samples testing with a compression testing machine



Fig. 7: after testing specimen

	7 days	14 days	28 days
For PET 0%	39.11	47.9	54.67
For PET 0.25%	40.31	49.5	56.49
For PET 0.5%	41.79	50.5	58.22
For PET 0.75%	42.59	51.75	60.98

Table II: Comparison of compressive strength for different proportion of fibre

	7 days	14 days	28 days
For PET 0%	2.7	3.32	4.13
For PET 0.25%	2.87	3.54	4.34
For PET 0.5%	3.01	3.81	4.72
For PET 0.75%	3.14	4.01	4.97

Table III: Split tensile strength comparison for different fibre mixes



Fig. 8: Cylinder specimen casting



Fig. 9: Testing of cylinder specimens in a compression testing apparatus

	7 days	14 days	28 days
For PET 0%	3.17	3.83	5.67
For PET 0.25%	3.33	4.17	6.33
For PET 0.5%	3.83	4.5	6.5
For PET 0.75%	4.33	5.33	7.67

Table IV: Flexural strength comparison for various fibre proportions

	YOUNG'S MODULUS IN MPa
For PET 0%	36747.34
For PET 0.25%	40114.28
For PET 0.5%	40630.20
For PET 0.75%	43221.51

Table V: Evaluation of Young's modulus with varying fibre percentages



Fig. 10: specimens are tested for Young's modulus

	Maximum central deflection in mm	Ultimate load in N
For Concrete 0% of fibre	7.8 mm	53936.57
For Concrete 0.5% of fibre	6.85 mm	58839.9
For Concrete 0.75% of fibre	5.89 mm	63743.26

Table VI: Various fibre proportions and maximum central deflection in millimetres and Newtons, respectively



Fig. 11: beam reinforcement



Fig. 12: Reinforced beams are cast



Fig. 13: PET 0.5% Reinforced Beam Testing

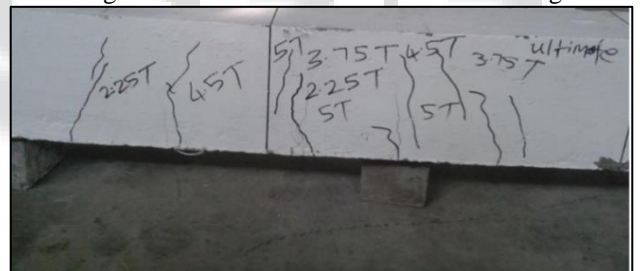


Fig. 14: PET 0% and PET 0.75% test samples

Concrete Mix	Stiffness in N/mm
PET 0%	6870.901
PET 0.5%	8589.23
PET 0.75%	10990.21

Table 5.7: Stiffness in N/mm for varying fibre percentage

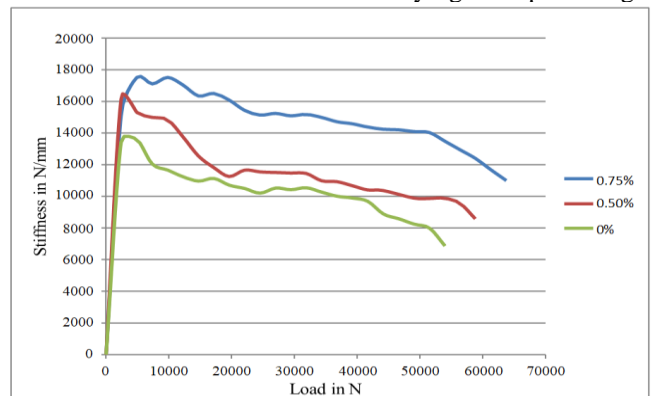


Fig. 15: Graph of stiffness versus load for an RCC beam with different fibre ratios

V. CONCLUSION

The specimens' compressive strength is tested after 7, 14, and 28 days. After seven days, PET's compression strength is 0.75 percent. A 0.75 percent fibre content by weight of cement was 3.2% higher than a 0 percent fibre content in PET. PET 0.75 percent outperformed PET 0 percent in terms of compression strength after 28 days. given that an improvement in compressive strength of 3% is essentially negligible. Compressive strength is found to be unaffected by an increase in fibre content.

After being split, the specimen's tensile strength is assessed at 7, 14, and 28 days. After seven days, PET 0.75 percent's split tensile strength is 16.2 percent more than PET 0 percent's. Following a 28-day period, PET 0.75 percent's split tensile strength exceeded PET zero percent's by 20.3%. When fibres are injected into the concrete and the mixture is tested, the cylinder specimen's crack depth decreases.

The specimens' flexural strength is measured at 7, 14, and 28 days. After 7 days, PET 0.75 percent had 35% more flexural strength than PET 0 percent. Flexural strength with PET 0.75 percent was 33 percent higher after 28 days than for PET zero percent.

The PET 0% specimen fails totally in flexural strength tests, but the depth of the break through the specimen is lessened when fibers are put into concrete and the test is repeated.

The specimen's Young's modulus is determined after 28 days. Following a 28-day period, PET 0.75 percent had a Young's modulus that was 17% greater than PET zero percent. The maximum Young's modulus value for all mixtures is 43211.51 MPa.

Table 4.6 displays the results of a seven-day test of a reinforced concrete beam specimen with fibres added to the concrete for maximum central deflection and ultimate load. The largest central deflection was 24.4% less with PET 0.75% than with PET 0% after 7 days. Seven days later, the PET 0.75 percent final load was 19% higher than the PET 0% final load.

The results of a seven-day test on the stiffness of a reinforced concrete beam specimen with fibres added to the concrete are summarised in Table 4.7. After seven days, the Young's modulus of PET 0.75 percent was 56% higher than that of PET 0%.

The first crack of all mixes is seen at the same stress, but the ultimate load rises, indicating that the beam's resistance to ultimate failure is enhanced by the addition of fiber. There is no need for the fibers utilized in this study to go through any expensive recycling processes; they are simply cut from PET bottles. The insulation on these fibers prevents them from corroding.

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