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EXPERIMENTAL STUDY ON DESIGN MIX CONCRETE USING WASTE PLASTIC BOTTLE FIBERS

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ABSTRACT

Virgin waste plastic mixture Research has been done on the characteristics of new concrete as well as hardened concrete. Various concrete mixtures employed varying percentages of waste plastic flakes to partially replace sand. Concrete constructed from waste plastic was tested at room temperature both with and without superplasticizer. Numerous cube samples were formed in order to evaluate the compressive strength of three specimens. Beams were also cast to evaluate the flexural strength properties of waste plastic. Superplasticizer can be used to increase the small amount of sand that the waste plastic has replaced. Plastics were miraculously created by man and have since become an indispensable part of the typical person's daily existence. The question of how to get rid of the various plastics that are currently found in nature has always caused man great anxiety. PET, also known as polyethylene terephthalate, is a polymer that is frequently used to make plastic bottles, which are then used to package a variety of drinks. Research studies have conclusively shown that PET waste may enhance a number of concrete qualities, making this a much better alternative to landfill disposal. The utilization of these materials can be improved by modifying the fibers' shape and bonding properties, according to studies on PET fibers. The primary objective of the current study is to review the use of concrete fibers in various shapes and aspect ratios (length to width ratio).

Keywords: Plastics And Landfill, PET, Aspect Ratios.

I. INTRODUCTION

Plastic trash disposal is regarded to be a serious problem because of its extreme poor biodegradability and ubiquitous use. To find out if it would be possible to dispose of these contaminants in mass concrete, where cement strength would not be the key determining factor, extensive study is now being done. For instance, a pavement that has a sizable percentage of OPC concreting. If plastic wastes, such as bottles, utensils, and other items, may be mixed into concrete mass without significantly changing or somewhat degrading it's other properties. By mixing plastic bottle pieces with concrete mass, we can absorb a lot of the trash. Plastic is one of the elements of municipal solid waste that is the subject of extensive investigation and debate due to its potential applications in concrete and light-weight concrete. or at least weakening it. By mixing plastic bottle pieces with concrete mass, we can absorb a lot of the trash. Plastic is one of the components of municipal solid waste that is the topic of substantial research and discussion with regard to its possible use in concrete and light-weight concrete. There are many recycling facilities around the world, but the more plastics are recycled, the weaker they get. As a result, instead of being continuously recycled, these plastics will eventually be turned into earth fill, which will be beneficial for the construction industry. Failure in aggregate crushing is the primary factor in concrete building failures. Additional downsides of concrete include its low tensile strength and cracking. Research studies on reinforcing various fibers have been expanded in order to help concrete get over this obstacle and improve in terms of cracking and tensile strength. 26-47. this restriction can be somewhat overcome by employing different PET fibers and other short fibers in the right forms as reinforcement. Studies on PET fibers have demonstrated that the presence of PET fibers has a variety of effects on the workability and strength properties of the matrix. The inclusion of PET fibers has also been observed to improve the matrix's resistance to abrasion. The PET bottles appear to be reasonably priced materials that could help with solid waste management and environmental preservation. Moreover, experts have suggested so there must be a successful strategy to enhance the bonding surface. The management of solid waste, particularly plastic trash, is dismal in India. Solid waste typically consists of packing materials, sludge produced by effluent processing systems 24, abandoned textiles from the textile sector, fiber produced by spinning units, and discarded fabric. Lack of efficient collection procedures leads to unclean conditions when waste is left lying around in public areas. Lack of waste separation at the source or at the pickup sites causes issues with trash management. 29. There is currently no effective mechanism for industries that produce plastics and other solid wastes to get rid of their waste. The garbage is wreaking havoc whether it moves by ground or air. Everyday use of PET packing contributes significantly to pollution. Leveraging certain coating phenomena by coating the plastic with specific reactive chemicals can increase the performance of PET fibers.

II. MATERIALS

a) Cement

Ordinary Portland cement was utilized because it complied with the specifications of IS: 269 – 1969, and the findings are listed in table 1.

Table 1: Properties of cements

Initial setting time		30
Final setting time		600
Compressive strength	3 days	33.3N/mm 2
	7 days	42.9N/mm2
	28 days	57.5N/mm 2
Fineness (90umsieve)		5%
Standard consistency		25%

b) Water

For specimen preparation and curing, portable tab water is employed.

C) Fine aggregate

According to IS 383-1970, the table 4 sand utilized in the experimental program was generated locally and complied with zone II. It was discovered that fine aggregate has a specific gravity of 2.638.

Table 2: Properties of fine aggregate

GRADATION	FALL N ZONE II
Fine modulus	6%
Silt content	0.50%
Specific gravity	3.1
Moisture content	1.2%

D) Coarse aggregate

In the current work, coarse material that passed through a 20mm screen and complied with IS 383-1970 was used. It was discovered that coarse aggregate has a specific gravity of 2.836.

Table 3: Properties of Coarse aggregate

Aggregate abrasion	12.6
Agreegate impact value	16
Specific gravity	2.0
Water absorption	1.07
Combined flakiness and elongation index	24%

E) Plastic fibers

Fibers made of low density polyethylene are employed. These are often created by cutting packaging strip

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lengths into laminar-shaped fibers, with thicknesses ranging from 0.150 to 01 mm. According to trail mix results, 1% (by cement weight) is added to the concrete used in the current experiment.

Table 4

Properties	Results
Specific gravity	0.75
Fineness modulus	2.86
Zone	II
Water absorption	NIL

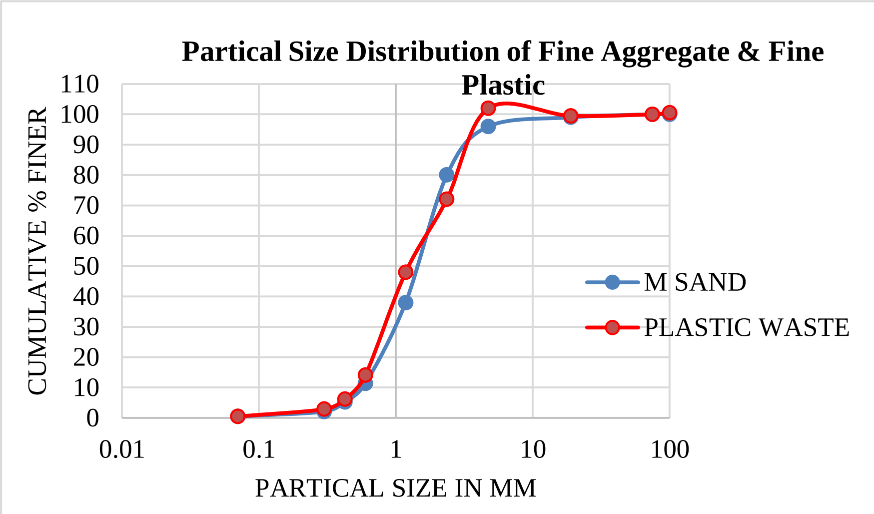

Fig. 1

F) Mix design

The mixture was created in accordance with IS 10262:2009 for concrete of M20 grade with a 0.5 water cement ratio. Concrete mixes are made by adding a constant percentage of plastic fibers (01 percent of the weight of cement) and replacing a portion of the natural aggregates with plastic aggregates at varying percentages (0 percent, 04 percent, 8 percent, 12 percent, respectively). Each mix's ingredients are listed.

Table 5: Mix design M25

	Water	Cement	F. A	C. A
By weight (Kg)	196.6kg	435.45	662.2	1119.5
By volume	0.8	2	1.33	2.61

Table 6: Mix Type

Mix	Cement	Coarse aggregate	Fine aggregate	Plastic Fibre
MIX 1	8.82%	22.67	13.49	0%
MIX 2	8.82%	22.67	13.49	4%
MIX 3	8.82%	22.67	13.49	8%
MIX 4	8.82%	22.67	13.49	12%

III. METHODOLOGY

3.1 Concrete mix design

According to IS10262:2009, the final design mix for M25, a grade of concrete, was developed using trial mixes with varied ingredient amounts. The water-to-cement ratio and the proportion of the concrete mix are shown in table 5. The best percentage of shred plastic waste to add to concrete without suffering significantly from loss of power is 15% by volume. To meet the needs of the test, various specimens were cast. Upon completion of the 28-day curing period, the samples were analyzed. For each category, three samples should be tested, and graphs showing the average result are provided.

3.2 .MECHANICAL PROPERTY TESTS

We looked at mechanical properties such split tensile strength, flexural strength, and compressive strength of cubes and cylinders. Three specimens were cast for each test, and the average outcome was given.

3.3 Compressive Strength of concrete cubes

Concrete cubes' compressive strength In order to predict how the NC and WPC constituents will behave when compressed, the compressive strength was established. The execution of tests and the preparation of specimens followed IS: 516-1959. The samples were cast using the necessary mix ratios, measuring 150 mm by 150 mm by 150 mm, and they underwent a 28-day curing process to get a 28-day compressive strength. A compression testing device with an 11 kN/sec loading rate was used to conduct the test. Progressive loading was used, and the specimen's maximum load was noted. the NC and WPC's compressive strengths.

By dividing the greatest force by the specimen's cross-sectional area, compressive strength was calculated. .

Compression coefficient: F/A MPa where F = the newton failure load A is the specimen's cross-sectional area in millimeters2.

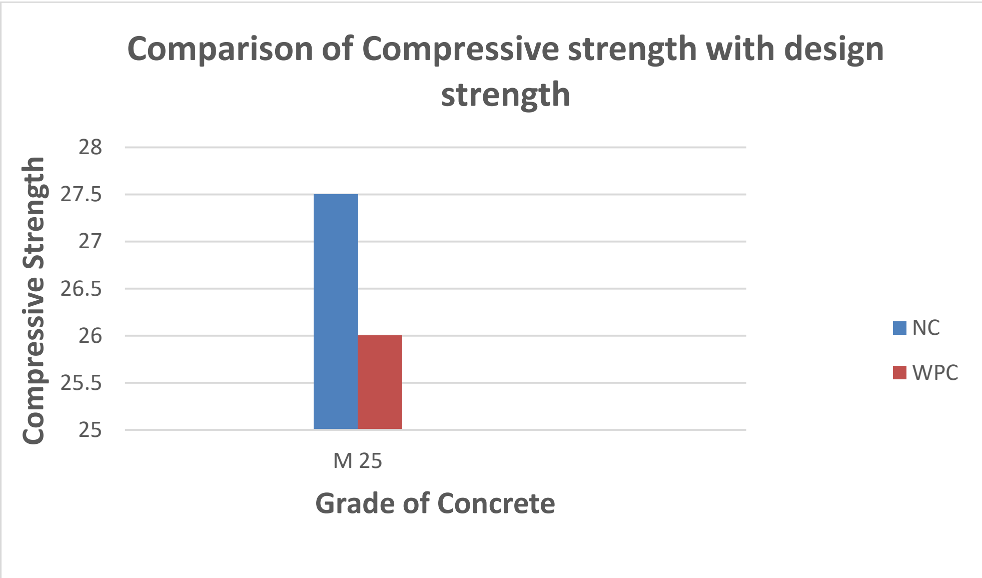

Fig. 2

3.4 Discussion on compressive strength test results

Discussion of the compressive strength test's findings The compressive strength of WPC decreased by 4 to 7 percent as a result of the addition of plastic. This loss could be attributed to the poor bonding strength between plastic particles and concrete. However, the inclusion of polypropylene fibers in WPC helped to somewhat counteract this loss, reducing it to roughly 3%.

3.5. Split tensile strength

The behavior of NC, WPC, and PFRWPC elements under direct strain was established using this test. Cylinders measuring 150 x 300 mm conducted an IS: 5816-1970 split tensile strength test at the age of 28 days. The specimen was fastened to the testing platform of the compression testing machine. Two 3 mm thick metal packing strips were placed at the top and bottom, breaking, and a constant load was applied while recording the load.

Following is how the split tensile strength was calculated:

Strength to split = 2P/ (DL)

P = the load at failure where

D stands for the cylinder's diameter.

L stands for cylinder length.

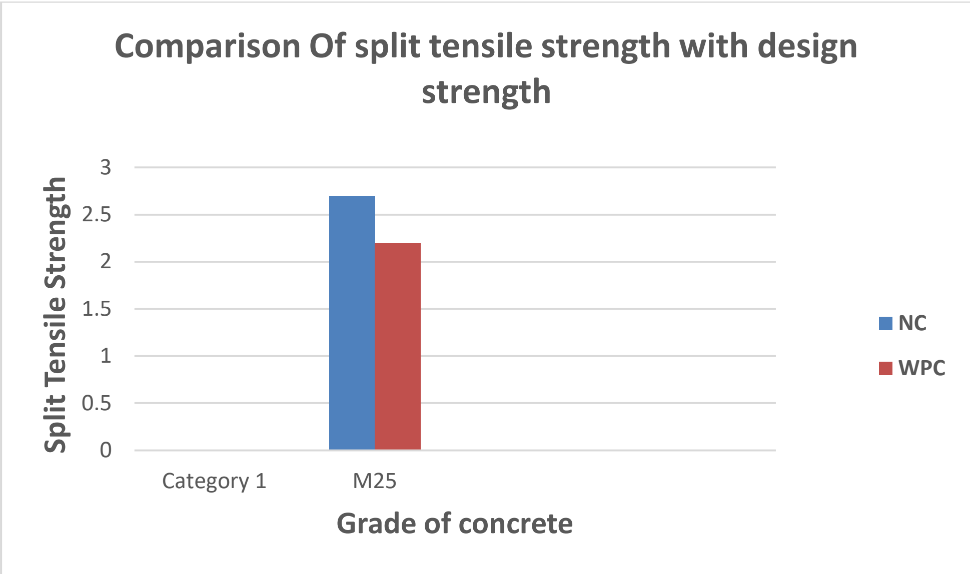

Fig 3:

3.6 Discussion on split tensile strength test results.

The split tensile strength of WPC fell between 4 and 12 percent when plastic was introduced. This loss could be attributed to the poor bonding strength between plastic particles and concrete. However, this loss was somewhat mitigated by the addition of polypropylene fibres to WPC. There will be a 5% increase in split tensile strength.

3.7. Flexural strength

The flexural strength test on prisms of size 100 X 100 X 500 mm was carried out at the age of 28 days and confirmed to IS 516-1959 in order to ascertain how flexural elements, such as beams, behave when cast with NC, WPC, and PFR WPC. While the specimen was installed on the universal testing instrument, hydraulic two-point loading was applied to it, and it was increased until failure. The flexural strength of the NC and WPC is shown in Figure **3.**

The flexural strength of prisms was calculated using the formula below:

Strength of flexion = PL/bd2, where P = Maximum load applied to the specimen.

b is equal to the specimen's measured width., L is the span's length,

d is the specimen's measured depth.

3.8 Discussion on flexural strength test results

The inclusion of plastic decreased the flexural strength of WPC by 10 to 18 percent. However, the addition of polypropylene fibres to WPC helped to slightly offset this loss. Flexural strength will grow by 25 percent.

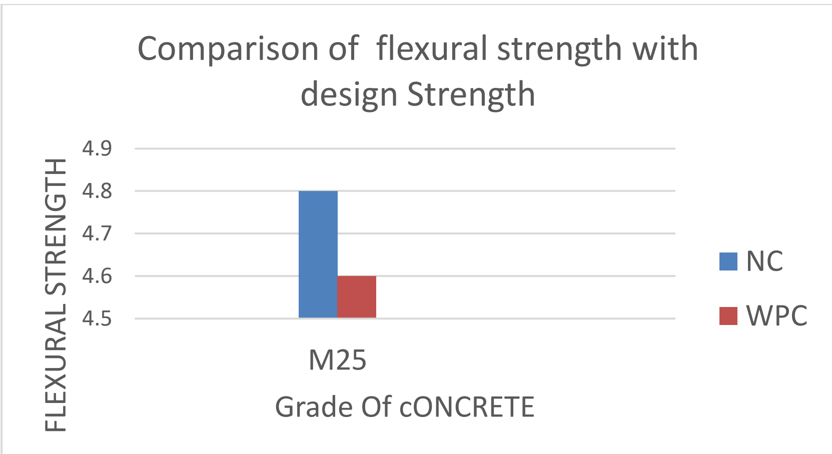

Fig 4

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IV. DURABILITY PROPERTY TESTS

We examined the features of durability like water absorption and resistance to acid and salt attack. Three specimens were cast for each mix, and the study used the average value. The durability test's specifics are provided below.

4.1. Water absorption

The water absorption test was carried out on 100 mm cube specimens in accordance with IS 1237:1959 to evaluate the porosity of specimens containing plastic particles. The NC, WPC, and PER WPC data are shown in Figure 8. Water absorption levels in all of the mixtures were far lower than the permissible value of 10%. As the compressive strength grew, the mixes' capacity to absorb water decreased. WPC absorbed water half as quickly as regular NC did. The plastic particles that caused this outcome might not be capable of absorbing water. The 15 percent higher absorption in PFRWPC than in WPC may be due to the polypropylene fibers' capacity to trap air during mixing.

4.2. Resistance to acidic solutions and seawater

The impact of seawater and acidic solutions on the durability of NC made up of plastic waste aggregates and polypropylene fiber was examined using tests on 100mm cube specimens for loss in mass and degradation in compressive strength. To test the cubes' acid resistance, they were immersed in a 5 percent solution of sulfuric acid (H2SO4) for 56 days. Compressive strength has decreased by % as compared to design strength. The reduction in compressive strength was larger than the decrease in mass, as seen in Figures 10 and 11. Specimens with the same strength of WPC and PFRWPC exhibited negligible mass loss, whereas the drop for 30 M Pa NC was 3.5 percent (less than 1 percent). This might be because fine particles have been replaced by plastic, which is less reactive in a chloride environment. The mass loss increased by 5% when fibers were added to WPC compared to WPC without fibers. This can be due to internal corrosion caused by air entrapment during mixing. For WPC, the mass loss in an acid solution and the fall in compressive strength were 7 and 28%, respectively.

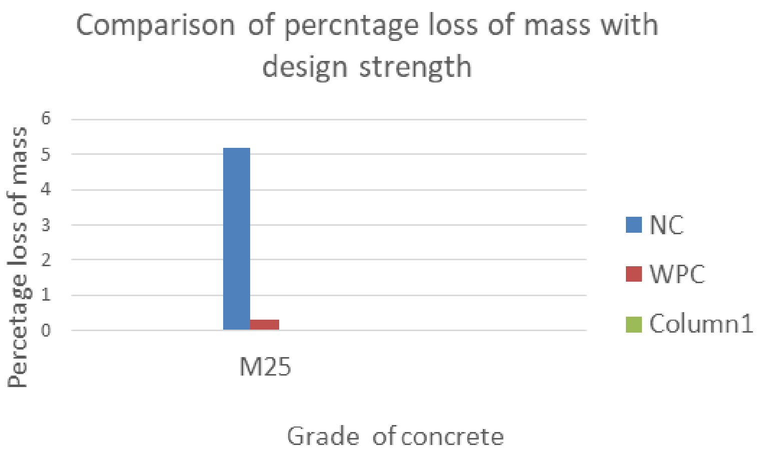

Fig 5

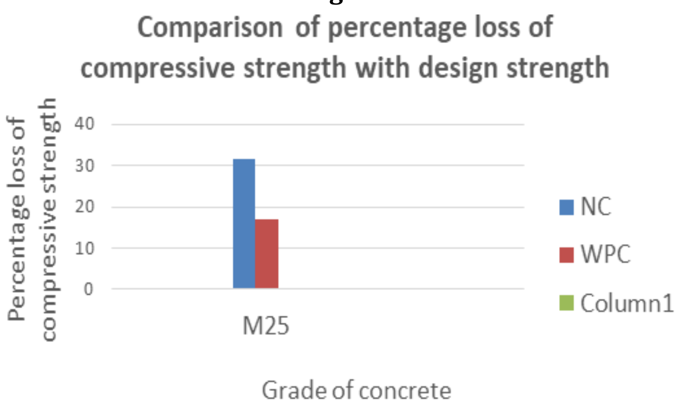

Fig 6

Fig. 6 shows the percent drop in compressive strength when compared to design strength. The reduction in compressive strength was larger than the decrease in mass, as seen in Figures 10 and 11. Specimens with the same strength of WPC and PFRWPC exhibited negligible mass loss, whereas the drop for 30 M Pa NC was 3.5 percent (less than 1 percent). This might be as a result of plastic replacing fine particles, which is less reactive in a chloride environment. The mass loss in WPC increased by 5% when fibers were introduced over WPC without fibers. This might be brought on by internal corrosion brought on by mixing and air tangling. For WPC, the mass loss and the fall in compressive strength were 7 and 28%, respectively, in acid solution. For 30 M Pa, losses in PFRWPC were 8% and 29%, respectively. .

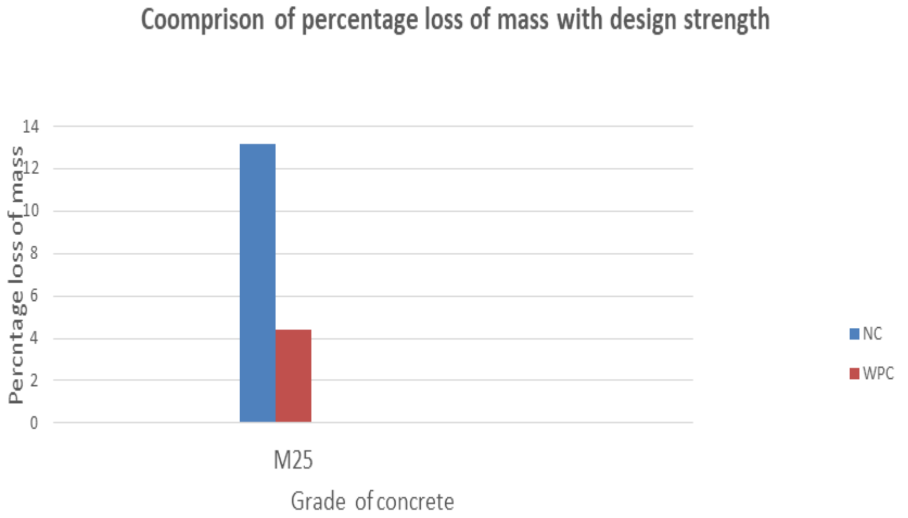

Fig 7

V. RESULTS AND DISCUSSION

5.1 Bulk Test before casting each mix, a slump test is conducted

As PCA in concrete increases, the slump of the concrete also increases. Less water absorption by plastic aggregates and fibers was the cause of the rising slump. Figure displays the results of the slump test.

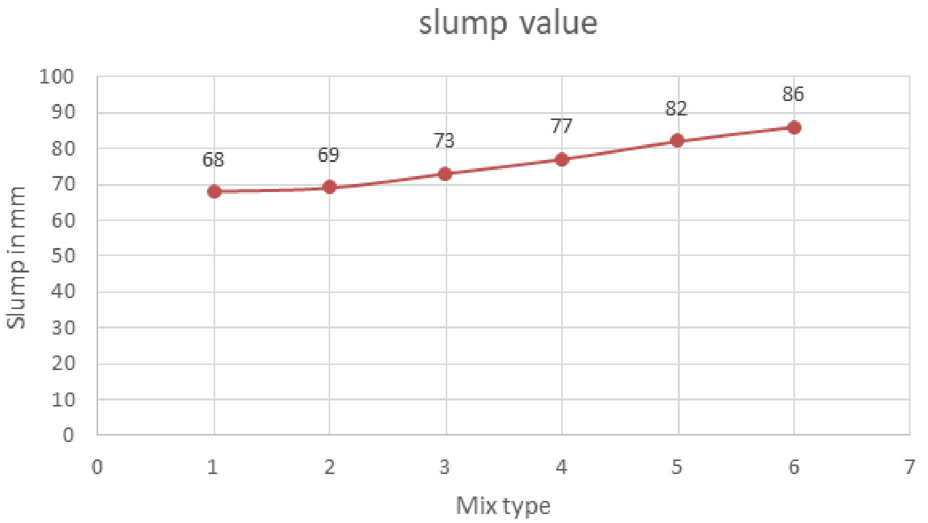

Fig 8

5.2 Compressive Strength curve after replacement with plastic fiber

Table 7 and provide the results of compressive strength for various combinations. In the current experiment, the compressive strength of concrete made by substituting natural aggregates with plastic aggregates and adding plastic fiber increases up to 12%. Results for compressive strength show that mix 2's use of plastic fibers increased compressive strength, mix 3's use of plastic fibers increased strength, and mix 4's use of PCA increased compressive strength. Table 6 and Figure 1 show the percentage of the compressive strength at this 0 percent to 30 percent replacement of PCA.

Table 7

Sr. no	Mix	Compressive Strength		
		7 DYS	14 Days	28 Days
01	Mix 01 (0%)	13.2	16.01	26.25
02	Mix 02 (4%)	17.6	21.2	28.15
03	Mix 03 (8%)	17.20	18.88	27.12
04	Mix 04 (12%)	15.20	18.36	28.52

Compressive Strength Results

5.3 Tensile Strength of concrete after replacement with plastic fiber

Similar to how employing plastic fibers increased mix 2's split tensile strength by up to 12 percent relative to CA, it also increased mix 2's tensile strength. Following mix 2, all mixes see a loss in concrete's tensile strength due to a rise in PCA content. Table 7 displays the percentage of split tensile strength for PCA replacement levels of 0% to 12%.

Table 8

Sr. No	Mix Type	Tensile Strength (N/m m2)
		28 Days
01	Mix 01 (0%)	4.38
02	Mix 02 (4%)	4.40
03	Mix 03 (8%)	4.80
04	Mix 04 (12)	4.95

VI. CONCLUSION

Over time, both concrete generated from waste plastic and concrete made without the addition of fibers were put to the test for durability. Polypropylene fibers may somewhat overcome the decrease in compressive strength caused by the integration of waste plastic in NC. The specifications for ordinary concrete were found to have restrictions on all of the assessed durability metrics. These findings imply that cementitious composites made from plastic waste may be more durable than traditional concrete.

VII. PORTFOLIO OF FUTURE RESEARCH

Long-term research on PET-reinforced concrete is viable, however some form of coating procedure must be developed to improve the bonding properties of PET fibers to concrete matrix. • A machine that can quickly extrude large amounts of fibers could be created. In this case, only mixes with goal strengths of 20 MPa, 25 MPa, and 30 MPa were included when evaluating mechanical and durability qualities. It is possible to broaden the study to cover higher NC, WPC, and PFRWPC grades. The durability evaluations utilized a limited number of tests Additional studies can be conducted to examine the effects of temperature, freezing and thawing, heat of hydration, etc. The strength loss brought on by the addition of waste plastic was made up for by the addition of polypropylene fiber in this work. Similar research can be conducted using other methods.

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