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Innovative use of pet waste fibre in concrete for improved strength and durability

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Abstract
Research has demonstrated that the existence of heavy metals in wastewater has a negative impact on concrete's characteristics, which is a major issue for building floors. In this study, the strength and durability of building floors were increased by adding plastic waste (PET) fibre to concrete. At percentages of 0%, 10%, 20%, 30%, and 40%, respectively, shredded plastic waste (PET) fibre was substituted for fine aggregate (sand). In the concrete laboratory, the strength of sixty concrete cubes was examined. The findings demonstrate that, for 0%, 10%, 20%, 30%, and 40% replacement of shredded plastic waste (PET) fibre, the compressive strength of concrete rises proportionately with concrete age. In addition to offering a remedy for the issue of wastewater adversely affecting building floors, this research will prevent pollution of the environment and lessen the usage of conventional building materials like cement, which emit carbon emissions into the atmosphere.

Keywords: Concrete, plastic waste, compressive strength, aggregates, building floor, pet

1. Introduction

Concrete is the second most used substance on earth, behind water, and the most often used man-made material in the construction industry [1]. Ten billion tons of rocks and sand, one billion tons of water, and 1.6 billion tons of concrete are used annually by the concrete industry [2]. Four constituents make up concrete: coarse aggregates, which make up the majority of the mixture; fine aggregates, like sand, which fill in the spaces; binding material, like Portland cement or lime, which binds the fine aggregates together; and water, which interacts with the binding materials [1].

Plastic has long been thought of as a man-made material with several advantages. It is readily formed to fit the designer's specifications and has lightweight qualities. Many of its uses are a result of its adaptable qualities. The amount of plastic consumed rose from 335 million tons to 348 million tons in 2016 [3]. By 2030, it is anticipated that this demand will amount to 485 million tons [4]. The usage of plastic has negative effects on the environment and waste generation since many polymers are not biodegradable and take 500–1000 years to decompose [5]. Pollution from the discharged pollutants can affect soil fertility, animal or human health, food chain poisoning, and groundwater quality [6]. Furthermore, plastics release carbon monoxide, a greenhouse gas, when they burn in an open area. Plastics can hinder water flows and produce siltation when disposed of in rivers, increasing the danger of flooding [7, 8]. It can also result in vehicle-related accidents in waterways that might be fatal. Research conducted on beaches has revealed that the quantity of plastic debris found along the coastlines of 192 nations in 2010 ranged from 4.8 to 12.7 million metric tons. Due to the damage this garbage poses to marine life [9], several requests have been made to limit the use of plastic and change consumer behavior [10]. Since 2006 [4], recycling has grown in industrialized nations and provides some relief from the issue of plastic waste. Sorting plastic into different polymer types is the first step in the standard recycling process. It is then cleaned, scraped, melted, and turned into pellets that may be used to make plastic bags, containers, carpets, jacket insulation, and other products. In 2018, 43% of the total collected post-consumer waste stream was used to convert plastic garbage for energy4. Additionally, inadequate plastic waste treatment facilities at every level of collection, separation, and disposal pose a challenge for processing and managing plastic garbage globally. It is estimated that over 12 billion metric tons of plastic waste will wind up in landfills and the environment by 2050 [11].

Finding a place inside the value chains is necessary to address the issues surrounding plastic waste and keep it out of landfills. Creating a link between the waste and construction sectors appears to be one way to improve the circularity of plastics, particularly the widely used macro-plastics [12]. Their usage as an additive in concrete mixes would yield additional value and open up new commercial opportunities [13].

One of the issues impacting building floors is the presence of heavy metals such as Ca, Mg, Mn, Pb, and Fe in wastewater, which has a negative impact on the characteristics of concrete. These metals include salt, which dissolves and separates the components of concrete, drastically altering its characteristics and eventually causing it to deteriorate [14, 15]. The aim of this research is to increase the strength and lifespan of building floors by incorporating plastic waste (PET) fibre into concrete. The characteristics of concrete are susceptible to the kind of additional materials used in excess of what is called for in the conventional project mix design. The size and kind of aggregates used in concrete determine its strength [16, 17], and the addition of different materials results in differences in the concrete's compressive and tensile strengths [18-21]. Single-use plastics, such as PET (polyethylene terephthalate) [22] and HDPE (high-density polyethylene) [23], are regarded as low-carbon recyclable materials that can be disposed of as admixtures in concrete.

PET is frequently used as a raw material to make plastic food packaging containers, soft drink bottles, and other finished goods. Polyethylene terephthalate (PET) is one of the plastic materials that is most frequently discovered in solid urban waste, according to Mello [24].

In 2007, it was reported that the annual consumption of 250,000 million PET bottles, weighing 10 million tons, was growing at a rate of 15%. The use of PET waste in concrete has been shown by several researchers to improve its flexural toughness, impact resistance, and workability [25, 26, 21]. However, it also demonstrated a decrease in compressive strength as PET waste increased. The manufacture of polyethylene terephthalate, or PET, is expanding quickly, and PET waste is starting to pose a serious threat to the environment. The transportation and construction sectors have been using PET waste as an alternative to aggregate, and as the waste's content rises, so do the modified mixtures' mechanical properties.

In the US, the EPA [27] reports that only 7% of post-consumer plastic waste is recycled and that 80% is disposed of in landfills or burned. The use of plastic admixtures in concrete offers several advantages, including reduced weight, enhanced weather resistance, waterproofing, and the provision of thermal insulation. Efficient incorporation of plastic waste into concrete can enhance its tensile strength and ductility, among other properties. In addition, incorporating plastic waste into concrete reduces its weight and increases the seismic resistance of buildings [28]. By using plastic aggregates from the foam-extrusion process, the aggregate / binder interface has been improved, the structure's dead weight has decreased, and the amount of natural sand used overall has decreased [29]. Particularly in comparison to silica-based aggregate, which can be used to regulate heat gain in the winter and heat loss from buildings in the summer, plastic aggregates have a five-fold lower thermal conductivity. Mixed findings were found in several studies regarding tensile strength improvement [30]. Generally speaking, though, it has been demonstrated that adding PET reduces compressive strength.

2. Materials and Methods

2.1 Materials Collection

The coarse and fine aggregate were sourced from a Quarry along Owo Road, Shasha Akure, Ondo State, Nigeria. Plastic waste was collected at Obakekere and Obanla. The cement was also sourced from a local cement store at Futa North Gate. The presentation in Figure 1 showcases the collection of the plastic waste.

Fig 1: Collection of plastic waste

2.2 Material Preparation

60 concrete cubes measuring 150 mm by 150 mm x 150 mm were cast, cured, and then tested for strength at the concrete laboratory at ages 7, 14, 21, and 28, respectively. At Dura Foam, Near Benin Garage, Akure, Ondo State, the plastic waste was shred. Compressive strength, slump, and compacting factor tests were performed on both fresh and hard concrete. Sieve analysis, moisture content determination, aggregate crushing value, and aggregate impact value tests were performed on both fine and coarse aggregate. At percentages of 0%, 10%, 20%, 30%, and 40%, shredded plastic waste fibre was used in place of fine aggregate (sand).

2.2.1 Coarse Aggregate

The coarse aggregate of 10-27 mm size was used for this research, and the fineness modulus of the aggregate is 4.39.

2.2.2 Fine Aggregate

The river sand with a fineness modulus of 5.69 was used as a fine aggregate for this research.

2.2.3 Cement

Cement was used as a binder material in concrete. The Ordinary Portland Cement of 53 grades, conforming to the stipulated standard in Nigerian Industrial Standard available in the local market, was used for this research.

2.2.4 Water

Portable water was used for the mixing and curing of the concrete.

2.2.5 Shredded Plastic Waste (PET)
Plastic waste was collected at various locations around the school environment (North gate, South gate). This waste was further mobilized to Dura Foam around Benin Garage, Akure, Ondo State, for shredding. The shredded plastic, with fineness modulus of 8.94 was used for this research.

Fig 2: Shredding of plastic waste

2.3 Methods
The various methods carried out on fine aggregate, coarse aggregate, fresh concrete (workability test), and hard concrete (concrete strength test) in this research include:

a. Natural Moisture Content Determination.
b. Sieve Analysis (Particle Size Distribution).
c. Aggregate Crushing Value (ACV).
d. Aggregate Impact Value (AIV).
e. Slump test.
f. Compacting factor test.
g. Production of the concrete cubes.
h. Density of Concrete Test.
i. Water Absorption Capacity.
j. Compressive Strength Test.

2.3.1 Natural moisture content determination
Natural moisture content determination was carried out in the laboratory to determine the amount of moisture present in a given representative quantity of sand. This test was conducted in accordance with BS 1377 Part 2 [31].

The percentage moisture content (M.C %) was determined using the following formula:

$$\text{M.C}\ (\%) = \frac{W_2 - W_3}{W_3 - W_1} \times 100$$

Where
W_1 = Weight of the empty moisture content pan.
W_2 = Weight of the empty moisture content pan and wet sample.
W_3 = Weight of oven dried sample and pan.

2.3.2 Sieve Analysis (Particle Size Distribution)
Soil is mechanically analysed using sieve analysis. It is the process of dividing soil into various fractions according to particle size. The proportion of different sized particles in the soil by mass is expressed quantitatively. A particle size distribution curve provides a graphic representation of it. The test was carried out in compliance with BS 1377 Part 2 [31]. Figure 3 presents the sieve analysis test. The distribution/grading type of various size particles can be expressed depending on the following parameters derived from the particle size distribution curve:

a. Effective Size (D_{10}): This is the diameter through which 10% of the total soil mass is passing.

b. Uniformity Coefficient (Cu): This is given by,

$$Cu = \frac{D_{60}}{D_{10}}$$

Where, D_{60} is the diameter through which 60% of the soil mass is passing.

c. Coefficient of Gradation (Cc): This is given by,

$$Cc = \frac{D_{30}^2}{D_{60} \times D_{10}}$$

Where, D_{30} is the diameter through which 30% of the soil mass is passing.

Fig 3: Sieve analysis test

2.3.3 Aggregate Crushing Value (ACV)
This represents the percentage of crushed material by weight that is obtained after test aggregates are put through a predetermined load under predetermined guidelines.

It shows the aggregate's resistance capacity to a gradually applied compression load. The aggregate crushing values test is the procedure used to gauge this relative resistance.

$$ACV = \frac{W_2}{W_1} \times 100\ (\%)$$

Where
W_1 = The weight of the sample
W_2 = The weight of the fraction passing through the 2.36 mm B.S sieve

Note: Aggregate crushing value must not exceed 30.

2.3.4 Aggregate Impact Value (AIV)

The aggregate impact value provides a comparative assessment of an aggregate's ability to withstand abrupt shock or impact, which is usually distinct from the aggregate's ability to withstand a gradually applied compressive load or crushing value. The aggregate impact value machine is shown in Figure 4.

Aggregate that has been retained on the pan after passing through a 2.36 mm B.S. sieve is used for the standard aggregate impact value test.

Fig 4: Aggregate impact value test

$$AIV = \frac{W_2}{W_1} X\,100\ (\%)$$

Where, W_1 = The weight of the sample

W_2 = The weight of the fraction passing through the 2.36 mm B.S sieve

Note: Aggregate impact value must not exceed 30.

2.3.5 Workability

The property of raw or fresh concrete that determines how easy it is to use or work with is called workability. Slump test and compacting factor test are two tests that can be used to measure it. The tests are examined in the section below.

2.3.5.1 Slump Test

The most widely used technique to assess the consistency of concrete work is the slump test. In order to ascertain the concrete mix's workability or ease of use, this test, which can be conducted in the field or in a lab, was conducted. The slump test is shown in Figure 5.

Fig 5: Slump test

2.3.5.2 Compacting Factor Test

This was carried out in order to assess the concrete's workability. The weight of the partially compacted concrete divided by the weight of the same volume of fully compacted concrete is known as the compaction factor. The test for compacting factors is shown in Figure 6.

The compacting factor is computed using this formula:

$$\text{Compacting Factor} = \frac{\text{Weight of partially compacted concrete}}{\text{Weight of fully compacted concrete}}$$

Fig 6: Compacting factor test

2.3.6 Production of Concrete Cubes

In the concrete laboratory, a total of sixty 150 x 150 x 150 mm concrete cubes were cast, cured, and tested for strength at ages 7, 14, 21 and 28, respectively. Shredded waste plastic was used in place of fine aggregate (sand) in the following percentages: 0%, 10%, 20%, 30%, and 40%.

Fig 7: Production of concrete cubes

2.3.6.1 Estimation of Concrete Materials/ Mix Design

The estimation of concrete materials involves determining the quantity of materials such as fine aggregate, coarse aggregate, cement, shredded plastic waste fibre, and water used for the experiment. The results of the estimated material are presented in Table 1.

The quantity of concrete materials for this project are calculated using these formulas:

Volume of one mould = 0.15 x 0.15 x 0.15 (m^3)

Mix proportion = 1:2:4 (Cement: Sand: Granite, a: b: c)

Volume of wet concrete = 1 m^3

Dry volume = Wet volume + 54% of wet volume

Material (a, b or c) = $\frac{\text{a or b or c}}{\text{a + b + c}}$ x dry volume x density of the material x total volume

Required amount of water = $\frac{\text{Water}-\text{cement ratio}}{\text{Sum of the ratio} + \text{Water}-\text{cement ratio}}$ x density of concrete x volume of concrete x no of cubes

Table 1: Result of estimated materials

Plastic (%)	Cement (kg)	Sand (kg)	Granite (kg)	Plastic (kg)	Water (kg)
0	14.75	28.69	57.38	0.00	6.50
10	14.75	25.82	57.38	2.87	6.50
20	14.75	22.95	57.38	5.74	6.50
30	14.75	20.08	57.38	8.61	6.50
40	14.75	17.21	57.38	11.48	6.50

2.3.7 Density of Concrete Test

Density of concrete is ratio of the weight of concrete to the volume of concrete. The density of concrete test was carried out at the concrete laboratory and compared to the standard density of concrete, which is 2400kg/m^3. The density of concrete at various replacement of shredded plastic is determined using this formula:

$$\text{Density}\ (\text{kg/m}^3) = \frac{\text{Weight of cube}}{\text{Volume of cube}}$$

2.3.8 Water Absorption Capacity

This is the rate at which the concrete absorbs water. After batching, mixing, and casting of the concrete cubes, the cubes were weighed before curing and after curing. The water absorbed was estimated by subtracting the weight of the concrete cubes before curing from the weight after curing for four different set of days (7, 14, 21, and 28 days). Afterward, the water absorption capacity was then calculated in percentage.

Water absorbed = Weight of cube after curing – Weight of cube before curing

$$\%\ \text{Water absorbed} = \frac{\text{Weight of cube after curing} - \text{Weight of cube before curing}}{\text{Weight of cube before curing}} \times 100\ (\%)$$

2.3.9 Compressive Strength

This is the strength test performed in the laboratory using a universal testing machine which is powered electrically, working hydraulically and was operated manually. After batching mixing, casting, curing and removing the concrete cubes from the curing tank at the specified days, the concrete was weighed and allowed to dry for 24 hours to attain the actual strength before testing them. The load was applied on the cubes until the concrete cube fails/collapses. After the test, analysis was done to compare the compressive strength of concrete at 0% shredded waste plastic to the compressive strength of concrete replaced by shredded waste plastic at percentages of 10%, 20%, 30%, 40%. The following formula was used to calculate the compressive strength of concrete at the end of the experiment. Figure 8 presents the compressive strength test.

$$\text{Compressive Strength}\left(\frac{\text{N}}{\text{mm}^2}\right) = \frac{\text{Compressive load (N)}}{\text{Cross} - \text{sectional area of the specimen (mm}^2)}$$

Fig 8: Compressive strength test

3. Results and Discussion

3.1 Test Results and Discussion on Fine Aggregate

3.1.1 Moisture Content Determination on Fine Aggregate: The moisture content (M.C %) was determined using the following formula:

$$M.C\ (\%) = \frac{W_2 - W_3}{W_3 - W_1} \times 100$$

Where, W_1 = Weight of the empty moisture content pan

W_2 = Weight of the empty moisture content pan and wet sample.

W_3 = Weight of oven dried sample and pan.

Table 2: Moisture content readings

Weight (g)	Sample 1 (g)	Sample 2 (g)	Sample 3 (g)
Weight of the empty moisture content pan (W_1).	23.4	23.4	23.4
Weight of the empty moisture content pan and wet sample (W_2)	135.4	130.2	150.6
Weight of oven dried sample (W_3)	130.2	125.4	140.9

Sample 2

$$M.C\ (\%) = \frac{130.2 - 125.4}{125.4 - 23.4} \times 100 = 4.71\%$$

Sample 3

$$M.C\ (\%) = \frac{150.6 - 140.9}{140.9 - 23.4} \times 100 = 8.26\%$$

Average Moisture Content (%) = $\frac{4.86 + 4.71 + 8.26}{3} = \frac{17.83}{3}$

= 5.94%

The moisture content of the fine aggregate is adequate. This implies that the fine aggregate is suitable for usage. This result was used to regulate the amount of water to be added to each mix of the fresh concrete used during the concrete cube production.

3.1.2 Sieve Analysis (Particle Size Distribution) On Fine Aggregate (sand)

A graph of percentage finer versus the particle size, presented in Figure 9, shows the results from the sieve analysis carried out on fine aggregate (sand).

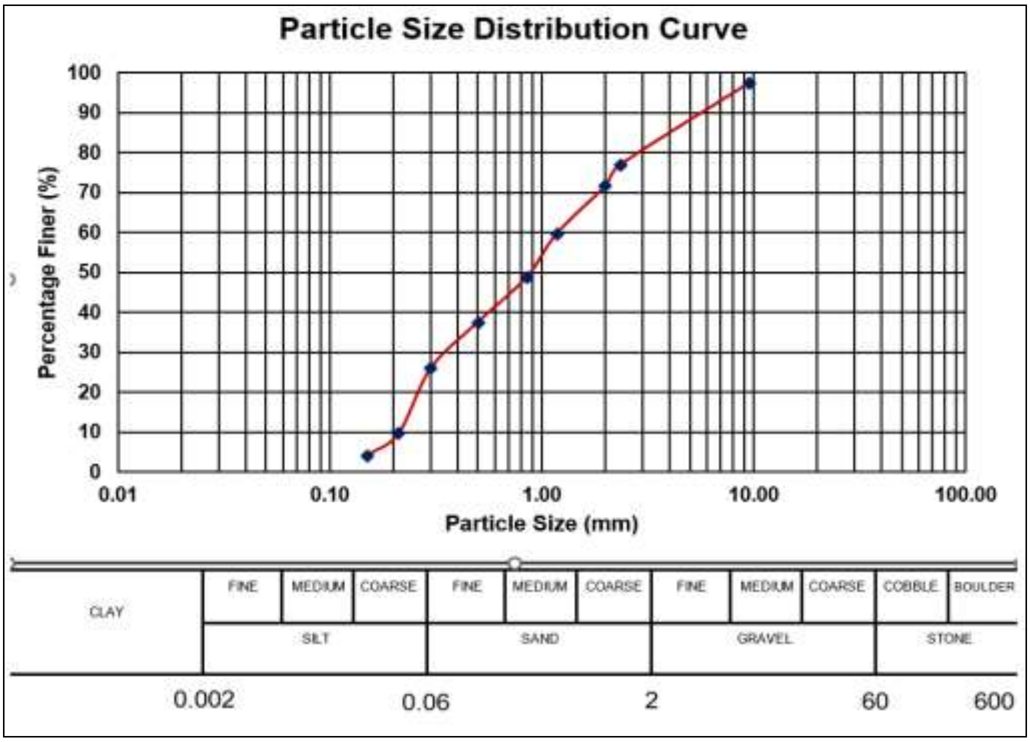

Fig 9: A graph of particle size distribution of fine aggregate (sand)

D_{10} = 0.22 mm
D_{60} = 1.2 mm
D_{30} = 0.35 mm

Therefore
The Effective Size = D10 = 0.22mm

The Uniformity Coefficient, Cu = $\frac{D_{60}}{D_{10}} = \frac{1.2mm}{0.22mm} = 5.5$

The Coefficient of Gradation, Cc = $\frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{0.35^2}{1.2 \times 0.22}$ $= \frac{0.1225}{0.264} = 0.46$

It can be deducted from Figure 9 that the particles sizes of the sample are distributed through the range of fine sand and fine gravel. It's also deducted from the particle size distribution chart that the sample contains no silt/clay particle. The values obtained for the Uniformity Coefficient (Cu) and the Coefficient of Gradation (Cc) indicate that the sample is well-graded.

3.1.3 Sieve Analysis (Particle Size Distribution) On Fine Aggregate (Shredded Plastic)

A graph of percentage finer versus the particle size, presented in Figure 10, shows the results from the sieve analysis carried out on fine aggregate (shredded plastic).

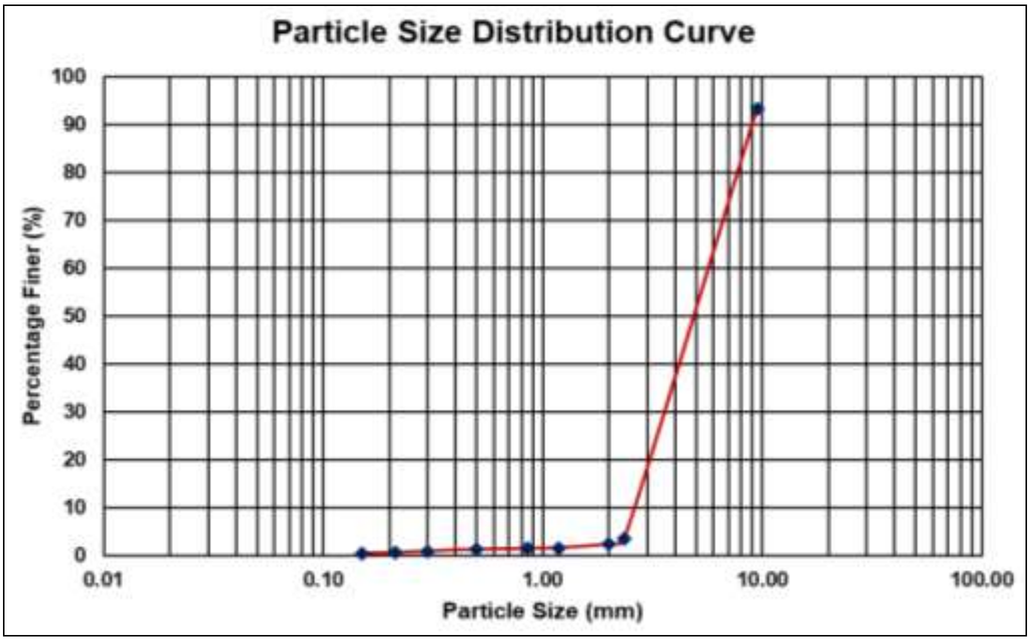

Fig 10: A graph of particle size distribution of fine aggregate (shredded plastic)

D_{10} = 2.6mm
D_{60} = 5.9mm
D_{30} = 3.6mm
Therefore,

The Effective Size = D10 = 2.6 mm

The Uniformity Coefficient, Cu = $\frac{D_{60}}{D_{10}} = \frac{5.9\text{mm}}{2.6\text{mm}}$ = 2.27

The Coefficient of Gradation, Cc = $\frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{3.6^2}{5.9 \times 2.6}$

$= \frac{12.96}{15.34}$ = 0.84

It can be deducted from Figure 10 that the particles sizes of the sample are distributed through the range of 0.1mm and 10mm. The values obtained for the Uniformity Coefficient (Cu) and the Coefficient of Gradation (Cc) indicate that the sample is well-graded.

3.2 Test Results and Discussion on Coarse Aggregate

3.2.1 Sieve Analysis (Particle Size Distribution) On Coarse Aggregate

A graph of percentage finer versus the particle size presented below in Figure 11 shows the results from the sieve analysis carried out on coarse aggregate.

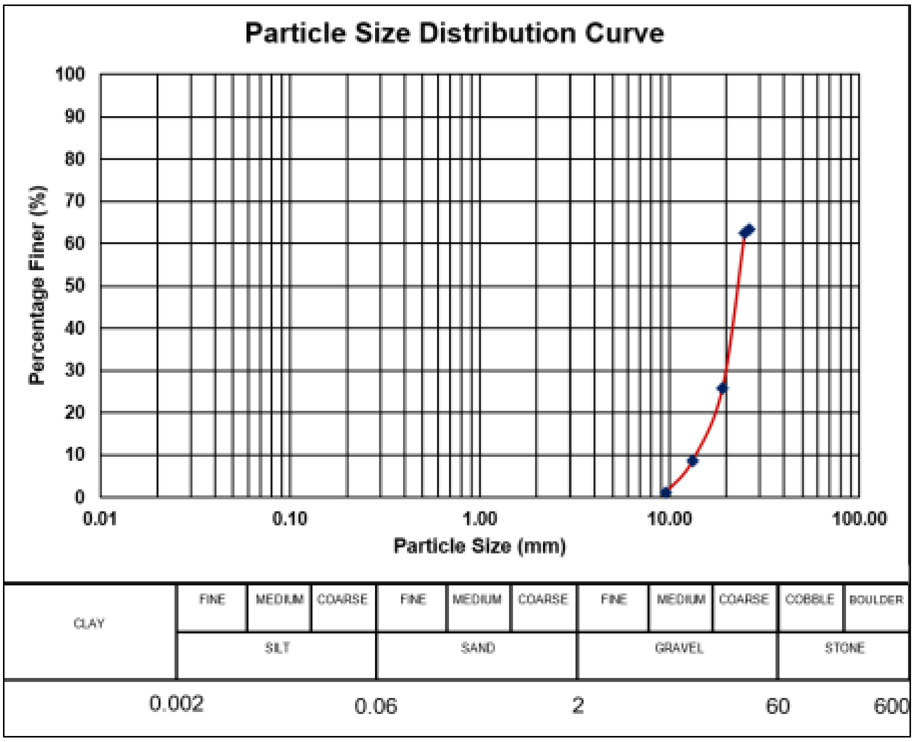

Fig 11: A graph of particle size distribution of coarse aggregate

D_{10} = 14 mm
D_{60} = 25 mm
D_{30} = 20 mm

Therefore,
The Effective Size = D10 = 14 mm

The Uniformity Coefficient, Cu = $\frac{D_{60}}{D_{10}} = \frac{25\text{mm}}{14\text{mm}}$ = 1.79

The Coefficient of Gradation, Cc = $\frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{20^2}{25 \times 14}$

$= \frac{400}{350}$ = 1.14

It can be deducted from Figure 11 that the particles sizes of the sample are distributed through the range of fine gravel and coarse gravel. It's also deducted from the particle size distribution chart that the sample contains no clay, silt and sand particle. The values obtained for the Uniformity Coefficient (Cu) and the Coefficient of Gradation (Cc) indicate that the sample is well-graded.

3.2.2 Aggregate Impact Value Test on Coarse Aggregate

The results obtained from aggregate impact value test for the granite at the laboratory is presented in Table 3 below.

Table 3: Aggregate impact value test result for granite

Observations	Sample 1	Sample 2	Sample 3
Weight of aggregate (W_1)	525.6g	602.7g	616.5g
Weight of aggregate retained in 2.36mm B.S sieve	462.0g	539.83g	538.6g
Weight of aggregate passing through the 2.36mm B.S sieve (W_2)	63.6g	62.87g	77.9g
Aggregate Impact Value (%)	12.1%	10.4%	12.6%
Average Aggregate Impact Value (%)	11.7%		

According to BS 812: Part 112 [32], the aggregate impact value for concrete must not exceeds 30%. Hence, since AIV is less than 30%, this implies that the material is good for construction work.

3.2.3 Aggregate Crushing Value Test on Coarse Aggregate

The results obtained from aggregate crushing value test for the granite at the laboratory is presented in Table 4 below.

Table 4: Aggregate crushing value test result for granite

Observations	Sample 1	Sample 2	Sample 3
Weight of aggregate (W_1)	454.9g	472.1g	466.7g
Weight of aggregate retained in 2.36mm B.S sieve	306.6g	302.6g	287.8g
Weight of aggregate passing through the 2.36mm B.S sieve (W_2)	118.3g	139.3g	128.9g
Aggregate Impact Value (%)	26.0%	29.5%	27.6%
Average Aggregate Crushing Value (%)	27.7%		

According to BS 812: Part 110 [33], the aggregate crushing value for concrete must not exceeds 30%. Hence, since ACV is less than 30%, this implies that the material is suitable for construction work.

3.3 Test Results and Discussion on Fresh Concrete

Tests such as the slump test and the compacting factor test were carried out on fresh concrete at the concrete laboratory to determine the workability of the concrete. The results of both tests are presented in Table 5 and Table 6.

3.3.1 Slump Test

Table 5: Slump test result

Shredded Plastic (%)	0	10	20	30	40
Slump (mm)	38	90	85	110	90

The outcome displayed in Table 5 suggests that adding shredded plastic to concrete raises the concrete's slump (workability). The slump result for the shredded plastic (control) at 0% shows low workability, while the results at 10%, 20%, 40%, shows medium workability and 30% shows high workability, respectively.

3.3.2 Compacting Factor Test

Table 6: Compacting factor test result

Shredded Plastic (%)	0	10	20	30	40
Weight of Partially Compacted Concrete (kg)	16.2	16.3	16.8	15.8	16.2
Weight of Fully Compacted Concrete (kg)	17.6	17.4	17.4	17.2	17.2
Compacting Factor	0.92	0.94	0.96	0.92	0.94

The result shown in Table 6 indicates that as the percentage of shredded plastic increases, the compacting factor (workability of the concrete) also increases.

3.4 Test Results and Discussion on Hardened Concrete

3.4.1 Density: The variation of density of concrete with shredded plastic content at 7, 14, 21, and 28 days is presented in Figure 12. The density of concrete at various replacement of shredded plastic is compared to the standard density of concrete, which is 2400 kg/m^3. The density of concrete at various replacement of shredded plastic is determined using this formula:

$$\text{Density (kg/m}^3) = \frac{\text{Weight of cube}}{\text{Volume of cube}}$$

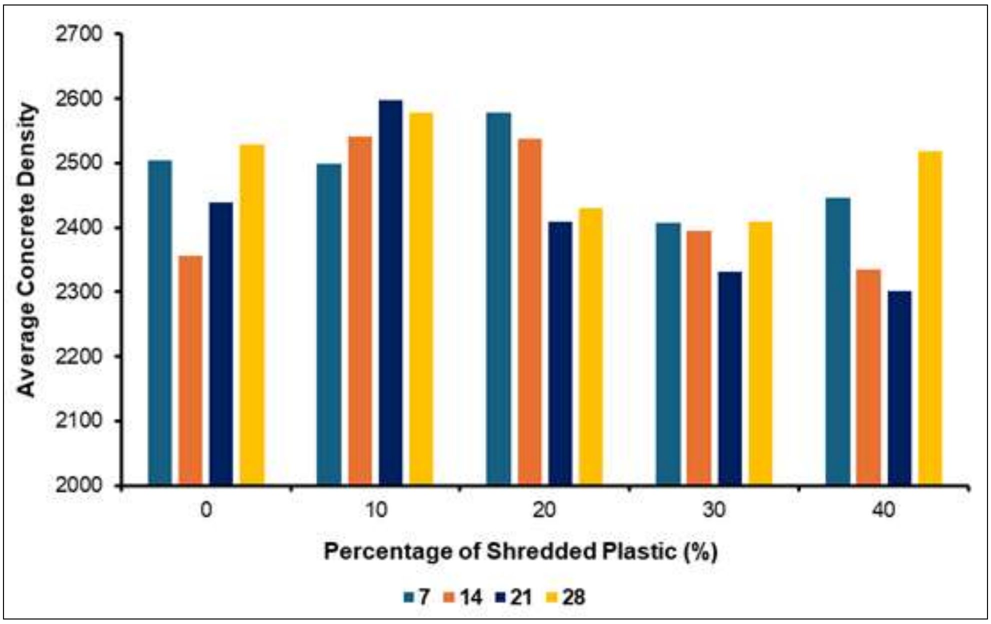

Fig 12: A graph of average concrete density vs percentage of shredded plastic

The results shown in Figure 12 indicates that as the percentage of shredded plastic increases, the weight of the concrete reduces. Additionally, the results indicate that the average density of concrete ranges from 2300 kg/m^3 to 2500 kg/m^3, falling within the range of 2400 kg/m^3. In view of this, the concrete is suitable for construction.

3.4.2 Water Absorption Test Result

Figure 13 indicate the relationship between the average water absorbed by the concrete and the percentage of shredded plastic at various curing days.

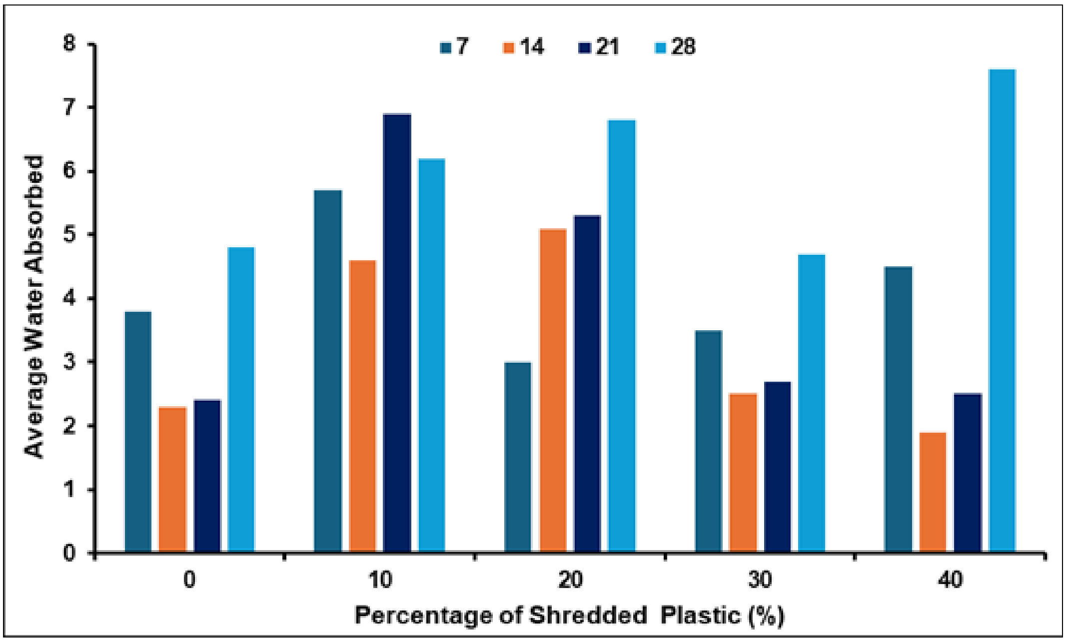

Fig 13: A graph of average water absorbed vs percentage of shredded plastic

From the result in Figure 13, it was observed that after curing the concrete for 28 days, the water absorption rate increases as the percentage of shredded plastic increases.

3.4.3 Compressive Strength Test Result

The Figure 14 and Figure 15 presents the relationship between average compressive strength of concrete and the percentage of shredded plastic at various curing days.

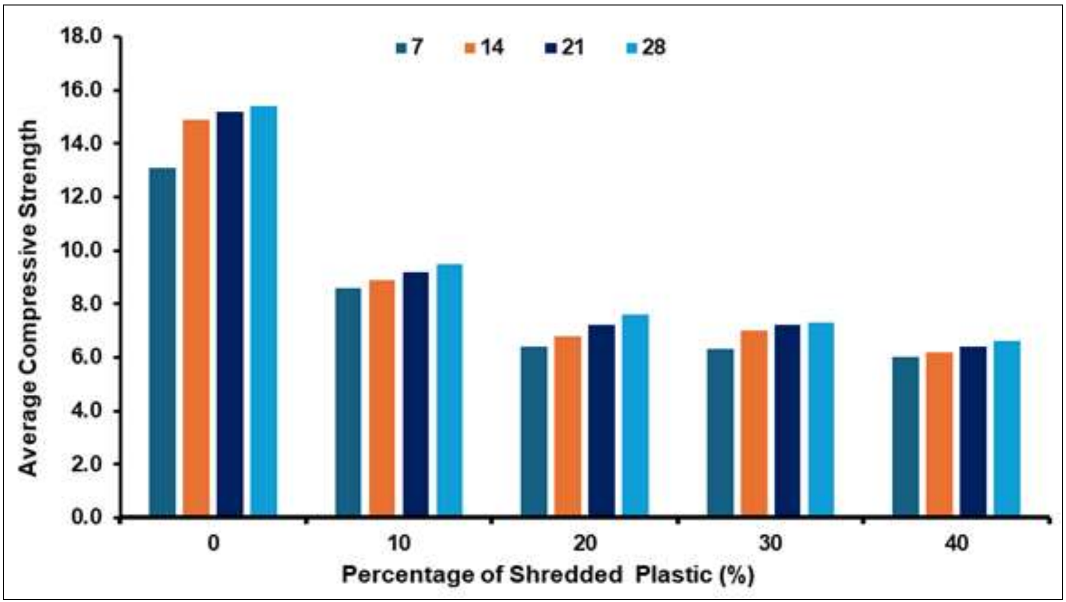

Fig 14: A bar chart of the average compressive strength vs percentage of shredded plastic

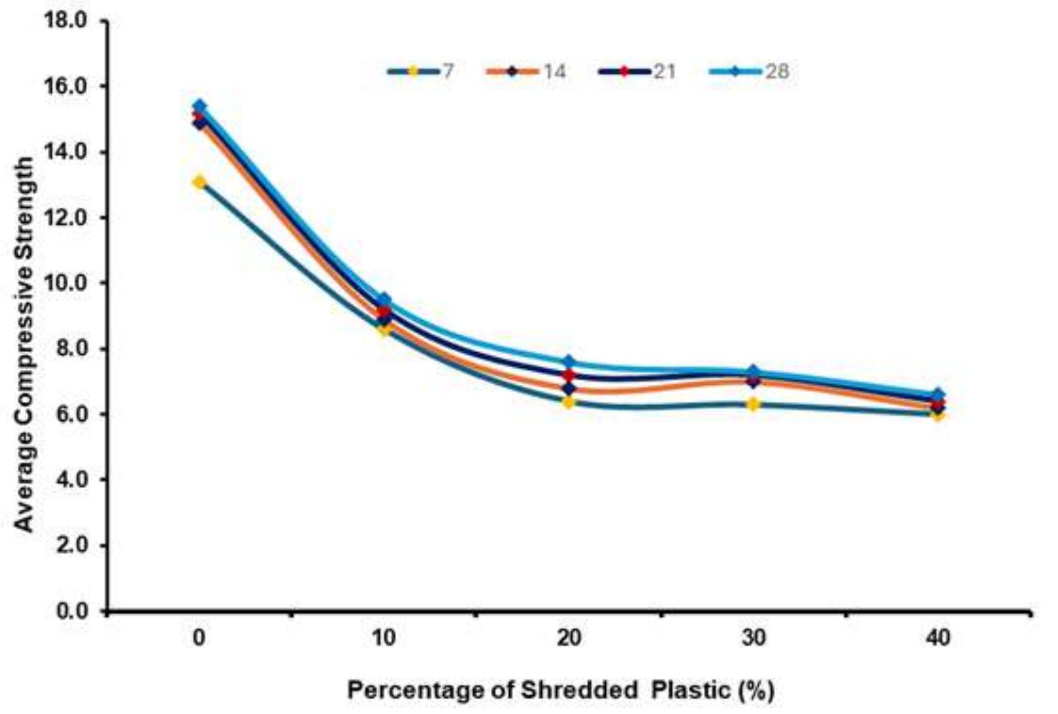

Fig 15: A line graph of the average compressive strength vs percentage of shredded plastic

The compressive strength of concrete decreases as the percentage of shredded plastic increases, according to the results of the compressive strength test shown in Figures 14 and Figure 15. Concrete's tensile strength decreases in tandem with its compressive strength. It was also noted that for 0%, 10%, 20%, 30%, and 40% replacement of shredded plastic, the age of the concrete increases concomitantly with the concrete's compressive strength.

In this study, the equality of concrete strength at various percentages of shredded plastic is tested using ANOVA. Table 7 displays the results of the concrete strength test's one-way analysis of variance (ANOVA).

Table 7: ANOVA result of the strength test

Summary				
Groups	**Count**	**Sum**	**Average**	**Variance**
0%	4.0	58.6	14.7	1.11000
10%	4.0	36.2	9.1	0.15000
20%	4.0	28.0	7.0	0.26667
30%	4.0	27.8	7.0	0.20333
40%	4.0	25.2	6.3	0.06667

Anova						
Source of Variation	**SS**	**DF**	**MS**	**F**	**P-value**	**F crit**
Between Groups	188.788	4.0	47.197	131.346011	1.75414E-11	3.05557
Within Groups	5.390	15.0	0.3593333			
Total	194.178	19.0				

From the ANOVA result of the average compressive strength presented in Table 7, it was observed that $p< 5\%$ which simply means the group yield are significantly different from each other. In addition, it was observed that the average compressive strength yield on the ANOVA table reduces as the percentage of shredded plastic waste fibre increases.

5. Conclusion

Concrete's qualities are negatively impacted by the presence of heavy metals such as Ca, Mg, Mn, Pb, and Fe in wastewater, which is one of the issues that affects building floors. In this study, the strength and durability of the building floor were increased by adding plastic waste (PET) fibre to concrete. At the concrete laboratory, sixty concrete cubes measuring 150 mm by 150 mm x 150 mm were cast, cured, and tested for strength at the ages of 7, 14, 21, and 28. Shredded plastic waste (PET) fibre was used in place of fine aggregate (sand) in the following percentages: 0%, 10%, 20%, 30%, and 40%. This study revealed that the age of concrete for 0%, 10%, 20%, 30%, and 40% replacement of shredded plastic increases the concrete's compressive strength at the same time. In addition to offering a solution to the wastewater's detrimental effects on building floors, this research will contribute to the decrease of plastic waste produced in Nigeria. It will prevent pollution of the environment, lessen the usage of conventional materials like cement that contribute to climate change by releasing carbon emissions into the atmosphere, and have an impact on several lives and infrastructures. All things considered; it will make a major contribution to Nigeria's efforts to combat plastic pollution.

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