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Experimental Study On Utilisation Of Waste Plastics As A Partial Replacement Of Fine Aggregate In Concrete

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ABSTRACT: One of the numerous causes wreaking havoc on the global ecosystem is plastic trash. Problems arise as a result of variables such as the difficulty of recycling plastic and its restricted usage. Plastic is a significant kind of solid waste with significant global environmental consequences. The purpose of this experiment is to see how using poly-ethylene terephthalate (PET) as a partial replacement for fine aggregate in concrete affects the results. This material's impacts on the physical and mechanical characteristics of concrete were investigated. A set of six concrete mixes using poly-ethylene terephthalate (PET) as a partial replacement for fine aggregate were created, with substitution levels of 0%, 10%, 20%, and 30%. The purpose of this experiment was to see how fresh and cured concrete behaved in terms of Slump Cone, compressive strength. The testing findings revealed a decrease in unit weight, that fine aggregate substitution damaged the mechanical characteristics of concrete at different rates, and that plastic waste can be disposed of in specified ratios, proving that it may be successfully used in industrial applications.

Keywords: poly-ethylene terephthalate (PET), Slump Cone, compressive strength, recycled plastic

I. INTRODUCTION

One of the most significant problems in environmental conservation is the rising use of different kinds of plastic goods. Large amounts of plastic trash, as well as its poor biodegradability, have a detrimental impact on the environment. All kinds of plastic used by people in everyday life ultimately become trash; storing several tonnes of these plastic wastes takes up a lot of space, and they can't all be recycled at the same time. Globally, about 6.5 billion tonnes of plastic trash and wasted rubber are produced each year; the disposal of these polymers, owing to their lengthy breakdown periods, represents a significant danger to the environment. Waste reuse is essential from a variety of viewpoints because it helps to recycle and save energy in the manufacturing process, lowers pollution, and helps to maintain and conserve nonrenewable natural resources. Using plastic waste in the materials business is an environmentally friendly way to reduce the amount of trash incinerated in landfills. Plastic has been proven to work in concrete in studies, and this kind of material has been a significant study topic in recent years. The lightweight construction materials business is seen to be beneficial in encouraging reused materials. Replacement of natural aggregates with lightweight materials often results in a reduction in concrete unit weight. In the building business, weight reduction is a critical goal. Lightweight concrete offers a number of benefits, including a strong thermal insulation response of the structure and lower handling and production costs. Earthquake forces are known to be linearly dependent on the self-weight of constructed buildings; therefore, as this self-weight reduces, the effect of an earthquake is lessened. Polypropylene (PP), polyethylene terephthalate (PET), and high-density polyethylene (HDPE) have all been investigated in recent years (HDPE). The effect of adding plastic material to fresh and hardened concert has been studied. Workability findings have varied, with most studies reporting a propensity to decline when the replacement level is increased, while the slump of new concrete increases as the replacement ratio is increased. All studies agree that when the replacement level rises, the unit weight decreases. Furthermore, most studies indicate that using plastic waste in concrete reduces compressive strength. Several researchers have investigated the use of plastic waste in concrete. The purpose of this research is to see whether PET may be used in lieu of sand in concrete. To evaluate the effect of replacement levels on concrete characteristics, a concrete mix with a 28-day compressive strength of 35 MPa was produced, and natural sand was substituted with 10%–30% crushed recycled plastic. The impact on workability and mechanical characteristics was assessed. The goal of this research is to create and promote the usage of a sustainable concrete mix.

1.1 CONCRETE

Concrete is the world's most extensively used man-made building material, second only to water, and is produced by combining concrete components, and occasionally admixtures, in the proper quantities. When poured into moulds and left to cure, the mixture hardens into a rock-like mass known as concrete. Because the hardening is produced by a long-lasting interaction between water and cement, the concrete may also be regarded an artificial stone in which the spaces of fine aggregate are filled with cement. In a concrete mix, combine the cementing material and water form a paste known as cement water-paste, which, in addition to filling fine aggregate voids, coats fine aggregate surfaces and binds them together as it dries, cementing fine aggregate particles together in a compact mass.

1.2 Plastics

Plastics now play a significant part in our everyday lives. Plastics are used in almost every aspect of production. Every day, thousands of tonnes of plastic goods are manufactured, and the trash continues to pile up. Because most plastics are not biodegradable, a massive quantity of plastic trash continues to accumulate throughout the globe, with developed countries contributing the most. More particular, packaging and containers account for the bulk of plastic waste. The quantity of land needed for landfills is becoming a growing source of worry throughout the globe. From 1950 to 2018, an estimated 6.3 billion tonnes of plastic were manufactured globally, with 9 percent recycled and the remaining 12 percent burned. Each year, India consumes more than 5 million tonnes of plastic, of which only about a quarter gets recycled, with the rest ending up in landfills. This massive quantity of plastic trash will eventually end up in the ecosystem, with research estimating that plastic debris may be found in the bodies of 90% of seabirds.

Plastic type	Name	Properties	Density Range	Common Uses
1 PETE	Polyethylene Terephthalate	Tough, rigid, shatter-resistant softens when heated	1.38-1.39 g/mL	Soda, water, juice, and cooking oil bottles
2 HDPE	High Density Polyethylene	Semi-rigid, tough, and flexible	0.95-0.97 g/mL	Milk and water jugs, bleach bottles
3 PVC	Polyvinyl Chloride	Strong, semi-rigid, glossy	1.16-1.35 g/mL	Detergent bottles, shampoo bottles, shrink wrap, pipes
4 LDPE	Low Density Polyethylene	Flexible, not crinkly, moisture proof	0.92-0.94g/mL	Garbage bags, sandwich bags, 6-pack rings
5 PP	Polypropylene	Non-glossy, semi-rigid	0.90-0.91 g/mL	Yogurt cups, margarine tubs, screw-on lids/caps
6 PS	Polystyrene	Often brittle, sometimes glossy, often has strong chemical reactions	1.05-1.07 g/mL	Styrofoam, egg cartons, packing pellets, take-out containers

1.3 NEED OF PROJECT:

River erosion, fine aggregate demand, and other environmental problems have resulted in a shortage of river sand nowadays. The decrease in natural sand supplies, along with the desire to reduce the cost of concrete production, has led in a greater need to discover new alternative materials to replace river sand in order to avoid excessive river erosion. The use of substitute materials such as plastics, quarry dust, polyethylene terephthalate, iron slag, and others to partially or completely replace natural sand has been studied over the last two decades in order to preserve the ecological balance. This paper presents one experimental study of the strength properties of PET-Polyethylene Terephthalate in place of natural sand.

1.4 SCOPE

The research adds to and aids in the creation of new, ecologically friendly concrete binders. The impact of PET-Polyethylene Terephthalate on the strength and durability of concrete characteristics was extensively studied in this research.

Pulverized PET-Polyethylene Terephthalate is used to replace fine aggregate in OPC paste and concrete in various amounts ranging from 0% to 30%. Prior to being pulverised into powder, the granulated PET-Polyethylene Terephthalate was evaluated for its physical properties, such as aggregate grading, water absorption, and relative density, in contrast to typical fine aggregates used in concrete production.

II. MATERIALS

The following materials are used for the present work Cement

1. Fine aggregate
2. Coarse aggregate
3. Water
4. Plastic (poly Ethylene terephthalate)

2.1.Cement

Cement is a bonding substance with cohesive and adhesive characteristics that allows it to connect various building materials and compacted assemblies. Cement is a binder, a substance that sets and hardens as it dries, and may bind other materials together depending on how it interacts with carbon dioxide in the air. Lime, silica, alumina, and iron oxide are the most common basic ingredients used in cement production. In the kiln, these oxides react with one another to create more complicated compounds. The relative quantities of different oxide compositions have an impact on the various characteristics of cement, as well as the rate of cooling and grinding fitness. We utilised 53 Grade in this project

A.Ordinary Portland Cement:

The most common kind of cement is ordinary Portland cement (OPC). All of the previous chapter's talks, as well as the majority of the next chapters' debates, have been focused on OPC. There was just one grade of OPC before to 1987, which was regulated by IS 269-1976. Higher-grade cements were introduced in India after 1987. Based on the strength of the cement at 28 days when tested according to IS 4031-1988, the OPC was categorised into three grades: 33, 43, and 53. 33 grade cements have a 28-day strength of not less than 33N/mm2, 43 grade cements have a strength of not less than 43N/mm2, and 53 grade cements have a strength of not less than 53N/mm2.

However, the real strength of the manufacturing specimens isn't significantly greater than the BIS standards. Using high-quality limestone, contemporary technology, and tighter online control of components, it has been able to improve the characteristics of cement. This has resulted in improved practical size distribution, final grinding, and packaging. The use of higher-grade cement has a number of benefits in terms of producing stronger concrete. Despite the fact that they are somewhat more expensive than low-grade cement, they provide a 10-20% reduction in cement composition as well as a slew of other advantages.

Table 2.1: Approximate Oxide Composition Limits Of Ordinary Portland Cement

Chemical Compound	Percentage
Lime, (CaO)	60-66
Silica, (SiO_2) Alumina , (Al_2O_3)	17-25 3-8
Iron Oxide, (Fe_2O_3)	0.5-6
Magnesia , (MgO)	0.5-4
Sulphur Trioxide, (SO_3)	1-2
Alkalis	0.5-1.3

2.1.1. Fine Aggregate:

When fine aggregates pass through a screen size of less than 4.75mm, they are referred to as fine aggregates. The separation limit for coarse and fine aggregates is 4.75mm. Aggregates with a diameter more than 4.75mm are classified as coarse, while those with a diameter less than 4.75mm are classified as fine. Natural sand or, subject to permission, other insert material with comparable qualities, or mixtures of hard, robust, durable particles should make up the fine aggregate. Fine aggregates from various sources must not be combined or kept in the same pile, nor utilised in the same class of building or mix in any order. The fine aggregate should be devoid of harmful inorganic and organic contaminants. The purpose of fine aggregates is to fill the spaces left by coarse aggregates. Fine aggregate is mostly composed of silica. In this study, sand that passes through an IS sieve of less than 4.75mm is chosen as a fine aggregate material for concrete production.

2.1.2. Coarse Aggregate:

Because aggregate makes up at least three-quarters of the volume of concrete, it's no surprise that its quality is so important. The aggregate characteristics have a significant impact on the concrete's durability and structural performance. Coarse aggregate is defined as particles with a diameter larger than 4.75 mm. Because coarse aggregates are the primary load bearing components of concrete, they take up more space than cement and fine aggregates. In the finest concrete producing technique, the quality and amount of these are very important.This is the current project; the coarse aggregates used are a mix of 20 mm and 12 mm in size. For this project, 60 percent of 20 mm and 40 percent of 12 mm were selected.

2.1.3 Drinking Water:

Water is an essential component of concrete because it is involved in the chemical process known as hydration. By releasing the products of hydration known as tri calcium silicates and di-calcium silicates, this hydration gives the cohesive character to the cement particles in binding the coarse and fine aggregates. In effective concrete practise, the amount and quality of water are critical. Extra concrete is deemed a felony if it exceeds the required amount. Because it creates capillary holes in concrete, it may significantly decrease the strength of the material. The usual yardstick for quality is "the water that is utilised for drinking water may be a suitable match for concrete production." This project makes use of potable water. For this research, a W/C ratio of 0.50 was used.

2.1.4 Poly Ethylene Terephthalate (PET):

PET or PETE stands for polyethylene terephthalate, which is a thermoplastic polymer that belongs to the polyester family. Polyester resins are well-known for their outstanding mix of mechanical, thermal, chemical, and dimensional stability characteristics.

PET is one of the most recycled thermoplastics, and its recycling sign is the number "1."

PET that has been recycled may be made into fibres, textiles, and sheets for packaging and automobile

components. Poly butylene terephthalate is chemically extremely similar to Poly ethylene terephthalate. PET is a semi-crystalline resin that is extremely flexible, colourless, and semi-crystalline in its natural form. It may be semi

stiff to rigid depending on how it's treated. It has excellent dimensional stability, impact resistance, moisture

resistance, and resistance to alcohols and solvents.

2.2 TESTING ON MATERIALS

2.2.1 Test on cement

The following tests are done on the cement

- **a.** Fineness test
- **b.** Specific gravity test.
- **a. Fineness of cement:**

Place 100 grammes of cement on a normal 90 micron IS sieve and weigh it precisely. Fingers should be used to break down any air-set lumps in the cement sample. For 15 minutes, sift the sample continuously in a circular and vertical motion. Sieving devices that are mechanical may also be utilised.Weigh the residue that has accumulated on the sieve.

The weight of residue as a proportion of the entire sample is given as,

$$\% \text{ Weight of residue} = \frac{\text{Weight of sample retained on sieve}}{\text{Total Weight of sample}}$$

The proportion of residue in the sample should not be more than 10%.

Table 2.2: Observations of Fineness of Cement Test

Trail No.	1	2
Weight of cement in grams	100	100
Weight of residue on sieve in grams	4	4
Amount retained	4	4

Fineness of cement = 4%.Hence it is within the permissible limits.

- **b. Specific Gravity Test:**

Take a particular gravity bottle and clean and dry it before weighing it (W1). Fill the specific gravity bottle halfway with water and weigh the water weight using the bottle (W2). After draining the water and drying the specific gravity container, fill it with kerosene up to the rim (W3). Fill the specific gravity bottle with cement and use the weight of the container to calculate the weight of the cement (W5). Fill the specific gravity bottle with kerosene and calculate the weight of the bottle with kerosene and cement as follows: (W4).

According to IS: 456-2000

Limits: Specific Gravity of cement <3.15gm/cc

TABLE 2.3: OBSERVATIONS OF SPECIFIC GRAVITY OF CEMENT TEST

S.NO	Description	Trial(gm)
1	Mass of empty bottle(W_1)gm	50.0
2	Mass of bottle + water (W_2)gm	182.0
3	Mass of bottle + kerosene (W_3)gm	155.0
4	Mass of bottle + cement + kerosene (W_4)gm	192.2
5	Mass of cement (W_5)gm	50.0

Specific gravity of cement (G) $= \frac{W5(W3-W1)}{(W5+W3-W4)(W2-W1)}$

$= \frac{50(155-50)}{(50+155-192.2)(182-50)}$

= 3.11 gm/cc

The specific gravity of cement obtained is 3.11 gm/cc.

Hence it is within the permissible limit.

Table 2.4. Test results of cement

S.NO	Properties		Results	Suggested values as per IS Specification
1	Fineness of cement		4% retained	<10%
2	Specific Gravity		3.11	<3.15

2.3.Tests on Fine Aggregate (sand):

The tests below are carried out to determine the characteristics of fine aggregates:

a. Grading of sand

b. Specific gravity and water absorption Test

a. Grading of Sand –Sieve Analysis: By quartering a 50 kg sample via a riffle box, you can get 1 kilogramme of sample. Arrange the appropriate sieves one on top of the other, with the sieve size increasing as you go closer to the top. Place the pan on the bottom of the pot. Cover the sieve and place it in the top sieve. In a sieve shaker, agitate the sieves for 20 to 30 minutes. Weigh the material retained in each filter as well as the pan. Determine its fineness modulus based on its grading parameters.

The sizes of sieves use are: 4.75 mm, 2.36 mm, 1.18mm, 600μ, 300μ, 150μ and a pan.

TABLE 2.5: OBSERVATIONS OF SIEVE ANALYSIS TEST:

S.NO	Sieve size	Weight retained	% Weight retained	Cumulative % of weight retained	% weight passing	Cumulative % weight passing
1	4.75mm	9	0.9	0.9	99.1	99.1
2	2.36mm	11.6	1.16	2.06	97.94	197.04
3	1.18mm	188.5	18.85	20.91	79.01	276.05
4	600μ	300	30.0	50.91	49.09	374.15
5	300μ	380	38.0	88.91	11.01	385.16
6	150μ	102.5	10.25	99.16	0.84	386
7	Pan	6	0.6	99.76	0.24	386.24

From the table the fineness modules of the sand $=\frac{\sum F}{100}=\frac{386.24}{100}=3.86$

Hence it is within the permissible limits.

b. Specific Gravity of fine Aggregate (sand):

Take the clean, dry density bottle and weigh it as W1. Fill a density bottle halfway with oven dry soil that has passed through a 4.75mm sieve, and weigh it as W2. In the event of medium to coarse-grained soil, take 200 grammes. Fill the density bottle halfway with distilled water and thoroughly mix it with the glass rod. Replace the sieve top and fill the density bottle with water from the outside, weighing it as W3. Remove the contents, wash the density bottle, and fill it with distilled water to the conical cap's hole. Weigh it as W4.

Table 2.6. Observations of Specific Gravity of Fine Aggregate Test:

S.NO	Description	Trail(gm)
1	Weight of density bottle (W_1)gm	181
2	Weight of density bottle + Dry soil (W_2)gm	381
3	Weight of density bottle + Dry soil + Water (W_3)gm	879

4	Weight of density bottle + Water (W_4)gm	752

$$\text{Specific gravity of sand} = \frac{W2-W1}{(W4-W1)-(W3-W2)}$$

$$= \frac{(375-181)}{(752-181)-(879-381)}$$

$$= 2.65$$

Table 2.7: Test Results of Fine Aggregate

S.NO	Properties	Results
1	Grading of sand	3.86
2	Specific gravity	2.65

Hence these values are within the permissible limits.

Tests on coarse aggregate:

To determine the characteristics of coarse aggregate, the following experiments are carried out:

a. Water absorption and specific gravity tests

a. Crushing value of aggregates test

c. test of the total impact value

a. Water Absorption and Specific Gravity Test:

A sample of aggregate weighing at least 2 kg is collected. The aggregate is carefully cleaned to remove the finer particles and dust that have adhered to it. After that, it's put in a wire basket and submerged in distilled water at a temperature of 22 to 32 degrees Fahrenheit. The entrapped air was eliminated from the sample immediately after immersion by raising the basket containing 25 mm above the tank's base and letting it to drop 25 times at a rate of approximately 1 drop per second. During the procedure, it is important to keep the basket and aggregate fully submerged in water. They are then submerged in water for a duration of 24 + 12 hours. The basket and aggregate are then shocked and weighed (W1) in water between 220 and 320 degrees Celsius. After removing the basket and aggregate from the water and allowing them to drain for a few minutes, the aggregate is removed from the basket and put on a dry towel, where it is gently dried. The aggregate is then moved to a second dry towel to be dried further. The empty basket is submerged in water for a second time, shocked 25 times, and weighed in water (W2). The aggregate is exposed to the environment for at least 10.10 minutes, away from direct sunlight, until it looks fully dry on the surface.

The aggregate is then weighed in the air (W3). The aggregate is then baked at a temperature of 100 to 1100 degrees Celsius for 24 hours and 12 hours. It is then chilled and weighed in an airtight container (W4).

Table 2.8: Observation of Specific gravity and Water Absorption of Coarse Aggregate

S.No	Details	Values
1	Water of saturated aggregate suspended in basket with water (w1) gm	2750
2	Weight of basket suspended in water (w2) gm	750
3	Weight of saturated aggregate in water (ws) gm= w1-w2	2000
4	Weight of saturated surface dry aggregate in air (w3) gm	3133
5	Weight of water equal to volume of aggregate (w3-ws) gm	1133
6	Weight of oven dried fine aggregate (w4) gm	2994

Specific gravity = $\frac{w4}{w3-(w1-w2)} = \frac{2994}{3133-2000}$ = 2.64 gm/cc

Apparent specific gravity = $\frac{w4}{w4-(w1-w2)} = \frac{2994}{2994-2000}$ = 3.01 gm/cc

Water absorption = 100× $\frac{3133-2994}{2994}$ = 0.40%

LIMITS:

The specific gravity of aggregate ranges from 2.5-3.0

The water absorption ranges from 0.1-2.0%

The specific gravity of coarse aggregate is determined to be 2.64, and its water absorption is 0.40 percent.

As a result, these two are inside the acceptable range.

b. AGGREGATE CRUSHING VALUE TEST

The standard aggregate crushing test is performed using material that has passed through a 12.5mm IS sieve and has been kept on a 10mm IS sieve. Other sizes up to 25mm may be tested if needed or if the normal size is not available. However, since the aggregate is not homogeneous, the findings will not be comparable to those obtained in the conventional test. A total of 6.5 kg of aggregate that passes the 12.5mm and 10mm sieves is collected. In three layers of about equal depth, the aggregate is filled in to the standard cylindrical measure in a surface dry state. Each layer is tamped with the tamping rod 25 times before being levelled with the tamping rod as a straight edge. The weight of the sample in the cylinder is calculated (A). For the following repeat test, the same weight of the sample is used. The test equipment cylinder is placed on the base plate with the aggregate filled in a conventional way, the aggregate is properly levelled, and the plunger is inserted horizontally on this surface. The plunger must not get stuck in the cylinder. The equipment is put on the compression testing machine with the test sample and plunger in place, and it is evenly loaded up to a total load of 40 tonnes in 10 minutes. The load is released, and the whole contents of the cylinder are withdrawn and sieved on a 2.36mm IS Sieve. The percentage of the sample that passes through the sieve is weighted (B).

The aggregate crushing value = $\frac{B}{A} * 100$ Where,

B = Weight of friction passing 2.36mm sieve.

A = In a mould, weigh a surface-dry sample. The aggregate crushing value for concrete other than for wearing surfaces shall not exceed 45 percent, and 30 percent for concrete used for wearing surfaces such as runways, highways, and air field pavements.

TABLE 2.9 OBSERVATION AND CALCULATIONS

S.NO	**TOTAL WEIGHT OF AGGREGATE SAMPLE (A) gm**	**WEIGHT OF FINE PASSING 2.36mm IS SIEVE(B) gm**	**AGGREGATE CRUSHING VALUE =$\frac{B}{A}$*100**
1	2711.5	447.0	16.5

The crushing value of given aggregate is 16.5%. As per IS: 456-2000, it should be less than 30%.

C. **AGGREGATE IMPACT VALUE TEST:**

The aggregate impact value is a measure of an aggregation's resistance to abrupt shock or impact. This aggregate's resistance to a gradual compressive force is different.

The test samples are made up of aggregate that has passed through a 12.5mm sieve and has been kept on a 10mm IS sieve.

The aggregate must be dried and chilled in an oven for 4 hours at a temperature of 1000 C to 1100 C. The aggregate is poured to approximately one-third capacity and tamped with the tamping rod for 25 strokes. A comparable amount of aggregate is added and tamped in the traditional way. The measure is filled till it overflows, then levelled. The net weight of aggregate in the measure (weight A) is calculated, and this weight of aggregate is utilised in the duplicate test on the same material. The whole sample is placed in a cylindrical steel cup that is securely attached to the machine's base. A 14kg hammer is lifted to 380mm above the top surface of the aggregate in the cup and then allowed to fall freely on the aggregate. The test sample will be exposed to a total of 15 such hits, each given at a one-second interval. The crushed aggregate is taken from the cup and sieved on a 2.36mm IS sieve in its whole. The percentage that passes through the sieve is weighted to a precision of 0.1gm (weight B). The weight of the fraction retained on the sieve is also calculated (weight C). If the total weight (B+C) is more than one gramme less than the starting weight (A), the findings must be rejected and a new test performed. Two tests are carried out. In each test, the weight of fines formed is reported as a percentage of the overall sample weight.

Therefore, aggregate impact value $=\frac{B}{A} * 100$

Where,

B= Weight of fraction passing 2.36mm IS Sieve.

A= The weight of the sample after it has been dried in the oven. For aggregates used in concrete other than wearing surfaces, the aggregate impact value should not exceed 45 percent by weight, and for concrete used as wearing surfaces, such as runways, highways, and pavements, the aggregate impact value should not exceed 30 percent by weight.

TABLE 2.10 RESULTS OF AGGREGATE IMPACT TEST:

S.NO	DETAILS	TRAILS
1	Total weight of aggregate sample filling in the cylindrical measure=(a)gm	1282
2	Weight of aggregate passing 2.36mm sieve after the test = (b)gm	923
3	Weight of aggregate retained on 2.36mm sieve after the test= (c)gm	53.5
4	Difference in the weight = a-(b+c) gm	359
5	Aggregate impact value $=\frac{B}{A} * 100$	14.902%

According to IS: 456-2000, the effect value of a particular aggregate is 14.902 percent; it should be less than 45 percent, therefore it is likewise within acceptable limits.

TABLE 2.11: TEST RESULTS OF COARSE AGGREGATES:

S.NO	PROPERTIES	RESULTS	SUGGESTED VALUES AS PER IS: 456-2000 SPECIFICATIONS
1	Specific Gravity	2.82	2.3 to 3.0
2	Water Absorption	0.35%	0.1% to 2.0%
3	Crushing Value	16.5%	30%
4	Impact Value	14.902%	45%

III.Plastic (poly Ethylene terephthalate):

PET is one of the most recycled thermoplastics, and its recycling sign is the number "1."

PET that has been recycled may be made into fibres, textiles, and sheets for packaging and automobile components. Poly butylene terephthalate is chemically extremely similar to Poly ethylene terephthalate.

PET is a semi-crystalline resin that is extremely flexible, colourless, and semi-crystalline in its natural form. It may be semi-stiff to rigid depending on how it's treated. It has excellent dimensional stability, impact resistance, moisture resistance, and resistance to alcohols and solvents.

Plastics that can't be deteriorated any more are ground into fine powder. The majority of these polymers are made of high-density polyethylene (HDPE)

3.1 Uses OF Plastic

Plastic's popularity is growing due to its many advantages, which include:

- Lighter weight than comparable materials, lowering transportation fuel use.
- Longevity and durability
- Chemical, water, and impact resistance
- Excellent insulation qualities, both thermally and electrically.
- Lower manufacturing costs in comparison.

IV.METHODOLOGY

The procedure for the research "partial replacement of natural sand with Polyethylene terephthalate" is as follows.

The sand in the M20 concrete mix is partly replaced with polyethylene terephthalate up to 30% at intervals of 10%, i.e. 0%, 10%, 20%, and 30%. The following table provides a quick overview of the project.

THEME: Up to 80% replacement of sand with polyethylene terephthalate, with a 10% interval.

CEMENT USED: OPC M20 Concrete Mix proportions are used i.e., 1:1.5:3 No. of days cured: 7&28 days.

1:1.5:3 ; 10kg: 15kg: 30kg

So, for each percent replacement, 6 cubes were cast, with 3 cubes allocated for every 7 and 28 days of curing to evaluate compressive strength.

Table 4.1: Details of Cement, FA, CA and PET Composition in Concrete

	Materials used to cast cubes

% of Poly ethylene terephthalate	Cement(kg)	F.A + Poly ethylene terephthalate	C.A	W/C Ratio
0%	10	15+0	30	0.54
10%	10	13.5+1.5	30	0.54
20%	10	12+3	30	0.54
30%	10	10.5+4.5	30	0.54

The following procedural stages are followed in order to achieve the work's goal.

1. Batching
2. Mixing
3. Casting of cubes
4. Compaction
5. Curing
6. Testing

4.1. BATCHING:

It is the process of measuring and adding concrete mix components into the mixture, either by volume or by mass. Batching has traditionally been done by volume, however most standards demand batching by mass rather than volume.

coarse aggregate

Fine aggregate

Cement

poly ethylene terephthalate

4.2 MIXING

Mixing should take place on a non-porous surface. In alternating layers, spread out the specified amounts of coarse and fine aggregate. Pour the cement on top of it and mix it dry with a shovel, stirring the mixture many times until the colour is consistent. This homogeneous mixture is applied in a 20cm thick layer. The mixture is sprinkled with water and flipped over at the same time. This process is repeated until a nice uniform, homogenous concrete is achieved. It's also important to note that the water is sprinkled rather than poured. To get the desired consistency, a little amount of water should be added towards the conclusion of the mixing process. Even a little amount would suffice at that point.

(i) Workability testing of concrete mix:

Concrete compaction of 100 percent is an essential factor in achieving optimum strength. Lack of compaction will result in air spaces, which will have an equivalent or greater impact on strength and durability than the existence of capillary cavities. Workable concrete is defined as concrete that meets the following specifications. The phrase "workability" or "workable concrete" has a considerably broader and deeper meaning than the term "consistency," which is frequently used interchangeably with workability. Consistency is a broad word that refers to the degree of fluidity or movement. The word "workability" refers to the "property of concrete that affects the amount of beneficial internal work required to achieve complete compaction." Another definition that has a broader meaning is the "Ease with which concrete may be compacted 100 percent regardless of method of compaction and location of deposition."

4.2.1 SLUMP CONE EXPERIMENT:

It's the most popular technique for determining the consistency of concrete, and it may be used in the lab or on the job site. It's not a good technique for extremely wet or very dry concrete, it doesn't account for all variables that affect workability, and it's not always indicative of concrete's ability to be placed. It is, nevertheless, useful as a control test and indicates the consistency of concrete from batch to batch. If the weights of aggregate cement and admixture are consistent and aggregate grading is within attainable limitations, repeated batches of the same mix delivered to the same slum will have the same water content and water content ratio. Observing how the concrete slumps may provide further information on the workability and amount of the concrete. The quality of concrete may also be determined by tamping or blowing the base plate using a tamping rod. The thickness of the metal sheet used to make the mould should not be less than 1.6mm. Suitable lifting guides are sometimes included with the mould. A steel tamping rod 16mm diameter, 0.6m length with bullet end is used to tamp the concrete. Before starting the test, the interior surface of the mould is carefully cleaned and free of excess moisture and adhesion of an old set concrete. The mould is set on a non-absorbent, smooth, flat, solid surface. The mould is then filled in four stages, each about 1/4 of the way up the mold's height. The tamping rod is used to tamp each layer 25 times, taking care to uniformly disperse the strokes throughout the cross section. The concrete is levelled using a trowel and tamping rod after the top layer has been rodded. The mould is immediately removed from the concrete by gently and carefully lifting it vertically. The concrete will be able to settle as a result of this. Concrete SLUMP is the term for this kind of subsidence. The level difference between the mold's height and the highest point of the subsiding concrete is measured.

TABLE 4.2: TEST RESULTS OF SLUMP WITH DIFFERENT %REPLACEMENT OF SAND WITH POLY ETHYLENE TEREPHTHALATE

% of polyethylene terephthalate	SLUMP VALUE(mm)
0%	90
10%	80
20%	70
30%	50

4.3. CASTING OF CUBES:

The concrete cubes were made to test the concrete's compressive strength. Metal moulds made of steel or cast iron were used to make the cubes. To avoid deformation, these moulds should be thick enough. These moulds are designed to make it easy to remove the moulded item without damaging it. A plane-surfaced base plate is included with each mould. The base plate should be large enough to hold the mould during filling without leaking, and it should be screwed to the mould. To prevent concrete adherence, the inner surface of the mould is lightly coated with oil.

Following these steps, the concrete components, which include cement, fine aggregate, coarse aggregate, plastic (polyethylene terephthalate), and water, are completely mixed in dry conditions until a uniform colour is obtained. The water is then added in the proper amounts and properly mixed again. The concrete is then poured into the mould.

The concrete cubes (150mm x 150mm x 150mm) were cast and tested as part of the test programme. Six specimens were utilised to evaluate the compressive strength of M20concrete, with two specimens for each percentage of PET replacement level (0 percent , 10 percent , 20 percent , 30 percent). Casting and testing of partially plastic waste replaced (10%, 20%, and 30% of replacement with fine aggregate in concrete cubes) with the ingredients of ordinary Portland cement 53 Grade, natural river sand, and crushed stone of maximum size 20 mm, as well as casting and testing of partially plastic waste replaced (10%, 20%, and 30% of replacement with fine aggregate in concrete cubes) (150mm x150mm x 150mm)

4.4 COMPACTION

Ensure that the concrete is sufficiently compacted by tamping it with a tamping rod. Insufficient compaction may result in poor workability, which makes the concrete harsh. Due to incorrect compaction, cavities may be present, allowing water to percolate through the concrete and compromising its durability. Proper compaction and mechanical compaction should be accomplished via hand compaction and mechanical compaction. The use of a table vibrator for mechanical compaction is possible. Remove the extra concrete using a trowel after the compaction is complete. Make a reference mark on the concrete cubes. Allow these cubes to sit for 24 hours without losing moisture. Then soak these cubes in water to cure them.

The cubes are made using the following quantities of concrete components and a replacer of polyethylene terephthalate.

4.5 Curing of Cubes

The hydration of cement particles gives concrete its strength. The hydration of cement is a long-term process rather than a masonry activity. Of course, the rate of hydration is rapid at first, but it slows down with time. The amount of hydration product produced, and therefore the amount of gel created, is determined by the degree of hydration. For filling the spaces in the gel pores, the cement needs a W/C ratio of 0.15. To put it another way, a water/cement ratio of approximately 0.38 would be needed to hydrate all of the cement particles as well as fill the gel pores. A W/C concentration of 0.38 might theoretically fulfil the need for water for hydration in a concrete produced and contained in a sealed container while leaving no capillary cavities.

However, it is clear that a water content of 0.5 is needed for full hydration in a sealed container in order to maintain the desired relative humidity level.

4.6 Concrete Testing CUBES-Compressive Strength Test:

The most frequent test on hardened concrete is compressive strength, partly because it is simple to execute and partly because most of the desired characteristics of concrete are qualitatively linked to its compressive strength.

The compressive strength is measured on a cubical or cylindrical specimen. Prism is also employed on occasion, although it is not widely utilised in our nation. Parts of a beam tested in flexure are sometimes used to evaluate the compressive strength of concrete. After a flexure failure, the end portions of the beam are left intact, and since the beam is typically of cross section, this part of the beam may be utilised to determine the compressive strength. The cubes are 15*15*15 cm in size. If the aggregate's greatest nominal size does not exceed 20mm, 10cm size cubes may be utilised instead. Cylindrical test specimens are twice as long as they are wide. They have a diameter of 15cm and a length of 30cm. Smaller test specimens may be utilised, but the diameter of the specimen must be at least 3 times the maximum size of aggregate.

V. RESULTS

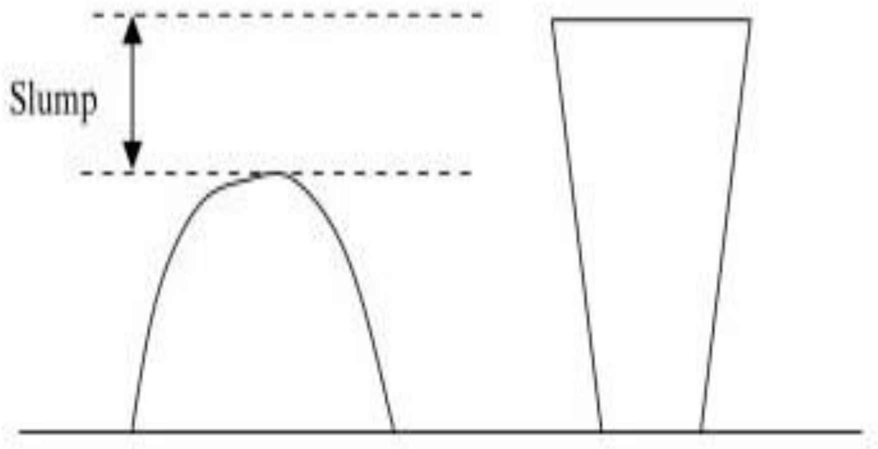
The findings of the experimental research are presented in the next section.

1. The workability of various percentages of Polyethylene terephthalate as a partial substitute for fine aggregate in terms of slump values is shown below.

Table 5.1: Result of Slump Values

% OF POLY ETHYLENE TEREPHTHALATE	SLUMP VALUE(mm)

0%	90
5%	80
10%	70
15%	50



Compressive Strength of Concrete

$$\text{Compressive strength} = \frac{\text{Ultimate load}}{\text{Area of Specimen}}$$

Table 5.2 values for 0% replacement of fine aggregate with polyethylene terephthalate

Cube No.	Days curing of	Load in kN	Area in cm^2	Compressive strength in N/mm^2
1	7	658	225	29.24
2	28	897	225	39.86

Table 5.3: values for 10% replacement of fine aggregate with polyethylene terephthalate

Cube No.	Days curing of	Load in kN	Area in cm^2	Compressive strength in N/mm^2
1	7	624	225	27.73
2	28	864	225	38.4

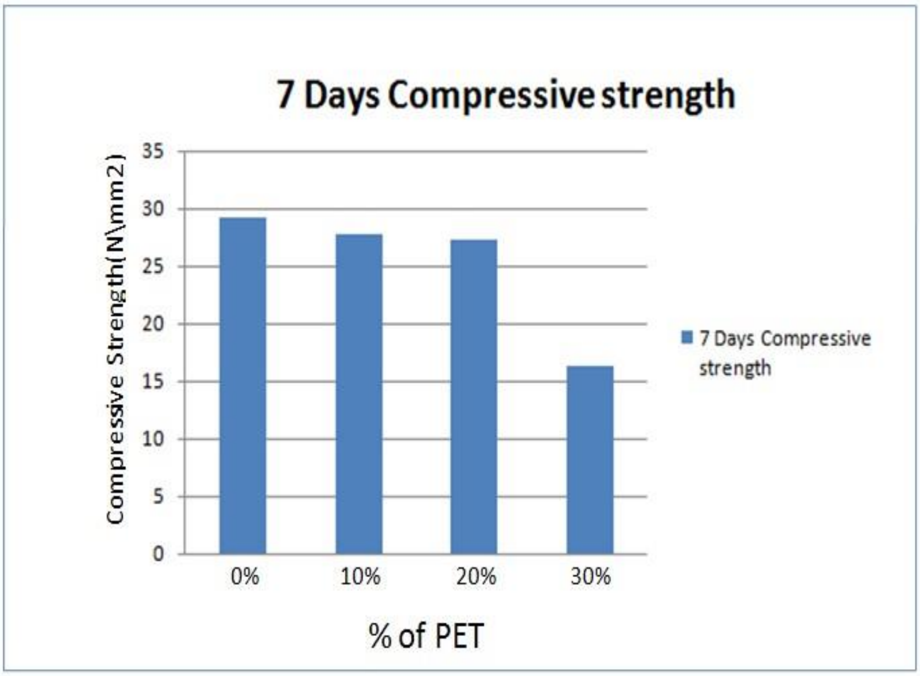
Table 5.4: values for 20% replacement of fine aggregate with polyethylene terephthalate

Cube No.	Days curing of	Load in kN	Area in cm^2	Compressive strength in N/mm^2
1	7	614	225	27.2
2	28	719	225	31.95

Table 5.5 values for 30% replacement of fine aggregate with polyethylene terephthalate

Cube No.	Days curing of	Load in kN	Area in cm^2	Compressive strength in N/mm^2
1	7	368	225	16.35
2	28	486	225	21.6

Graph: 7 days compressive strength



Graph: 28 days compressive strength

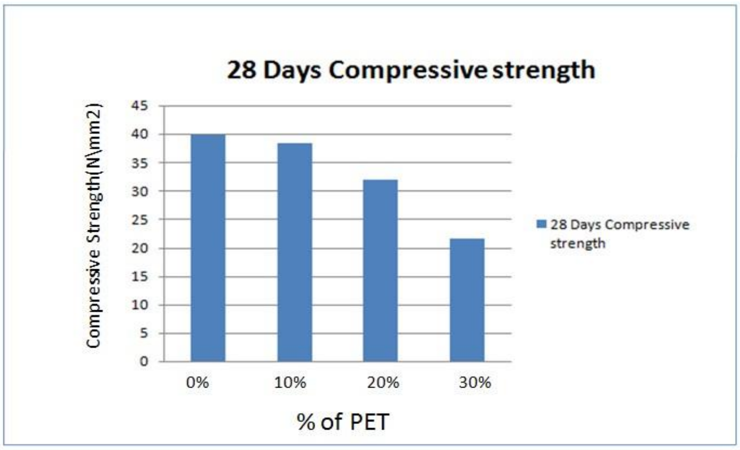
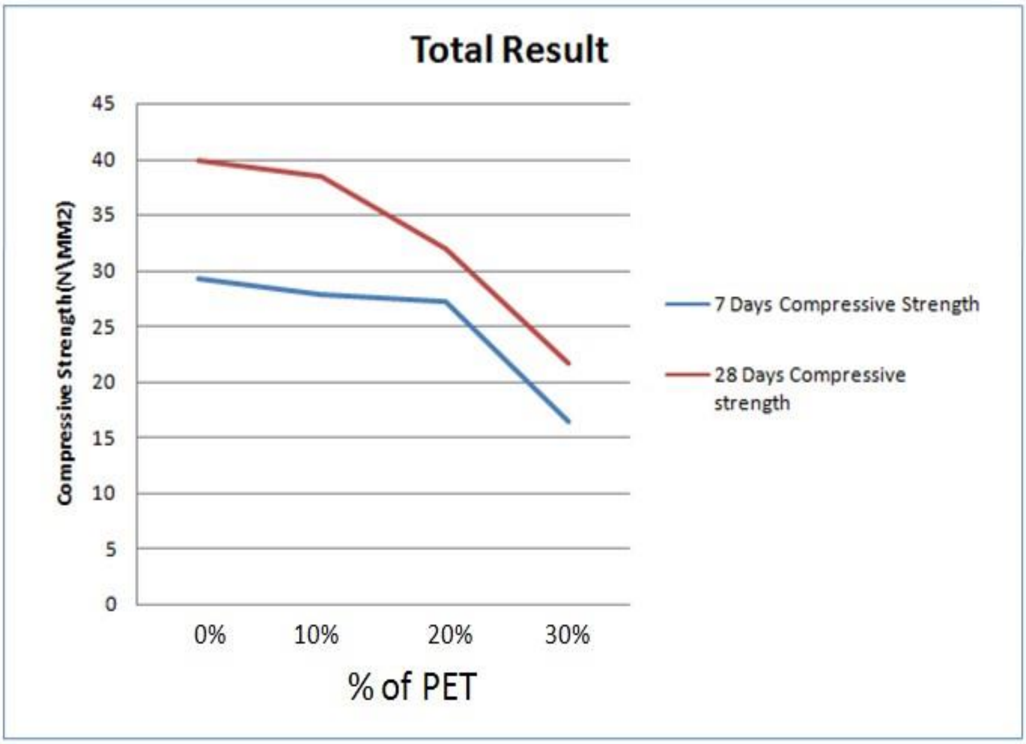


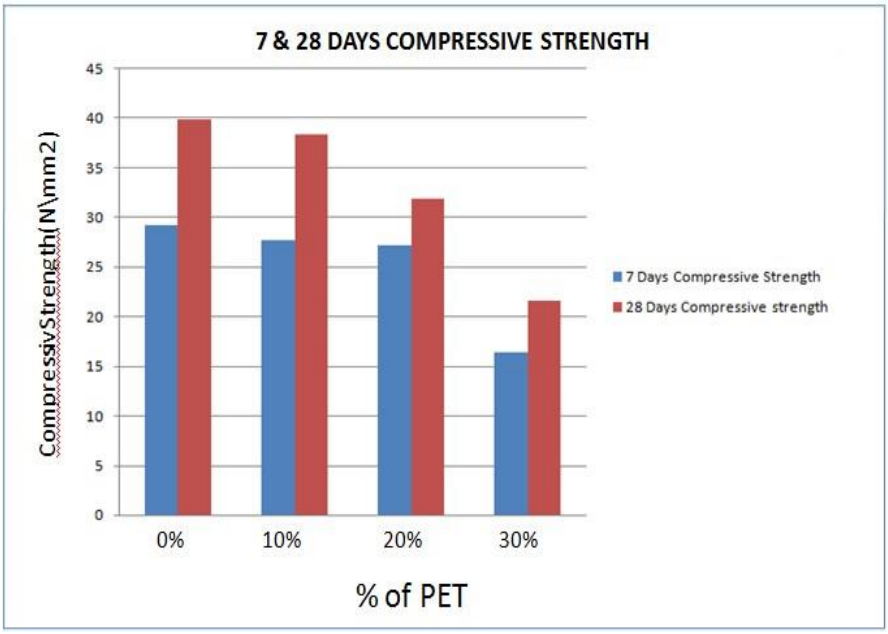
Table 5.6: Test results of Replacement of Fine Aggregate with PET

Type of aggregate	No. of days cures	Average compressive strength at different % replacement of fine aggregate with polyethylene terephthalate (N/mm^2)			
		0%	10%	20%	30%
Fine Aggregate	7	29.24	27.73	27.2	16.25
	28	39.86	38.4	31.95	21.6

Graph: Total Result



Graph: Comparison of 7 & 28 days Compressive Strength



VI.CONCLUSIONS

The following conclusions are derived from the examination of the test results.

1. The same water-to-cement ratio is used. Because of the angular and non-uniform plastic waste aggregates with sharper edges, the slump of concrete is observed to decrease as the percentage of sand replaced by plastic material increases up to 20%. After that, the concrete stiffens and becomes difficult to work.

2. As the percentage of sand replaced by plastic increases, the weight of the cube drops.

3. Material. It can be observed that the weight loss is proportional to the amount of replacement.

4. The M20 reference mix obtained a compressive strength of 39.86 MPa.

5. The strength of conventional concrete and concrete with a 10% replacement rate as it ages. A similar pattern is followed by sand by plastic stuff.

6. There is a gradual decrease in compressive strength for replacement of Sand by Plastic material up to 20%, and then the strength decreases rapidly for 30% of Sand by Plastic material. After 30%, the strength variation is somewhat gradual because, unlike natural aggregate, plastic waste aggregate does not interact with cement paste, and thus the interfacial transition zone (ITZ) in aggregate containing sand is not present.

7. When compared to the reference concrete, the compressive strength falls when fine aggregate is substituted with polyethylene terephthalate at different percentages. This is displayed in the table below.

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