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Partial Replacement of Course Aggregate in Manufacturing of Waste Plastic Concrete Blocks

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***Abstract*: The amount of Plastics consumed annually has been growing progressively in utilization. Consequently, waste plastic usage has become one among the main challenges in recent times. The management and usage of plastic waste is speedily growing because it may be a valuable resource of industries and it's terribly unsafe substances and with low usage rate. The employment of plastic waste materials may be a partial answer to environmental and ecological issues, because the use of plastic waste can reduces the mixture value and provides a good strength for the structures. It'll reduces the lowland value and it is energy saving. This study has chosen waste PET, a chemical compound of synthetic resin Terephthalate, to analyze its potential use as plastic mixture in concrete application. The waste plastic was utilized in concrete with partial replacement of 5%, 10% and 20% by volume of standard coarse aggregate. The tests were conducted on block prepared with course aggregate, fine aggregate, waste plastic, M-sand, and cement to their property i.e. compressive strength. 3 varieties of concrete specimens each type 3 blocks, for comparison purpose, were ready. All the concrete specimens were tested for its completely different mechanical properties after a curing period of 7 days. Moreover, it's complete that the utilization of waste PET in concrete provides some benefits like reduction within the use of standard mixture, disposal of wastes, prevention of environmental pollution, and energy saving.**

***Keywords*: Waste plastic, PET aggregate.**

1. Introduction

A. Introduction

The quantity of plastic waste in municipal solid waste assortment is increasing speedily, the rate of growth is double for each ten years since it's non-biodegradable that stay on earth for 4500 years without degradation and it's a good challenge in putting off waste plastics, it is additionally danger in repeat utilization of plastic waste it poses a danger of being transformed to a cancer materials and only a little quantity of PET bottles are recycled, it has a several sensible characteristics like versatility , hardness, resist to chemical, water impacts.

In recent years, the natural sand is replaced by the m-sand, m-sand is additionally utilized in mixture of plastic & soil, during this work a trial has been created to manufacture of blocks by exploitation the waste plastic in vary of 5-20% by weight of course aggregate.

The blocks manufactured possess the properties such as neat and even-finishing with negligible water absorption and which satisfies the compressive strength to a certain extent.

B. Objectives

- To reduce the waste plastic quantities on the land and water to avoid land and water pollution.
- To identify that waste will be disposed by utilizing them as construction material.
- To develop another building material.
- To determine the compressive strength of concrete containing plastic mixture.

C. Scope

The scope of work consists of making ready waste plastic concrete block by partial replacement of course aggregate to attain nearly equal strength as M20 grade of concrete. And to cut back constructional price, reducing the environmental pollution and a few of the overall disposal ways are reduced.

D. Advantages

- Plastic block possess more advantages which includes cost efficiency, resource efficiency, reduction in emission of greenhouse gases, etc.
- Excellent thermal and electrical insulation properties.
- By use of plastic block, the water absorption of the block is less and presence of alkalies was highly reduced.

E. Disadvantages

- Plastics are having low bonding properties so the strength of concrete gets reduced like compressive, tensile and flexural strength.
- As such they'd have a restricted period of time because of degradation by ultraviolet radiation. Hot climate or direct exposure to sun may build them soft.
- Its melting point is low so it cannot be utilized in furnaces as a result it gets soft when it comes in contact with the heat at extreme temperature.

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F. Applications

- High-quality plastic blocks, which possess standard shape, sharp edges, smooth surfaces, high durability, are often used for permanent structural construction.
- The Concrete Blocks are employed in many small Landscape Projects. as an example, in Outdoor Seating, Decorative Screen, Outdoor Bar, Flower Bed, many Outdoor Furniture.
- Low-quality blocks or poorly mixed blocks are used as aggregate for foundation concrete and rock works. This can be because they will break easily and not suitable for construction purpose.

2. Materials Used

A. Plastic Waste (Chips)

Fig. 1. Plastic chips

By definition the plastics is created to totally different shapes once they are heated in closest surroundings it exists within the different forms like cups, furniture's, basins, plastic bags, food and drinking containers, and they are become waste product. Accumulation of such wastes may result into dangerous effects to both human and vegetation.

B. Polyethylene Terephthalate (PET)

PET is employed as a raw material for creating packaging materials like bottles and containers for packaging a large range of food merchandise and alternative commodity. Examples embrace soft drinks, alcoholic beverages, detergents, cosmetics, pharmaceutical merchandise and edible oils. PET is one among the foremost common client plastics used. Bottles made from synthetic resin terephthalate (PET, generally PETE) are often used to create lower grade merchandise, like carpets. to create a food grade plastic, the bottles have to be compelled to be hydrolysed right down to monomers, that are purified then re-polymerised to create new PET. In several countries, PET plastics are coded with the organic compound identification code range "1" within the universal recycling symbol, sometimes situated on the lowest of the container.

C. M-Sand

Manufactured Sand (M-Sand) is sand made from exhausting granite stone by crushing. The crushed sand is of cube like form with grounded edges. It is then washed and ranked with consistency to be used as a substitute of river sand as a construction material. Factory-made sand is an alternate for river sand, because of quick growing industry, the demand for sand has raise hugely, causing deficiency of appropriate river sand in most part of the globe.

Fig. 2. M-Sand

D. Course Aggregate

Fig. 3. Course aggregate

Coarse aggregates are irregular broken stone or naturally-occurring rounded gravel used for preparing concrete. Materials that are large to be retained on 4.7 mm sieve size are referred to as coarse aggregates, and its maximum size will be up to 63 mm. They must be washed well before using in concrete. Aggregate is one amongst the foremost vital part components of the concrete. Coarse Aggregates offers volume to the Concrete. Coarse aggregates are used in every Construction projects which includes the development of roads, Buildings, Railway Tracks etc.

E. Cement

Fig. 4. Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to alternative materials to bind them together. Cement is rarely used on its own, however rather to bind sand and gravel (aggregate) along, Cement mixed with fine mixture produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material existing and is behind only water because the planet's most-consumed resource.

F. Water

The water used for experiments was potable water Fresh portable water free from organic matter and oil is employed in mixing the preparation of plastic bricks. Water in required quantities were measured by graduated jar and added to the quarry dust and M-sand mix. The rest of the material for preparation of concrete was taken by weigh batching. The pH value shouldn't be less than 7.

3. Methodology

A. Steps followed for cube preparation for test

1) Preparing of material for Cube test

The material of M20 grade ratio 1:1.5:3 was brought and stored to an approximate temperature of 27 ±3 degree Celsius. Also our waste product i.e. waste plastic was brought. Water cement ratio for M20 grade of concrete we used is 0.45 for maintaining workability of concrete.

i. Mix ratio for 5% replacement of plastic waste (1:1.5:2.85)

Table 1
Ratio for 5% replacement

S. No.	Material	Weight (g)
1.	Cement	1500
2.	M - Sand	2250
3.	Course Aggregate	4275
4.	Plastic waste	225

ii. Mix Ratio for 10% replacement of plastic waste (1:1.5:2.7)

Table 2
Ratio for 10% replacement

S. No.	Material	Weight (g)
1.	Cement	1500
2.	M - Sand	2250
3.	Course Aggregate	4050
4.	Plastic waste	450

iii. Mix Ratio for 20% replacement of plastic waste (1:1.5:2.4)

Table 3
Ratio for 20% replacement

S. No.	Material	Weight (g)
1.	Cement	1500
2.	M - Sand	2250
3.	Course Aggregate	3600
4.	Plastic waste	900

2) Mixing of concrete

Hand mixing: The process is completed on the rectangular pan until a uniform mix is obtained. Cement must be uniformly mixed with a trowel so as there exist no lumps.

Dry mixing of fine aggregates and cement, addition of coarse aggregate and plastic waste with the correct proportion, addition of m-sand and quarry, addition of calculated water in batch till consistency is achieved.

Fig. 5. Mixing of concrete

3) Casting of specimen

The casting mold was chosen made of cast iron and was rubbed with oil on inner side for easy removal of cubes. The specimen was casted in 3 layers (5cm each) and properly compacted in order to prevent honeycombing formation.

Fig. 6. Casting of Specimen

4) Compaction

Compacting was done through tamping bar, minimum 35 strokes was exhausted in all parts of a cube for correct compacting. This tamping bar has the dimension of diameter 16mm and length of 0.6m.

5) Age of test

The cube test for Compressive strength can be done on 3, 7, 14 and 28 days. In some cases, the strength of greater ages is required which is performed from 13 to 52 weeks. But we took cube test on 7th day after curing.

6) Number of specimens

It is necessary to have a minimum of 3 specimens for testing from different batches. The mean of compressive strength achieved by this specimen is employed to determine actual strength of the batch.

B. Procedure for Compressive strength of concrete or Cube test

1) Place the prepared concrete mix in the steel cube mould for casting.
2) Once it sets, after 24 hours remove the concrete cube from the mould.

3) Then specimen was kept in water for 7 days.
4) Ensured that concrete specimen was well dried before placing it on the CTM.
5) Weight of samples was noted in order to proceed with testing and it must not been less than 8.1Kg.
6) Testing specimens was placed in the space between bearing surfaces.

Fig. 7. Specimen placed on CTM

7) Care must been taken to prevent the existence of any loose material or gritted on the metal plates of machine or specimen blocked
8) The concrete cubes were placed on bearing plate and aligned properly with the center of thrust in the testing machine plates.

Fig. 8. Aligned specimen on CTM

Fig. 9. Failure/breakdown of specimen

9) The loading must been applied axially on specimen without any shock and increased at the rate of 140kg/sq cm/min till the specimen collapsed.
10) Due to the constant application of load, the specimen started cracking at a point and final breakdown of the specimen been noted.

4. Calculations and Results

A. Calculation Table after 7days

1) For 5% replacement of plastic waste (1:1.5:2.85)

Table 4
Calculation for 5% replacement

Details	For block 1	For block 2	For block 3
Test result	272 KN	256 KN	269 KN
Compressive strength	12.08 N/mm^2	11.37 N/mm^2	11.95 N/mm^2
Average	11.8 N/mm^2		

Calculation:

i. Compressive Strength of Concrete for block 1
= Load carried by block / Top surface area
= 272 x 1000 /150 x 150
= 12.08 N/mm^2

ii. Compressive Strength of Concrete for block 2
= Load carried by block / Top surface area
= 256 x 1000 /150 x 150
= 11.37 N/mm^2

iii. Compressive Strength of Concrete for block 3
= Load carried by block / Top surface area
= 269 x 1000 /150 x 150
= 11.95 N/mm^2

Average Compressive Strength of Concrete for blocks
= 12.08 + 11.37 + 11.95/3
= 11.8 N/mm^2

2) For 10% replacement of plastic waste (1:1.5:2.7)

Table 5
Calculation for 10% replacement

Details	For block 1	For block 2	For block 3
Test result	208 KN	216 KN	203 KN
Compressive strength	9.24 N/mm^2	9.6 N/mm^2	9.02 N/mm^2
Average	9.28 N/mm^2		

Calculation:

i. Compressive Strength of Concrete for block 1
= Load carried by block / Top surface area
= 208 x 1000 /150 x 150
= 9.24 N/mm^2

ii. Compressive Strength of Concrete for block 2
= Load carried by block / Top surface area
= 216 x 1000 /150 x 150
= 9.6 N/mm^2

iii. Compressive Strength of Concrete for block 3
= Load carried by block / Top surface area
= 203 x 1000 /150 x 150
= 9.02 N/mm^2

Average Compressive Strength of Concrete for blocks
= 9.24 + 9.6 + 9.02 /3
= 9.28 N/mm^2

3) For 20% replacement of plastic waste (1:1.5:2.4)

Table 6
Calculation for 20% replacement

Details	**For block 1**	**For block 2**	**For block 3**
Test result	107 KN	95 KN	103 KN
Compressive strength	4.75 N/mm^2	4.22 N/mm^2	4.57 N/mm^2
Average	4.51 N/mm^2		

Calculation:

i. Compressive Strength of Concrete for block 1
= Load carried by block / Top surface area
= 107 x 1000 /150 x 150
= 4.75 N/mm^2

ii. Compressive Strength of Concrete for block 2
= Load carried by block / Top surface area
= 95 x 1000 /150 x 150
= 4.22 N/mm^2

iii. Compressive Strength of Concrete for block 3
= Load carried by block / Top surface area
= 103 x 1000 /150 x 150
= 4.51 N/mm^2

Average Compressive Strength of Concrete for blocks
= 4.75 + 4.22 + 4.57 /3
= 4.51 N/mm^2

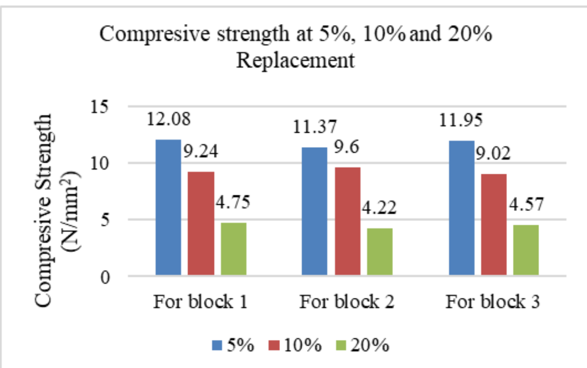

Fig. 10. Strength of blocks

B. Results

1. Average compressive strength for 5% replacement of plastic waste after 7 days = 12.88 N/mm^2
2. Average compressive strength for 10% replacement of plastic waste after 7 days = 9.28 N/mm^2
3. Average compressive strength for 20% replacement of plastic waste after 7 days = 4.51 N/mm^2

5. Conclusion

In this research, compressive strength have been investigated for various types of concrete containing 5%, 10% and 20% of waste plastic aggregate by volume of course aggregate.

The following conclusions can be drawn based on the above report:

- The compressive strength of concrete containing different proportion of waste plastic was different however the compressive strength at 5% volume of course aggregate provided higher strength that allowed it to be utilized in structural application.
- Plastics are often used to replace a number of the aggregates in a concrete mixture. This contributes to reducing the unit weight of the concrete. this is often helpful in applications requiring non-bearing light-weight concrete, such as concrete panels used in facades.
- Mainly, all the above are concluded that the waste plastic are utilized in concrete mix with completely different ratios. During this method to reducing constructional cost, reducing the environmental pollution and some of the final disposal ways are reduced.

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