



Experimental Investigation On Concrete By Using Non-Biodegradable Waste

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Abstract: The disposal of waste plastics is a serious issue in today's world, as the use of plastics is increasing all the time, and plastic material takes hundreds of years to disintegrate. So many practical methods for recycling and reusing plastics are being developed. This study looks into replacing natural fine aggregate in concrete with non- biodegradable plastic aggregate made out of High-Density Polyethylene waste (HDPE plastics). Replacement of fine aggregate weight by 10%, 20%, 25%, 30% in order to derive the optimum replacement. To determine the qualities and behaviour of concrete utilizing plastic aggregate, several tests are carried out, including compressive strength, split tensile strength, and flexural strength in the hardened state of concrete and basic tests on fresh concrete were taken care of which are slump cone test and compaction factor test. The results of concrete created strength in the hardened state of concrete and basic tests on fresh concrete, such as slump cone test and compaction factor test, were taken care of after the casted specimens were tested for various days which are 7th, 21st and 28th days . The results of concrete constructed using plastic aggregate are compared to those of normal concrete after being tested for 7 days, 14 days, and 28 day

Index Terms - Compressive Strength, High-Density Polyethylene waste (HDPE plastics), fine aggregates, Split-tensile strength.

I. INTRODUCTION

Concrete's long-term viability, while being the most frequently used construction material on the planet, is a major issue for the global construction industry. Noise pollution, air pollution, destruction of flora and animal habitats, as well as landscape degradation, land loss, deterioration of water quality, and population displacement, are all negative consequences of using aggregates in construction. Shredded plastics have become more popular as a partial replacement for aggregates in civil engineering projects. Waste inclusion in concrete has an extra benefit in terms of environmental and possible economic considerations. An attempt is undertaken to determine the best crushed plastic alternative for fine aggregate in concrete. Fine aggregates in cement concrete are

substituted in known percentages by finely crushed plastics, and the optimal proportion at which increased strength is attained is estimated. Durability, insulating characteristics, a high strength-to-weight ratio, and economy are only a few of their benefits.

I. Literature Review

S. No	Author(s) & Year	Non-Biodegradable Waste Used	Research Highlights	Key Findings
1	R. Siddique et al. (2008)	Waste plastic (PET)	Replaced fine aggregates with PET fibers in concrete	Increased toughness and impact resistance; workability reduced
2	S. Kandasamy & B. Dhinakaran (2012)	Rubber Tyre Waste	Used as coarse aggregate replacement	Reduced density, good shock absorption; compressive strength decreased slightly
3	Batayneh et al. (2007)	Crushed Glass	Used as partial replacement for sand	Up to 20% replacement showed comparable compressive strength
4	B. V. Reddy & P. K. Reddy (2014)	E-Waste (PCB particles)	Replaced fine aggregates in concrete	Up to 10% replacement improved durability and strength
5	A. R. Pavan Kumar et al. (2018)	Waste Plastic Granules	Used as fine aggregate replacement	Enhanced ductility; workability reduced; strength decreased after 20% replacement
6	N. M. Soliman & M. I. Shoura (2017)	Polyethylene Bags	Shredded plastic used in concrete mix	Improved resistance to chemical attack; reduced compressive strength
7	M. Safiuddin et al. (2010)	Waste Glass Powder	Cement replacement	Improved workability and durability; pozzolanic activity enhanced at 10-15% replacement
8	T. C. Ling et al. (2012)	Plastic Bottle Strips	Used as fiber reinforcement	Increased flexural and tensile strength; lower compressive strength
9	P. Sharma et al. (2020)	Thermocol Waste (EPS)	Replaced coarse aggregate	Good for lightweight concrete; significantly lower compressive strength
10	M. S. Memon et al. (2019)	Mixed Plastic Waste	Replaced fine and coarse aggregates	Suitable up to 15% replacement; improved impact resistance and sustainability

III.MATERIALS AND METHODS

3.1 MATERIALS USED

1. **HDPE Plastics** - High-density polyethylene (HDPE) or polyethylene high-density polymer is a thermoplastic polymer (PEHD). Shampoo bottles, toys, chemical containers, milk jugs, supermarket bags, recycling bins, and other items typically contain it. The used HDPE plastic wastes were collected, melted, and crushed to produce plastic granules with a diameter of less than 4.75mm. As indicated in the properties of HDPE plastics, the specific gravity, gravity, Fineness Modulus and Melting point are the major properties required in order to add the product in the concrete mixture. These High Density plastics are easy to process by most methods and these are economically friendly. The melting point indicates that these plastics can be moulded into any shape and size.



Fig 3.1 : HDPE Plastics

S.NO	EXPERIMENTS	RESULTS
1.	Specific Gravity	1.04
2.	Gravity	955kg/m ²
3.	Fineness Modulus	0.5mm
4.	Melting Point	130.8°C

Table 3.1: Properties of HDPE Plastics

2. **M-Sand-** For concrete buildings, manufactured sand (M-Sand) is used as a supplement to river sand. The crushed sand is cleansed and classed as a construction material since it is cubical in shape with rounded borders. Manufactured sand (M-Sand) has a decreased thickness of 4.75 mm. This is an alternative for natural sand because by using natural sand, the environment gets affected as the water level decreases. As referred in the properties of M- Sand, most of the m-sand does not contain silt content or its does not exceed 8% of silt content. Water absorption property is one of the important property because the absorption water affects the m-sand's durability.



Fig 3.1 : M-Sand

S.NO	EXPERIMENTS	RESULTS
1.	Silt Content	8%
2.	Water Absorption	3.32%
3.	Passing Percentage	Less than 4.75mm
4.	Specific Gravity	2.7
5.	Density	1850 kg/m ³

Table 3.2 : Properties of M-Sand

3.Coarse Aggregate- Coarse aggregates, such as sand, gravel, or crushed stone, are uneven and granular materials used to produce concrete. Coarse is frequently found naturally, but it can also be made by blasting quarries, manually crushing it, or utilising crushers. Before being utilised to make concrete, they must be thoroughly cleaned. The concrete is affected by its angularity and strength in a number of ways. Without a doubt, selecting these aggregates is a critical undertaking. This aggregate has an major effect on concrete properties which are abrasion resistance, hardness, elastic modulus and other characteristics. These help in shrinkage and surface cracking of the concrete.



Figure 3.2 :coarse aggregate

S.No	Experiments	Results
1	Density	1830 Kg/m ³
2	Size	20mm
3	Specific Gravity	2.78
4	Water Absorption	1.60%

Table 3.2 : Properties of coarse aggregate

4.Cement (PPC) - Pozzolana is a natural or man-made substance that includes reactive silica. Cement made from Pozzolanic elements is known as Portland Pozzolana Cement. In particular quantities, OPC clinker, gypsum, and pozzolanic ingredients make up this cement. Fly ash, volcanic ash, calcined clay, and silica fumes are examples of Pozzolanic materials. These elements are incorporated in percentages ranging from 15% to 35% by cement weight.



Figure 3.3: Cement

S.NO	EXPERIMENTS	RESULTS
1.	Specific Gravity	3.15
2.	Consistency	31.5%
3.	Initial setting time	25 mins
4.	Final setting time	165 mins

Table 3.3: Properties of Cement

IV.EXPERIMENTAL PROCEDURE

By varying the ratio of fine aggregates replaced with HDPE Plastic aggregates, different types of mixtures were created. Total 5 types of mixes are prepared. One is a conventional concrete block and the others are the blocks in which the fine aggregates are replaced by 10%, 20%, 25% and 30% of plastic aggregates.

Block 1- The first block is made with zero percent of HDPE plastic. The quantity of cement in order to make 3 conventional blocks is 9kg followed by sand with 19.24 kg for 3 conventional normal blocks and then coarse

aggregate required in 20mm is 13.736 kg and for 12.5mm the coarse aggregate has to be 13.745 kg at last 3.622

kg of water in required for 3 conventional blocks with 0% plastic.

Block 2- This block is made of 10% of HDPE plastic by replacing the fine aggregate. This includes 9 kg of cement, and 17.316 kg of sand as 10% of plastic has been added to it which is 1.924 kg of HDPE plastics, but the coarse aggregate and water quantity remain the same for these mixes.

Block 3 – This block is made of 20% HDPE plastic replaced with fine aggregate in order to check the workability and mechanical properties of concrete. The required materials for this p r o p o r t i o n are 9kg cement,15.392 kg of sand with 3.848 kg of HDPE plastic, 13.736 kg of 20mm coarse aggregate and 13.745 kg of 12.5mm coarse aggregate and the water required for this proportion is 3.622 kg.

Block 4 - This block is made of 25% HDPE plastic replaced with fine aggregate in order to check the workability and mechanical properties of concrete. The required materials for this p r o p o r t i o n are 9kg cement,13.468 kg of sand with 5.772 kg of HDPE plastic, 13.736 kg of 20mm coarse aggregate and 13.745 kg of 12.5mm coarse aggregate and the water required for this proportion is 3.622 kg.

Block 5 - This block is made of 30% HDPE plastic replaced with fine aggregate in order to check the workability and mechanical properties of concrete. The required materials for this p r o p o r t i o n are 9kg cement, 11.544 kg of sand with 7.696 kg of HDPE plastic, 13.736 kg of 20mm coarse aggregate and 13.745 kg of 12.5mm coarse aggregate and the water required for this proportion is 3.622 kg.



Figure 4.1 Casting

4.1 MIX DESIGN

Reference Block	Cement: Sand: Aggregate
Concrete Block M30	1:0.75:0.5

Table 4.1 : Mix Proportion for Reference Concrete

% Of Plastic waste replacement (mix design)	Cement: Sand: Aggregate
10% plastic waste replacement	1:0.65:0.5
20% plastic waste replacement	1:0.55:0.5
25% plastic waste replacement	1:0.5:0.5
30% plastic waste replacement	1:0.45:0.5

Table 4.2: Mix Proportions for Partially Replaced Plastic Waste Concrete (Cement: Sand: aggregate)

RESULTS

5.1 Compressive strength on concrete: Concrete's compressive strength is one of its most essential characteristics. In general, increases in compressive strength are proportional to increases in all other concrete qualities, i.e., these properties improved as compressive strength increased. A total of 12 cubes measuring 150 x 150 x 150mm were cast and tested for seven days, fourteen days, and twenty-eight days. The concrete is mixed in a precise quantity, put into the mould, and tempered appropriately to avoid voids. The results are listed in the table below.

PERCENTAGE OF PLASTIC	7 TH DAY	14 TH DAY	28 TH DAY
0%	18.5	24.4	29.9
10%	19.9	25.6	33.1
20%	21.1	27.4	35.6
25%	19.5	24.7	30.9
30%	14.7	18.5	24.9

Table 5.1 : Compressive strength of concrete

Table 5.2.1 denotes the compression strength of various concrete mixtures including plastic by different percentages such as 0%,10%,20%,25% and 30% and the results are achieved for three different time periods which are 7th day, 14th day and 28th day. The concrete mixture with 0% of plastic is the normal M30 concrete mix and the compressive strength for the 7th day, 14th day, and 28th day are derived. Then, compression strength tests were taken for 10% of plastic aggregate in the concrete mix which clearly states that there is a gradual increase in each time period. 20% of plastic aggregate in the concrete mix has the highest compressive strength value derived compared to all other proportions. However, the lowest compressive strength value is calculated in 30% of fine aggregate replaced with plastic. Therefore, an increase in plastic percentage decreases the compression strength.



Fig 5.1 : Compression strength of concrete

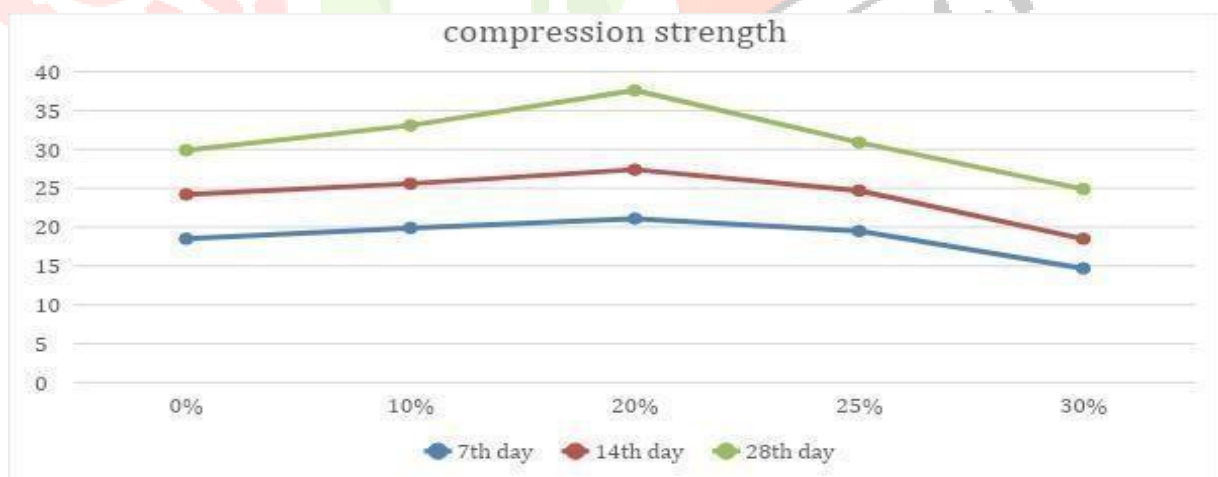


Fig 5.2: Compression strength of concrete

5.2 Flexural strength on concrete: The specimen is made by putting the concrete in the necessary mould form of 15 cm x 15 cm x 70 cm beam with adequate compaction, then placing the specimen in water for 24 hours to cure. The flexural strength of all the mixes prepared for various replacements acquired by testing the cylindrical specimen for the M30 grade of concrete are listed below.

The table 5.2.2, The flexural strength of concrete for the concrete mixtures has been calculated. The test is conducted on five different proportions of plastic aggregate which are 0%, 10%, 20%, 25% and 30%. The result for concrete mix with 0% plastic which is M30 conventional concrete has been taken for 7th day, 14th day and 28th day respectively. The highest flexural strength with inclusion plastic aggregate is achieved by 20% of plastic aggregate and the lowest flexural strength is derived for 30% of plastic aggregate.

PERCENTAGE OF PLASTIC	7 TH DAY	14 TH DAY	28 TH DAY
0%	25.1	31.2	41.1
10%	28.9	35.7	45.2
20%	34.2	44.0	50.3
25%	25.4	32.1	44.3
30%	14.5	29.9	30.8

Table 5.3: Flexural strength of concrete

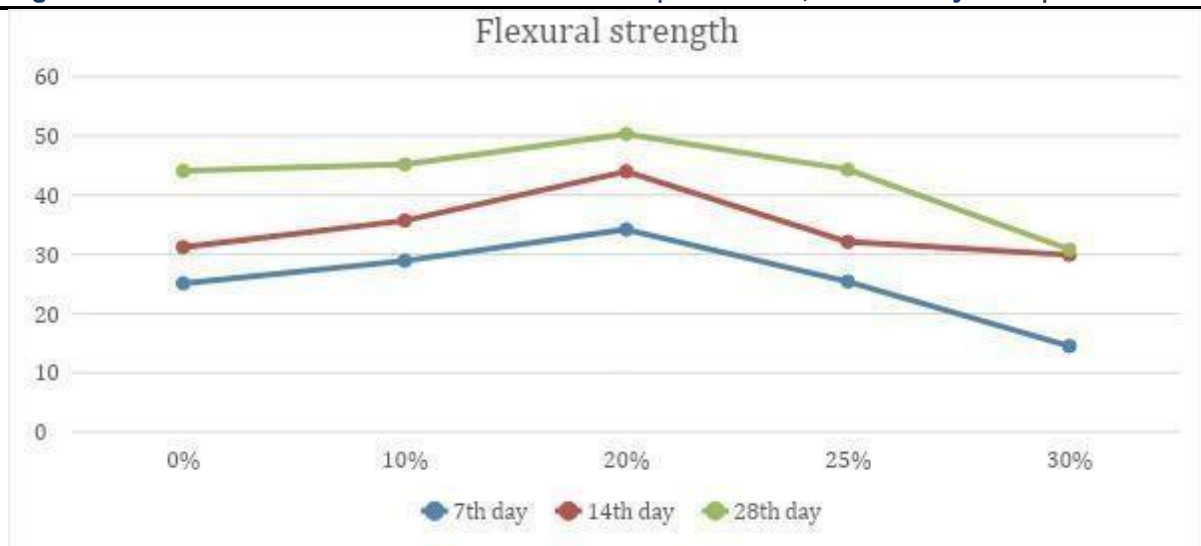


Fig 5.4 : Flexural strength of concrete

3 Split Tensile strength: After 24 hours, the concrete is mixed to the right proportions, and the specimen is made by pouring the concrete into a 15 cm x 30 cm cylinder mould and compacting it properly. Immerse the specimen in water to cure it. The split tensile strength of all the mixes prepared for various replacements acquired by testing the cylindrical specimen for M30 grade of concrete is presented below.

The table 5.2.3 indicates the Split Tensile strength of concrete for five different proportions of concrete mixture with the addition of HDPE plastics and the results are derived for 7th day, 14th day and 28th day. Sample 1 refers the normal conventional M30 concrete block with zero percent of plastic in it. Then, sample 2 indicates the concrete with 10% of plastic aggregate and the value of that mixture has increased compared to the normal conventional concrete block and 10% of plastic concrete mix holds the highest tensile strength compared to other concrete mixture with different percentage of plastic.



Figure:5.5 Split Tensile strength

PERCENTAGE OF PLASTIC	7 TH DAY	14 TH DAY	28 TH DAY
0%	15.9	28.1	36.8
10%	24.1	31.8	45.6
20%	21.8	27.2	38.1
25%	18.1	25.7	35.1
30%	15.3	21.2	29.8

Table 5.5: Split Tensile strength of concrete

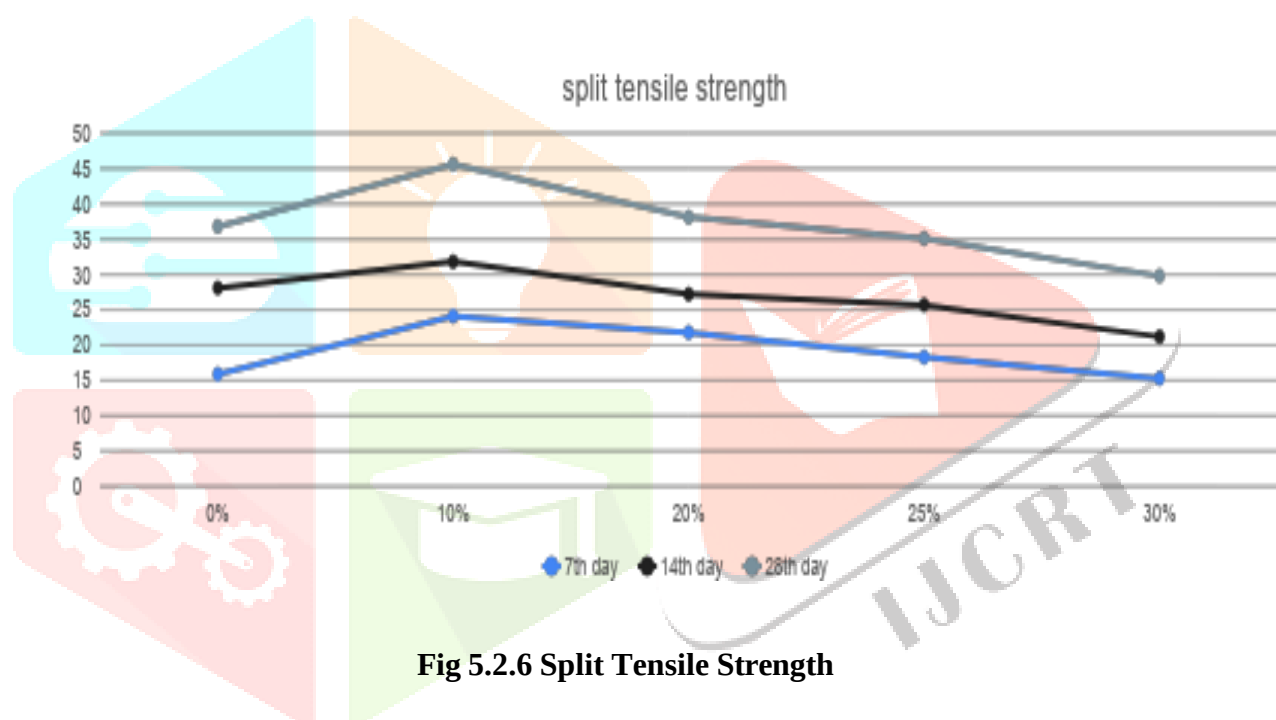


Fig 5.2.6 Split Tensile Strength

VI. DISCUSSION

The key benefit of this project is that it will improve workability by reducing the amount of water absorbed by the plastic. Furthermore, environmental pollution, fine aggregate scarcity, and material prices are also lowered. The results of the tests on components including cement, sand, and aggregate were all within permitted limits, according to IS requirements.

When it comes to workability testing, the slump cone test of the nominal mix is at its optimal value of 90mm, followed by the concrete blocks induced with plastic aggregates that vary in percentages of plastic. The slump value has grown up to 100mm in 10% of the sample and 102mm in 20% of the sample, however the slump value has swiftly dropped in 25% and 30% of the sample mix. As a result, the ideal slump value is calculated to be 20%.

The Compaction factor test has been conducted on the M30 concrete specimen in order to check the workability of the concrete. There is a slight increase in compaction factor for the sample 10% which is 0.91. Apart from the 10% sample, the other samples have similar values. Therefore, nominal mix and plastic induced mix have similar values in compaction factor.

The compressive strength of the concrete has reduced as the percentage of plastic increased. The optimum value had been derived in the 20% sample whereas the lowest value is from the 30% sample.

The flexural strength of concrete also decreased when the ratio of plastic increased. The concrete mixture with 30% of plastic has the lowest flexural strength at 28 days whereas the concrete mixture with 20% of plastic mix has the highest flexural strength at 28 days.

Similarly, the split tensile of concrete has decreased when the addition of plastic increased. The concrete mixture with 10% of plastic has the highest split tensile value whereas the lowest is at 30% plastic mix in concrete.

VII.CONCLUSION

On the whole, inclusion of plastic mixture in concrete blocks leads to several beneficial activities such as reducing the pollution of the environment, scarcity of fine aggregate and also reducing the cost of material. However, increase in plastic percentage tend to decrease the mechanical properties of the concrete whereas the workability of the concrete mixture did not change significantly. Without adding admixtures, the ideal percentage of plastic mix in concrete is 20% which has the optimum values in all the mechanical properties. The utilization of waste plastic aggregate can be beneficial from a conservation standpoint, as well as cost-effective and energy-saving.

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