



Plastic Wastes as Partial Replacement of Conventional Natural Aggregates

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ABSTRACT

Concrete is the most widely used construction material in today's world. It is very difficult to point out another material of construction as versatile as concrete. It is a material of choice where strength, durability, permanence, impermeability, fire resistance and abrasion resistance are required. It is so closely associated now with every human activity that it touches every human being in day today living. The basic materials required for producing concrete include cement, fine aggregate (sand), coarse aggregate (broken stone or boulders) and water. Sand and coarse aggregate required for making concrete are obtained from earth's crust, mainly from river basins. The extraction of aggregates from rivers has led to deterioration of river basins, large scale soil erosions, depletion of water table, decrease in sediment supply and has also led to increase in pollution and changes in pH level. Concrete being a crucial building material is utilized all over the world in billions of tones annually and the consumption is increasing at a faster rate with every passing year. The requirement of aggregates is also increasing with increase in the production of concrete. This large-scale extraction of aggregates will ultimately lead to irreparable damages to the earth's natural resources. So, we need to search for new construction materials. A no. of innovative ideas has been put forward by many researchers suggesting the potential replacements of conventional concrete constituents, particularly coarse and fine aggregates. Plastic wastes in the form of powder as well as solid pieces have also been suggested as potential replacements of conventional sand and stone aggregate. Use of plastic wastes will not only help in reducing the adverse effects if plastic pollution but will also help in producing economical and light

weight concrete. In my experimental work, I am going to prepare concrete by replacing certain percentage of fine and coarse aggregate by plastic waste powder and solid plastic waste pieces respectively and find its effects on physical properties as well as the decrease in pollution due plastic wastes and economic characteristics of concrete.

Keywords: *Plastics wastes, Polyethylene Powder, Aggregates*

1. INTRODUCTION

Concrete is a composite construction material which is prepared by mixing an aggregate like sand or broken stone with dry Portland cement and water forming a plastic mass that can be easily molded into any shape. The cement reacts chemically with water to form a hard matrix which binds all the materials together into durable stone like material called concrete. Certain materials are added to concrete to increase its properties like tensile strength, flexural strength, impact strength, this type of concrete is called reinforced concrete. The reinforcing materials used may be steel bars, fibers like asbestos, nylon, glass etc., polymers like polyester-styrene, methyl meta-crylate. Nowadays, experiments have been made for using plastics in concrete. Concrete is a crucial building material utilized all over the world. Concrete is best known for its long-lasting and dependable nature. However, additional ways that concrete contributes to social progress, economic growth, and environmental protection are often overlooked. Concrete structures are superior in energy performance. They provide flexibility in design as

well as affordability and are environmentally more responsible than steel or aluminum structures.

The concrete industry is today consuming billions of tons of concrete every year. All the materials required to produce such huge quantities of concrete from the earth's crust, thus depleting its resources every year creating ecological imbalance and environmental problems.

2. OBJECTIVES

Main Objective

- To investigate the properties of concrete when waste plastics in powdered form is used as partial replacement of fine aggregates in concrete.
- Specific Objectives
 - To compare the properties like compressive strength, workability, impermeability and density of conventional concrete with the concrete produced by using plastic wastes.
 - To find a means of reducing the pressure on natural resources of earth by decreasing the use of conventional aggregates.
 - To compare the physical characteristics including toughness, specific gravity, water absorption capacity etc. of conventional aggregate with aggregate obtained from plastic wastes. • To produce light weight concrete for multi-purpose use.
 - To provide a safe and useful method of disposal of harmful no biodegradable plastic wastes. • To affect economy in concrete production.
 - To examine the applicability of my experimental findings in field.

3. FUTURE SCOPE

The use of plastic wastes as potential replacements of fine and coarse aggregates in concrete will primarily help in controlling the depletion of natural resources of earth and controlling the pollution caused by plastic wastes. Not only this, it will also provide an efficient method of disposal of non-biodegradable plastic wastes and also help in producing economical and efficient concrete in future. Also, at a time when landfill space is becoming almost impossible due to increasing land value, then recycling and reuse of wastes particularly non-biodegradable wastes as beneficial products should be strongly encouraged and examined.

Since seeking aggregates for concrete and to dispose of the plastic waste is the present concern and also in today's world sustainability has got top priority in construction industry. In these circumstances, if plastic is utilized to prepare aggregates for concrete, it will be a boon to the construction industry

4. EXPERIMENTAL INVESTIGATION

Four trails were conducted in this investigation. Fine aggregate was replaced with 0 % polyethylene plastic powder in first trail, 3 % in second trail, 6 % in third trail and 9 % in fourth trail. The quantity of cement, fine aggregate, coarse aggregate and polypropylene powder used per 150 mm x 150 mm x 150 mm cube in each trail is given in the table below.

Table 4.1. replacement of different %ages of fine aggregates in mixing

Trail	Percent Fine Aggregate Replaced	Cement kg	Fine Aggregate kg	Coarse Aggregate kg	LDPE Powder kg	Water kg
Trail 1	0%	1.39	2.18	3.93	0.00	.062
Trail 2	3%	1.39	2.11	3.93	0.066	0.62
Trail 3	6%	1.39	1.99	3.93	0.132	0.62
Trail 4	9%	1.39	1.78	3.93	0.198	0.62

4.1.Slump Test Results of Fresh Concrete

The slump test for each of the four trails was conducted and the observations are given in the table below.

Table 4.2. slump test results conducted on different %ages of FA replacement

S. No.	Trail	Percent Fine Aggregate Replacement	Trail Slump Value (mm)
1	Trail 1	0%	50
2	Trail 2	3%	46
3	Trail 3	6%	40
4	Trail 4	9%	35

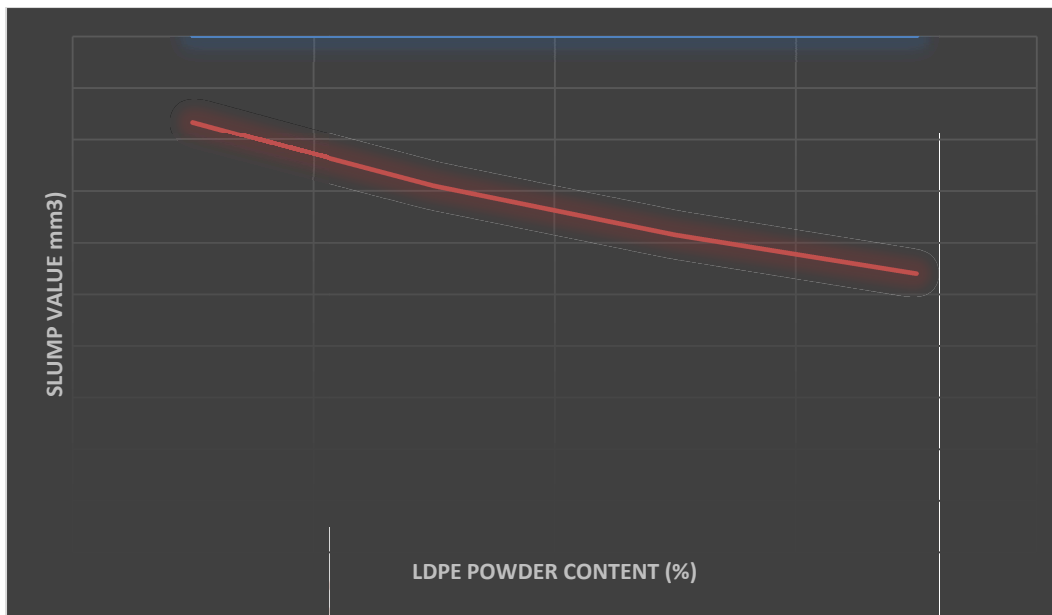


Figure 4.1. Polyethylene Powder Percentage Vs Slump Value Graph

4.2.Compressive Strength Test Results of Hardened Concrete

For each of the four trails three cubes were casted. Each of the cubes was test for compressive strength after 28 days of curing in compression testing machine. The observations of the compression test are given in the table below.

Table 5.3. Compressive Strength Test Results of Hardened Concrete

S. No	Percent Fine Aggregate Replacement	Grade of Concrete	Compressive Strength N/mm ²			Average Compressive Strength N/mm ²
			CUBE 1	CUBE 2	CUBE 3	
1	0%	M25	30.31	29.53	28.52	29.45
2	3%	M25	30.30	30.45	29.00	29.80
3	6%	M25	29.82	30.43	30.25	30.20
4	9%	M25	30.40	29.95	30.10	30.15

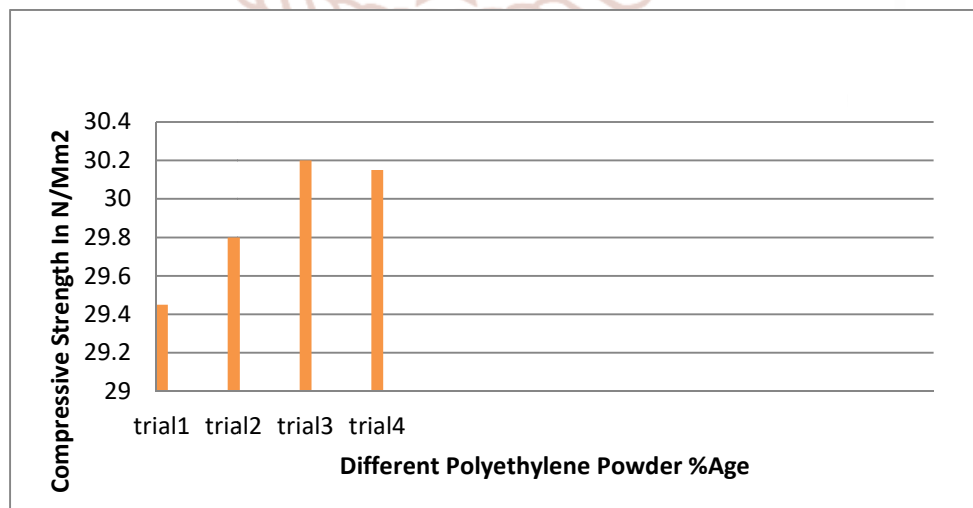


Figure 4.2. Polyethylene Powder Vs Compressive Strength Graph

4.3.Weight Analysis

The weight of the cubes in each trial was found out and the observations are given in the table below.

Table 4.4. Weight Analysis of cubes with different %age Polyethylene

S. No.	Trial	Percentage e of fine aggregate replacement not	Weight kg			Average Weight kg
			Cube 1	Cube 2	Cube 3	
1	Trail 1	0%	7.50	7.45	7.40	7.45
2	Trail 2	3%	7.35	7.20	7.30	7.25
3	Trail 3	6%	7.25	7.20	7.30	7.25
4	Trail 4	9%	7.10	7.05	7.15	7.10

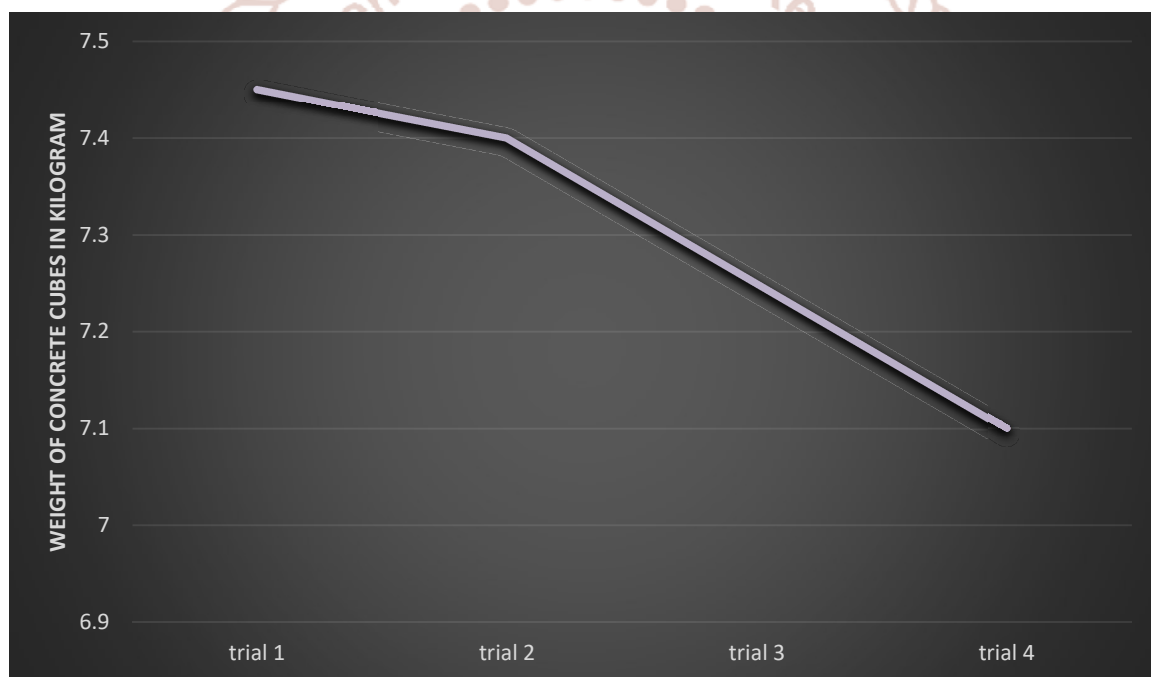


Figure 4.3. Graph Showing the Variation of Weight with Polyethylene Powder Content

5. COST ANALYSIS

5.1. Normal Concrete

Cost per kg of fine aggregate = Rs.5.00

Quantity of fine aggregate used in one M 25 cube = 2.18 kg

Cost of fine aggregate used in one cube = 2.18×5.00 = Rs. 10.9

Quantity of fine aggregate required for producing 1 m³ M 25 concrete = 647 kg

Cost of fine aggregate per cubic meter of m 25 concrete = 647×5 = Rs. 3235

5.2. Modified Concrete

➤ 3 % Replacement of Fine Aggregate:

Cost per kg of polyethylene powder = Rs 3.50

Cost incurred per cube in fine aggregate at 3 % dosage = $2.11 \times 5.00 + 0.0654 \times 3.50$ = Rs 10.7

Cost incurred in fine aggregate in 1 m³ of concrete at 3 % dosage = $627.59 \times 5.00 + 19.14 \times 3.5$ = Rs 3205

Saving per cubic meter of M 25 concrete at 3 % dosage = $3235 - 3205$ = Rs 30

➤ 6 % Replacement of Fine Aggregate:

Therefore, saving per m³ of M 25 concrete at 6 % dosage = 30 + 30 = Rs 60

➤ 9 % Replacement of Fine Aggregate: Saving per cubic meter of M 25 concrete at 9 % dosage = 30 + 30 + 30 = Rs 90

The cost per cubic meter of concrete seems to decrease by a small margin at these dosages but keeping in mind that billions and billions of cubic meters of concrete are produced every year throughout the world. Therefore, even at these 48 small dosages there is an enormous scope of saving money and resources.

6. RESULTS AND DISCUSSION

The main purpose of this investigation was replacing certain percentage of fine aggregate in concrete with low density polyethylene powder and fine its effects on compressive strength, workability and weight of concrete. The effect polypropylene powder on compressive strength, workability and weight of M 25 grade concrete is discussed below:

6.1.compressive Strength

The replacement of fine aggregate with polyethylene plastic powder has shown an increasing trend in compressive strength at 3 % and 6 % dosage. The average compressive strength of normal concrete was recorded as 29.45 N/mm² which increased to 29.80 N/mm² at 3 % replacement of fine aggregate with polyethylene powder. The compressive strength further increased to 30.20 N/mm² at 6 % replacement. However, the compressive strength showed a decreasing trend at 9 % replacement of fine aggregate. The compressive strength decreased to 30.15 N/mm² 9 % dosage, but the compressive strength at 9 % dosage is still in the permissible limit which means even 9 % replacement is totally safe for producing good quality concrete.

6.2.workability

The slump test was conducted for every trail and it was observed that slump value showed a decreasing trend with increase in polyethylene powder content. The slump value for normal concrete was found out to be 50 mm which decreased to 46 mm at 3 % replacement of fine aggregate with polyethylene powder. At 6 % replacement, the slump value decreased to 40mm and at 9 % replacement the slump value decreased to 36 mm. The decrease in workability is not a major issue because required

workability of concrete can be maintained with the help of plasticizers. The decrease in workability also takes place when fibers like steel fiber, glass fibrates are added to the concrete.

6.3. Weight

Weight is an important characteristic feature of concrete because self-weight of concrete has a major impact on the design parameters. The weight of concrete due to the replacement of fine aggregate with polyethylene powder has shown a decreasing trend. The average weight of cubes for normal 54 concretes was found out to be 7.45 kg. At 3 % replacement, the average weight decreased to 7.40 kg and at 6 % and 9 % replacement the average weight decreased to 7.25 kg and 7.10 kg respectively. Therefore, it may be concluded that polyethylene plastic powder can prove to be an effective alternative in the production of light weight concrete, that too with little or no compromise in compressive strength.

7. CONCLUSION

The following are the conclusive points obtained from the experimental investigation:

- 1) The replacement of fine aggregate with polyethylene powder up to 9 % has shown no significant negative impact on compressive strength of concrete. So, low density polyethylene powder can prove to be an effective alternative to natural sand in future with further research in this direction.
- 2) Slump value showed a decreasing trend with increase in polypropylene powder content. The decrease in workability is not a major issue because required workability of concrete can be maintained with the help of plasticizers. The decrease in workability also takes place when fibers like steel fiber, glass fibrates are added to the concrete.
- 3) The weight of concrete due to the replacement of fine aggregate with polyethylene powder has shown a decreasing trend. Therefore, it may be concluded that polyethylene plastic powder can prove to be an effective alternative in the production of light weight concrete, that too with little or no compromise in compressive strength.
- 4) The cost per cubic meter of concrete seems to decrease by a small margin at these dosages but keeping in mind that billions and billions of cubic meters of concrete are produced every year throughout the world. Therefore, even at these small dosages there is an enormous scope of saving money and resources.

5) The concept of using plastic wastes in concrete could be very environmental friendly method of disposal of plastic wastes, this study has shown a potential towards this concept.

7.1. Scope of Future Work

1) The modified concrete is to be tested for tensile and flexural strength to ascertain its behavior in tension and flexure.

2) The durability of modified concrete has to be tested for beams and columns with varying proportions of waste plastic.

3) Admixtures can be used to increase the strength of concrete.

4) The fire resistance of modified concrete has to be tested under controlled conditions.

5) Experimental study has to be conducted on other varieties of plastic like HDPE, Polyester, Polystyrene, Nylon etc.

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