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EXPERIMENTAL STUDY ON CONCRETE BEAM BY PARTIAL REPLACEMENT OF COARSE AGGREGATE BY LDPE GRANULES AND CEMENT BY ALCCOFINE

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Abstract - *The application of waste materials is getting more popular in the concrete industries, as it can reduce the associated costs and environmental impacts. In this paper Low Density Polyethylene (LDPE) granules and Alccofine are used as partial replacement for coarse aggregate and cement for producing concrete cubes and cylinders has been investigated and reported. Concrete cubes and cylinders are cast manually and the strength of concrete in terms of compression and split tension are experimentally evaluated. It is found that the strength of plastic replaced concrete in terms of compression, split tension and flexural strength can be comparable with the conventional concrete. The present study is aimed at concrete mix with partial replacement of coarse aggregate and cement by LDPE granules (0%, 2%, 4% & 6%) that will provide an advantage in reducing the dead weight of structure. Alccofine is used to improve the workability and strength of the concrete. This mix in the form of cubes, cylinders and beam were subjected to compression, split tension, flexural strength to ascertain the strength parameter. Hence the replacement of Coarse Aggregate and Cement in concrete making is not only beneficial but also eco-friendly.*

Key Words: Low Density Polyethylene granules, Alccofine, Fine Aggregate, Coarse Aggregate M 50, Compressive Strength, Split Tensile Strength, Flexural Strength.

1. INTRODUCTION

Concrete and plastic are the most widely used man made material in world. As the world population increases rapidly, various types of waste are generated. It is estimated that every year 4.8 to 12.7 million metric tons of plastic enter the ocean each year. Only 9% of plastic waste ever produced has been recycled. The remaining 79 percent has collected in landfills, dumps, or the environment, with just around 12 percent being burned. Leo Baekeland, who popularized the word "plastics," created Bakelite in 1907, the first totally synthetic plastic in the world. Disposing plastic has become a major problem; it can be reused in many ways.

Many research and study has been carried out in order to reuse the plastic in construction field, which is economical. In the plastic waste stream, High-Density Polyethylene (HDPE) and Low-Density Polyethylene (LDPE) form the largest fraction, followed by Polyethylene Terephthalate (PET), Polypropylene (PP) and Polystyrene (PS). Reusing plastic in concrete is seen to be the most practical solution for dealing with the disposal of vast amounts of plastic waste and to fulfil the growing demand for aggregates. Since plastic is built of polymers, which are composed of long string molecules comprised of carbon atoms coupled with other elements such as hydrogen, nitrogen, oxygen, and fluorine, it cannot be crushed as readily as natural coarse aggregate (NCA).

The goal of this experiment is to determine if it would be possible to partially replace the coarse aggregate in concrete with plastic-granulated waste materials while maintaining the strength of the concrete.

2. POLYETHYLENE

A thermoplastic polymer with a varying crystalline structure is polyethylene. Tens millions tonnes of plastic are produced globally each year, making it one of the most frequently used polymers. Its approximate melting point is 110 °C (230 °F). They are utilized in squeeze bottles, toys, household goods, agricultural mulch, garbage and grocery bags, wire and cable insulation, and packaging film.

3. ALCCOFINE

A new category of micro-fine materials called alccofine have much smaller particle sizes than conventional hydraulic materials like cement, fly ash, silica, etc. Alccofine is a supplemental cementitious material made from ultrafine

ground granulated blast furnace slag. Its unique property, an optimum particle size distribution, is produced during manufacturing under carefully regulated settings using specialized equipment. When making high-strength concrete (HSC) and high-performance concrete, the material Alccofine-1203, which has a low calcium silicate concentration, is used as an SCM to replace silica fume (HPC). Alccofine is also simple to use and can be mixed right in with cement. A better, smoother surface finish is produced by Alccofine's ultrafine particles.

4. OBJECTIVE

The project's primary objective is to i) Replace naturally occurring materials in order to reduce pressure on them. ii) Studying concrete's characteristics using LDPE and Alccofine. iii) To compare the compressive strength, split tensile strength, and flexural strength of conventional concrete with concrete that has been partially replaced. iv) Using concrete of the M50 grade. V) To investigate how freshly poured and hardened concrete behave.

5. LITERATURE REVIEW

The main aim of the paper is to compare the mechanical properties of concrete with regular plastic waste (RPW) and (IPW) as replacement of FA and OPC. The replacement of fine aggregate or cement by IPW may regain its strength due to improved microstructure. For 5% replacement of OPC with IPW 1.07% increases in compressive strength and 13.7% increases in split tensile strength. 7% replacement reduces 59.69kg/m3 of sand (3). In this paper the crumb tyre is used as the partial replacement of fine aggregate and alccofine is mixed in the ratio of 5%, 10% and 15% at the optimum percentage of crumb rubber. The ideal replacement rate for crumb tyres is determined to be 10%. The concrete is more affected by sulphuric acid curing as compared to hydrochloric acid curing. So the sulphuric acid is more dangerous for concrete (4-6). Using recycled plastic in replacement of natural aggregates in concrete, either completely or partially. The bond strength is decreased when increase with RPA. As the amount of RPA increased, the bond strength, elastic modulus, and compressive and flexural strength all reduced. The thermal conductivity of concrete decreased with an increase in the quantity of RPA. The thermal conductivity of RPA was 35–65% less than that of the control concrete(7-9).The cement is replaced by 10% by alccofine and fine aggregate is replaced by 5%, 10%, 15%, 20% Iron powder. The addition of alccofine and iron powder increases its Compressive strength, Tensile strength and Flexural strength of concrete when compared to conventional concrete. The result of the test showed that concrete containing iron powder has good resistance to sulphate attack, acid attack. (10-12).

6. MATERIALS

6.1 Cement:

Cement acts as a binding material in concrete. This project makes use of OPC 53 grade cement. The main reason for using OPC 53 grade is it helps in hydration process and also it increases the strength of concrete. The specific gravity of cement is 3.12. The physical properties of the cement is tested and resulted below.

Table -1: *Physical Properties of Cement*

PHYSICAL PROPERTIES	DESCRIPTION
Specific gravity	3.1 - 3.2
Compressive strength at 28 days	53 N/mm^2 (Minimum)
Initial setting Time	30 min (minimum)
Final Setting Time	600 min (maximum)

6.2 FINE AGGREGATE:

Fine Aggregate used here is M sand, which is manufactured sand made by crushing stones. The size of manufactured sand (M-sand) is less than 4.75mm. Specific gravity of fine aggregate is 2.62. The fundamental material tests for fine aggregate have been resulted below.

Table -2: *Physical Properties of Fine Aggregate*

PHYSICAL PROPERTIES	VALUES
Specific gravity	2.68
Fineness modulus	2.998
Surface texture	Smooth

6.3 COARSE AGGREGATE:

Coarse is usually found naturally and can be obtained by blasting quarries or crushing it by hand or with crushers. A coarse aggregate with a nominal size of 20mm is chosen, and the physical parameters are determined according to IS 383 – 1970.The aggregate which retained on 4.75mm sieve when sieved. The specific gravity of coarse aggregate is 2.70. The physical properties of Coarse aggregate is tabulated below.

Table -3: *Physical properties of Coarse Aggregate*

PHYSICAL PROPERTIES	VALUES
Specific gravity	2.70
Fineness modulus	7.364
Water Absorption	0.512%
Impact Value	38.43%
Particle Size	Angular

6.4 LOW DENSITY POLYETHYLENE

Low density polyethylene, or LDPE, is a supple, adaptable, and light-weight plastic. LDPE is simple to produce, easy to form, and has strong chemical and impact resistance. Low tensile strength but high flexibility characterise LDPE. Plastic bags are the low-density polyethylene product that is used the most frequently. Squeezable bottles, lids, and toys are some LDPE examples. LDPE's specific gravity ranges from 0.91 to 0.925.

Fig-1: LDPE Granules

6.5 ALCCOFINE

Alccofine, a mineral admixture employed here, has been shown to boost concrete's compressive strength over time. Due to its ideal particle size distribution, alccofine offers unique qualities that improve the performance of concrete in both fresh and hardened states. Alccofine comes in two varieties: Alccofine 1101 (which has a high calcium silicate content) and Alccofine 1203. (with low calcium silicate). The specific gravity is 2.7.

Fig-2: Alccofine

6.6 WATER

Water plays an important component of construction. Salts and solid particles must not be present in the water used for building or curing. Water's pH shouldn't be less than 6. Throughout the trial, portable water that met IS 456:2000 requirements was used.

7. MIX DESIGN

Grade of Concrete M50

Type of Cement OPC-53 grade

Nominal Maximum size of Aggregate-20mm

Exposure Condition-Sever

Maximum Cement Content-450Kg/mm3

Maximum w/c ratio-0.45

Mineral Admixture-Alccofine

7.1 MIX RATIO

Table-4: *Mix Ratio*

Cement	Fine Aggregate	Coarse Aggregate	Water
1	1.12	1.66	0.34

Table-5: *Percentage of materials replaced*

Mix Ratio	% of Coarse Aggregate	% of LDPE Granules	% of Cement	% of Alccofine	M-Sand
CC	100%	0%	100%	0%	100%
MR1	98%	2%	90%	10%	100%
MR2	96%	4%	90%	10%	100%
MR3	94%	6%	90%	10%	100%

8. RESULT AND DISCUSSION

8.1 SLUMP CONE TEST

To determine the concrete is workability, the Slump Cone test is performed. The distance between the top of the slumped concrete and the level of the top of the slump cone is used to calculate the concrete's slump. The result of the Slump cone test is mentioned below and the slump is said to be True or High Slump.

Table-6: *Slump cone test result*

Replacement of PEG 4000(%)	Trial No	Slump value (mm)	Average slump value (mm)	Type of Slump
Normal Slump	1	102	101	True or High Slump
	2	100		
MR1	1	105	104	
	2	103		
MR2	1	106	107	
	2	118		
MR3	1	105	`106	
	2	107		

8.2 HARDENED CONCRETE

The concrete is said to be hardened only when it is fully cured. The Hardened concrete test are Compressive strength, Split Tensile Test, and Flexural strength test.

8.2.1 COMPRESSIVE STRENGTH TEST

The ability of a material or structure to resist push forces that are applied axially is known as compression strength. A cube of standard dimensions of 150x150x150mm is used for the compressive strength test. The concrete is cured for 7and 28-day before a concrete test is conducted. The Compressive Strength of **4%** replacement of CA with LDPE granules **increased** when combared to conventional concrete. The results of the compressive strength is tabulated below(13-16)

Table-7: *Compressive strength of concrete*

% of Replacement	Average Compressive Strength (N/mm^2) at 7 days	Average Compressive Strength (N/mm^2) at 28 days
CC	33.21	50.34
MR1	33.38	51.14
MR2	**34.52**	**52.11**
MR3	34.20	51.28

Fig-3: Compressive Test on Cube

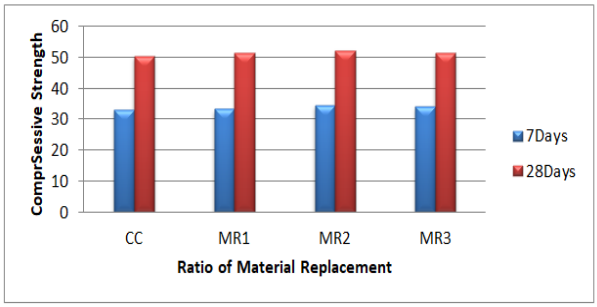

Chart-1: Compressive Strength of Concrete

8.2.2 SPLIT TENSILE STRENGTH

The tensile strength of concrete can be tested indirectly using this technique. This test takes place on a cylindrical specimen with dimensions of 300mm in length and 150mm in diameter. The concrete is cured for 7and 28-day before a concrete test is conducted. The Split Tensile Strength of **2%** replacement of CA with LDPE granules **increased** when combared to conventional concrete. The results of the split tensile strength is tabulated below(17-20).

Table-8: *Split tensile strength of concrete*

% of Replacement	Average Split Tensile Strength (N/mm^2) at 7 days	Average Split Tensile Strength (N/mm^2) at 28 days
CC	3.26	4.85
MR1	**3.31**	**5.52**
MR2	3.18	5.38
MR3	3.13	5.04

Fig-5: Split Tensile test on Cylinder

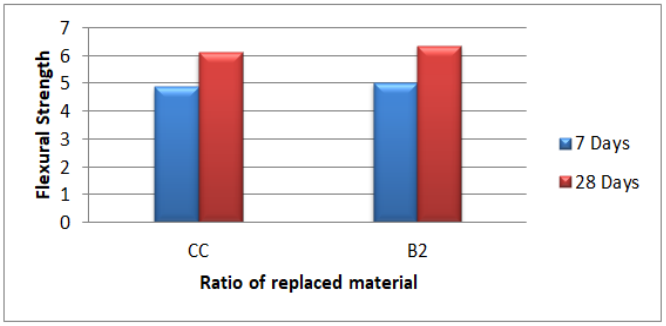

Chart-3: Flexural Strength Test

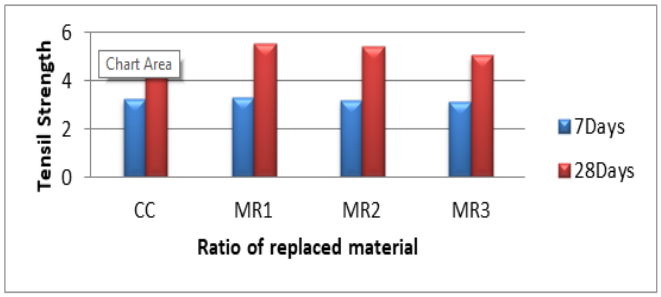

Chart-2: Split Tensile of Concrete

8.2.3 FLEXURAL STRENGTH TEST

Flexural strength is tested using a beam with a specimen size of 200 mm x 200 mm x 750 mm. The ideal percentage based on compressive strength is MR2, or **4 percent LDPE granule replacement and 10 percent Alccofine.** From the optimum percentage the beam is casted and after curing, the flexural test of a conventional concrete beam and a beam that has been replaced with materials is conducted, The Strength is **increased** at **4%** replacement when compared to conventional concrete and the results are tabulated below(21-26).

Table-9: *Flexural Strength of concrete*

% of Replacement	Average Compressive Strength (N/mm^2) at 7 days	Average Compressive Strength (N/mm^2) at 28 days
CC	4.87	6.11
MR2	**5.02**	**6.35**

Fig-6: Flexural test of Beam

9. CONCLUSION

The workability of the concrete is gradually increasing with replacement of plastic and mineral admixture when compared to normal slump.At 28days of curing the concrete attain its maximum strength and the tests are carried out. The Compressive strength of Replaced concrete high at **MR2 (52.11 N/mm2)** when compared to conventional concrete. The Split Tensile test of replaced concrete is high at **MR1 (5.52N/mm2)** when compare to conventional concrete at 28 days. The Flexural Strength of concrete beam is increasing at **B2 (6.35N/mm2)** with 4% replacement of CA by LDPE granules and 10% of Cement by Alccofine. Since the weight of the concrete is reguced by using plastic material it can be used as light weight material also. By introducing waste recycled plastic into the concrete is which is environmental friendly.

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