INVESTIGATION ON STRENGTH PROPERTIES OF CONCRETE MADE WITH PET BOTTLE CAPS AS A PARTIAL REPLACEMENT OF COARSE AGGREGATE AND FLY ASH AS A PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

Concrete is mainly classified into three types based on the density. Concrete containing natural sand and gravel or crushed- rock aggregate and water, when placed in the skeleton of form and allowed to cure, becomes hard like stone. Generally weighing about 2400kg/m^3 is called "normal-weight concrete" and it is the most commonly used concrete for structural purposes. For applications where a higher strength-to-weight ratio is desired, it is possible to reduce the unit weight of concrete by using natural aggregate with lower bulk density. The term lightweight concrete is used for concrete that weightless than 1800 kg/m^3. Heavy weight concrete used for radiation shielding, is a concrete produced from high density aggregate and generally weigh more than 3200kg/m^3.

Our aim it is to study the properties of concrete by partially replacing cement by fly ash and coarse aggregate by Pet bottle caps(PBC).

In this study, Cement was partially replaced by Fly Ash and Coarse aggregate were partially replaced by Pet bottle caps in concrete. A mix design was done for M_{30} grade of concrete by using IS method.. Grades of ordinary port land cement (OPC) namely: 53 as classified by bureau of Indian Standard (BIS) or commonly used in construction industry. Now in this project only 53 grade of cement is used. This paper reports comparative study on effects of concrete properties by partially replacement of OPC of 53 grades with fly ash and coarse aggregate partially replacement with pet bottle caps. The main variable investigated in the study of variation of fly ash dosage of 5%, 10%, 15% and pet bottle caps dosage of 2%,. The compressive strength and split tensile strength & acid attack of concrete were mainly studied. Test results shows that, inclusion of fly ash and pet bottle caps generally improves the concrete properties up-to certain percentage of replacement in53 grade of cement.

1. INTRODUCTION

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Regrettably, production of cement involves emission of large amounts of carbon dioxide gas into the atmosphere, a major contributor for green house effect and the global warming. Hence it is inevitable either to search for another material or partly put back it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact.

Fly Ash: Fly ash also known as flue-ash is one of the residues generated in combustion coal and comprises the fine particles that rise with the flue

gases.Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash.

PET bottle caps: Plastics are polymers, a very large molecule made up of smaller units called monomers which are joined together in a chain by a process called polymerization. The polymers generally contain carbon and hydrogen with, sometimes, other elements such as oxygen, nitrogen, chlorine or fluorine (UNEP, 2009).

Plastics have become an integral part of our lives. The amount of plastics consumed annually has been growing steadily

2. LITERATURE REVIEW

Extensive research work both at national and international level has been done on the use of various admixtures in mortars and concretes with common goal. The main objectives are:

- To combat the environmental hazards from the industrial wastes.
- To modify the properties of traditional concrete to the desired level suitable to the specific circumstances.
- To conserve the natural resources used in the production of construction materials.

Fly ash is produced by coal-fired electric and steam generating plants. Boiler tubes extract heat from the boiler, cool the flue gases and cause the molten mineral residue to harden and form ash. Coarse ash particles, called as bottom ash or pet bottle caps, fall to the bottom of the combustion chamber, and the lighter fine ash particles, termed as fly ash, remain suspended in the flue gas.

Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately gets ignites, generates heat and produces a molten mineral residue. Boiler tubes extract heat from the boiler, cool the flue gases and cause the molten mineral residue to harden and form ash. Coarse ash particles, called as bottom ash or pet bottle caps, fall to the bottom of the combustion chamber, and the lighter fine ash particles, termed as fly ash, remain suspended in the flue gas. Before exhausting the flue gas, fly ash is removed by particulate emission control devices, such as filter fabric bag houses or electrostatic precipitators

Every year, about 8-12 million tons of plastic enters our oceans (Jambeck et al., 2015; Eunomia, 2016), including many plastic bottle caps. The North Sea also contains large numbers of plastic bottle caps. Research carried out by The North Sea Foundation on beach litter over the last 12 years shows that on average, 19 bottle caps are found every 100 metres, mostly on non – touristic beaches2. During the annual beach litter monitoring, bottle caps are counted, however little is known about the type of bottle caps that are found. Obtaining this information would give a better understanding about the use and origin of the caps and their movements at sea.

The coupling between the atoms of a macromolecular chain happens by primary valence bonding. The backbone of the chain is built by carbon atoms linked together by single or double bonding. Given by the electron configuration of carbon atoms, the link between the carbon atoms occurs at a certain angle, for example, for single bonding at an angle of 109.5.

3. EXPERIMENTAL PROGRAMME

3.1 Materials

Constituent materials used to make concrete can have a significant influence on the properties of the concrete. The following sections discuss constituent materials used for pet bottle caps and fly ash based concrete. Chemical and physical properties of the constituent materials are presented in this section.

3.1.1 Fly ash

The physical properties of the Fly Ash as obtained by the manufacturer are presented in the Table 3.1.

Table 3.1 Physical Properties of Fly ash

S.NO	DESCRIPTION	PROPERTIES
1	Specific Gravity	2.0
2	Physical Form	Powder
3	Color	Dark grey

3.1.2 Coarse aggregate

The coarse aggregate is free from clayey matter, silt and organic impurities etc. The specific gravity of Sand is taken as 2.65. Coarse aggregate is tested for specific gravity, in accordance with IS: 2386-1963. The maximum size of 20 mm is used as a coarse aggregate in concrete. For most of building constructions, the

coarse aggregate consists of gravel or crushed stone up to 20mm size. However, in massive structures, such as dams, the coarse aggregate may include natural stones or rock.

3.1.3 Fine aggregate

Naturally available sand is used as fine aggregate in the present work.. The sand is free from clayey matter, silt and organic impurities etc. Hence used as a fine aggregate in concrete. The size of sand is that passing through 4.75 and retained on 150 micron IS sieve. The specific gravity of Sand is taken as 2.62. Sand is tested for specific gravity, in accordance with IS: 2386-1963

3.1.4 Water

Generally, water that is suitable for drinking is satisfactory for use in concrete. When it is suspected that water may contain sewage, mine water, or wastes from industrial plants or canneries, it should not be used in concrete unless tests indicate that it is satisfactory. Water from such sources should be avoided.

3.1.5 Pet bottle cops properties:

For the various mix proportion of plastic waste the concrete cubes, cylinder and prism have been prepared for 7days and 28days. The cube specimen were used for compressive strength whereas cylinder specimens were used for split tensile strength and prism specimens were used for flexural strength.

Table 3.2 Properties of pet bottle caps

S.NO	DESCRIPTION	PROPERTIES
1	Specific Gravity	1.4
2	Physical Form	Sized particles
3	Color	Available in a wide variety

3.2 Test Methods

This section describes the test methods that are used for testing the hardened properties of concrete.

3.2.1 Compressive strength test

Remove the specimen from water after specified curing time and wipe out excess water from the surface. Take the dimension of the specimen to the nearest 0.2m. Clean the bearing surface of the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Apply the load gradually without shock and continuously at the rate of 140kg/cm2/minute till the specimen fails. Record the maximum load and note any unusual features in the type of failure.

Fig.3.1 compressive strength of cubes

Minimum three specimens should be tested at each selected age. If strength of any specimen varies by more than 15 per cent of average strength, results of such specimen should be rejected.

3.2.2. spilt tensile strength:

The split tensile test were conducted as per IS 5816:1999. The size of cylinder is 300mm length with 150mm diameter. The specimen were kept in water for curing for 28, 60 and 90 days and on removal were tested in wet condition by wiping water and grit present on the surface. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The maximum load applied to the specimen was then recorded and the appearance of the concrete for any unusual features in the type of failure was noted. Average of three values was taken as the representative of batch.

Fig.3.2 spilt tensile strength of cylinders

The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder along the vertical diameter.

3.3 Mix design:

Materials	Cement (kgs)	Fly ash (kgs)	Bottle caps (kgs)	Water (lits)	Fine Aggregate (kgs)	Coarse Aggregate (kgs)
Controlled concrete	440	-	-	198	667.24	1136.11
5%FLA +2%BC	418	22	11.57	198	660.2	1101.64
10%FLA+2%BPC	396	44	11.64	198	664.22	1108.35
15%FLA+2%BC	374	66	11.76	198	671.26	1120.11

4. TEST RESULTS

4.1 compressive strength results

Compression test is the most common test conducted on hardened concrete, partly because it is easy test to perform and partly because most of desirable characteristic properties of concrete are qualitatively related to its compressive strength. Compression test is carried out on specimens of cubical shape. The size of specimen is 15×15×15 cm.

Table 4.1.1: compressive strength of concrete

S.NO	MIX TYPE	CONTROLLED CONCRETE	FA5% +PBC 2%	FA10% +PBC 2%	FA15% +PBC 2%
1	7 days	26.1	26.66	27.23	25.57
2	14 days	32.1	32.79	33.48	31.45
3	28 days	39.15	39.99	40.85	38.36

The below graph shows compressive strength V_s no of days .the horizontal axis represents the compressive strength and vertical axis represents days.

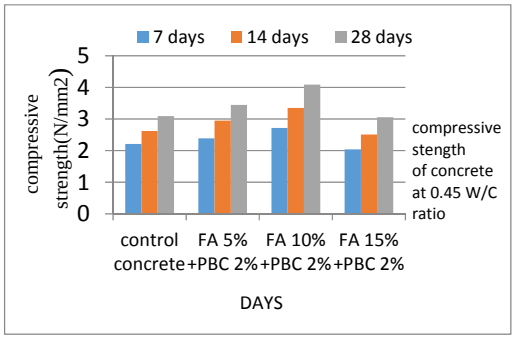

Fig 4.1(a) compressive strength graphs

4.2 spilt tensile strength results

By conduct the split tensile test the cylinders is placed horizontally on the compressive testing machine and two parallel plates are kept in top and bottom of the cylinder because of the reason is the load is uniformly distributed on the cylinder. Then the load is applied on the specimen and to observe the crushing load values and they are recorded. After knowing the crushing load values by using split tensile formula and to calculate the split tensile values they are shown in below tables

Table 4.2.1: spilt tensile strength of concrete

S.NO	MIX TYPE	CONTROLLED CONCRETE	FA5% +PBC 2%	FA10% +PBC 2%	FA15% +PBC 2%
1	7 days	2.21	2.39	2.72	2.04
2	14 days	2.26	2.95	3.35	2.51
3	28 days	3.09	3.45	3.95	3.06

The below graph shows compressive strength V_s no of days .the horizontal axis represents the compressive strength and vertical axis represents days.

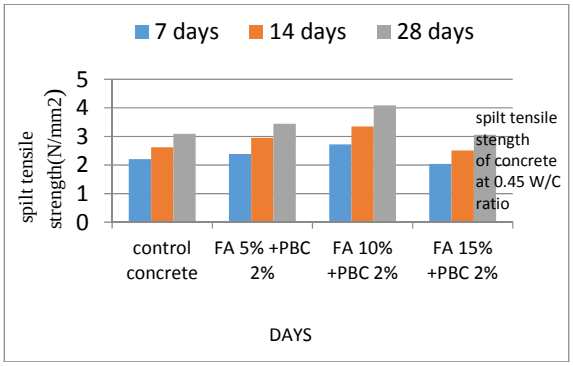

Fig.4.2 (b) spilt tensile strength graph

5. CONCLUSION

Fly Ash and pet bottle caps is used in production of concrete cubes and cylinders replacement cement by fly ash dosage of 5% at replacement coarse aggregate by plastic bottle caps dosage of 2% replacement cement by fly ash dosage of 10% at replacement of coarse aggregate by pet bottle caps dosage of 2%, replacement of cement by fly ash dosage of 15% at replacement of coarse aggregate by pet bottle caps dosage of 2%, .These cubes and cylinders were cured and tested for compressive strength

and split tensile strength for 7days, 14days, 28days and results were noted.

- The Compressive strength of concrete for 10% FA and 2% PBC is more compared to that for 5% FA and 2% PBC and 15% FA and 2% PBC.
- The maximum strength attained 40.85N/mm^2 at 10 % FA and 2% PBC replacement.
- The maximum split tensile strength had attained 3.95N/mm^2 at 10%FA and 2% PBC replacement.
- The split tensile strength values were found to be gradually decreased while the combination of percentage replacement of admixtures is increased.

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