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Partial Replacement of Coarse Aggregate with Waste Plastic in Concrete

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Abstract-This paper investigates the effect to fusing waste plastic materials on the concrete. Waste plastic were collected from homes. Most plastics are not biodegradable. They will stay in landfills until they are cleaned up. An important problem we are facing is dumping of plastic materials it causes lot of problems. In order to decrease the plastic waste, it can be used in construction field, plastic is inorganic in nature so it does not alter the chemical properties of concrete and also it does not affect the quality and consistency of concrete. The plastic can be as filler material in concrete as well as it can be used to improve the mechanical properties of concrete. Concrete is a composite material consists of Cement, Water, Fine Aggregate and Coarse Aggregate. High strength concrete was prepared of W/C 0.35 and the percentage of waste plastic replaced by 3, 6, 9, 12, 15 and18 % of cement, coarse aggregate used in concrete.

Keywords: - Concrete, plastic, aggregate, cement.

I. INTRODUCTION

Plastics currently play a massive role in our daily lives. Plastics are utilized in virtually all areas of manufacturing. Tons and tons of plastic products are molded on a daily basis, even as the waste continues to build up. Due to the fact that most plastics are not biodegradable, an enormous sum of plastic waste continues to build up worldwide, with industrialized nations contributing the largest amount of plastic waste. More specifically, the majority of plastic waste comes from packaging and containers. The amount of land required for landfills is of increasing concern everywhere in the world.

From the 1950 up to 2018, an estimated 6.3 billion tons of plastic has been produced worldwide, of which an estimated 9% has been recycled and another 12% has been incinerated. India alone, produces more than 5 million tons of plastic are consumed each year, of which only an estimate done-quarter is recycled, with their main dyer going to landfills. This large amount of plastic waste inevitably enters the environment, with studies suggesting that the bodies of 90% of seabirds contain plastic debris.

Khilesh (2014) studied the impact of use of plastic waste and steel fiber addition on the properties of concrete. The fine aggregate was replaced by plastic waste at 0.2%, 0.4%, 0.6%, 0.8% and 1% by weight of cement and 0.1%, 0.2%, 0.3% 0.4% and 0.5% steel fibers were incorporated in concrete mixes. They observed that, replacement of fine aggregate by plastic waste in different percentages showed an increase in compressive strength whereas marginal reduction in slump as compared to that of control mix [10].

Subramani and Pugal (2015) reportedthat, the use of plastic waste as a replacement for conventional coarse aggregate improves the physical and mechanical properties of concrete mixes.

It was reported that, the compressive strength, flexural strength and split tensile strength of concrete was increased by 8%, 5% and 3% as compared to that of control concrete at 15% replacement level. As the percentage of replacement increased beyond 15% all the properties of concrete

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showed downward trend. This fact was due to excess presence of water in the concrete mix because plastic waste has very low water absorption as compared to that of conventional coarse aggregate [15].

Harini and Ramana (2015) studied the influence of replacement of plastic waste and silica fume as fine aggregate and cement respectively in concrete mixes. The plastic waste was replaced in the percentage 5%, 6%, 8%, 10%, 15%, 20% by volume and silica fume 5%, 10%, 15% by weight in concrete. They reported that, the degree of work ability was high in all there placement levels.

It was also stated that, in all the replacement levels of plastic waste as fine aggregate showed marginal reduction approximately 10% in compressive strength as compared to that of control mix.

In case of silica fume replacement the compressive strength of concrete mixes increased by 13%, 20% and 23% at 5%, 10% and 15% respectively. Tensile strength of concrete reduced marginally at 8% to 20% replacement and increased marginally at 5% and 6% replacement levels as compared to that of control mix [11].

II. MATERIALS USED AND THEIR PROPERTIES

Cement: Ordinary Portland Cement (43 Grade) with 29 percent normal consistency conforming to IS: 8112-1989 was used. The specific gravity and fineness modulus of cement are 3.15. Fine Aggregate-The properties of sand by conducting tests according with IS 2386 (part-1)–1963. Coarse Aggregate-Crushed stone coarse aggregate conforming to IS 383 – 1987 was used. The values of loose and compacted bulk density values of coarse aggregates were 1600 and 1781 Kg/m3. Water-Water is an important ingredient of concrete as it actively participates in chemical reactions with cement. Clean potable water conforming to IS456 – 2000 was used for the preparation of concrete mixture.

1. Mixing Details

The concrete mix has been designed for M20 grade as per IS 10262 –2009. Volume of concrete required for a cube of 150 x 150 x 150 mm mould = 0.003m3, Quantity of cement, Fine aggregate and Coarse aggregate is 1.47 kg, 1.47 kg, 2.94 kg.Volume of concrete required for a cylinder = 0.005 m3, Quantity of cement, Fine aggregate and Coarse aggregate is 2.45 kg, 2.45 kg, 4.9kg.

2. Basics of Plastic Manufacturing

The term “plastic” includes materials composed of various elements such as carbon, hydrogen, oxygen, nitrogen, chlorine and sulfur. Plastics typically have high molecular weight; meaning can have thousands of atoms bound together.

Most plastics are based on the carbon atom. Silicones, which are based on silicon atom, are an exception. The carbon atom can link to other atoms with up to four chemical bonds. When all of the bonds are to other carbon atoms, diamonds or graphite or carbon black may result.

For plastics the carbon atoms are also connected to hydrogen, oxygen, nitrogen, chlorine or sulfur. When the connections of atoms result in long chains, like pearl son a string of pearls, the polymer is called a thermo plastic. About 92% of plastics are thermo plastics. Figure.1 shows plastic bottle chemicals.

Fig 1. Plastic Bottle Chemicals.

Some examples of material properties in plastic product applications are:

- Hot-filled packaging used for products such as ketch up.
- Chemical-resistant packaging used for products such as, bleach.

2.1 Types of Plastics:

2.1.1 Thermoset: 1. Polyurethanes: Mattresses, Cushions, Insulation. 2. Epoxies: Adhesive glues, Coating for electrical devices, Helicopter and jet engine blades. 3. Phenol Formaldehyde:

plywood, Electrical appliances, Electrical circuit boards and switches.

2.1.2 Thermoplastics: 1. Packaging, Electrical insulation, Milk and Water bottles, Packaging film, House Wrap, Agricultural film.

2.1.3 Polypropylene: Carpet fibers, automotive bumpers, Microwave containers, External prostheses.

2.1.4 Polyvinyl chloride (PVC): Floor and wall covering, Automobile instruments. Figure 2 and 3, shows the application of plastics in different fields.

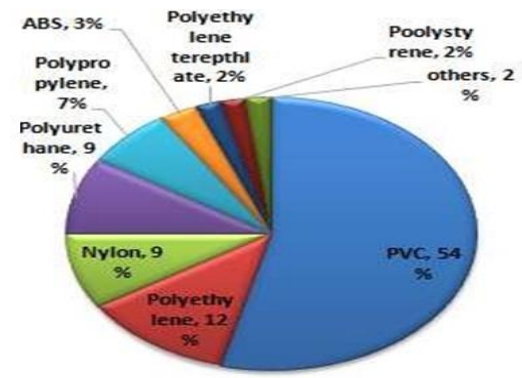

Fig 2. Plastics used in Construction Field.

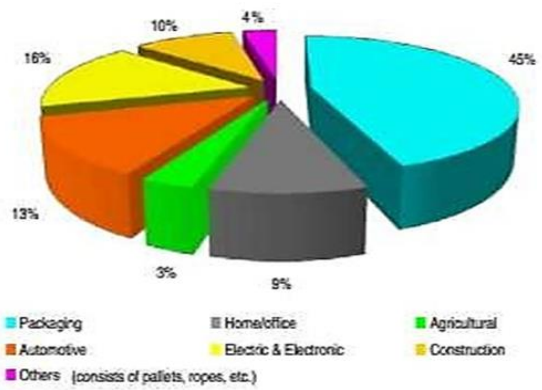

Fig 3. Plastics used in Different Fields.

2.3 Test Methods

The density and consistency of fresh concrete was estimated according to standard methods. The compression strength and water absorbability of hardened concrete were established according to standard methods.

The size of tested concrete specimens with the age of 28 days. Test of fresh and hardened concrete were applied to control concrete and concrete with partly changed coarse aggregates to plastic waste. Plastic carry bags are filled in empty water bottles and are compacted to remove the air in the container.

Fig 4. Waste Plastic Compacted in Bottle.

Fig 5. Compression Test on Concrete Cube.

Figure 6Split Tensile Test on Concrete.

III. RESULTS AND DISCUSSIONS

The compression test was conducted on the concrete cubes and beams are shown.

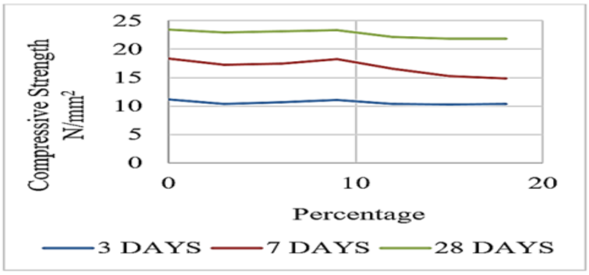

Fig 7. Variation on Compressive Strength.

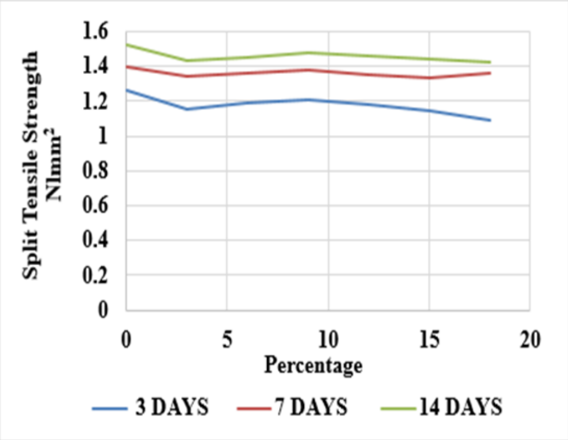

Fig 8. Variation on Split Tensile Strength.

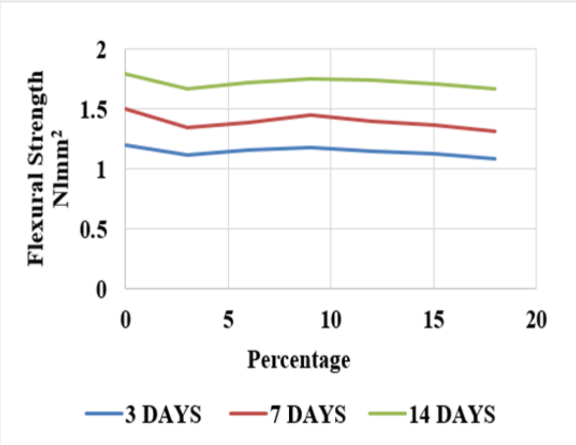

Fig 9. Variation on Flexural Strength.

Compressive strength of the concrete reduced with increasing percentage of plastic replacement. The cube compressive strength of concrete at the age of 7 days resulted in marginal reduction with 10% replacement of cement, Fine aggregate and Coarse aggregate. The split Tensile strength was reduced by 10% replacement of cement, Fine aggregate and Coarse aggregate when compared with conventional concrete. The strength of concrete decreased as the percentage of replacement of the conventional material increased. The reduction in compressive strength is less in comparison with the split tensile strength with the replacement of conventional material.

The split tensile strength at the 7 and 14 days for the replacements of conventional material is marginal. The reduction in flexural strength of replacements at the age of 28 days is less when compared with early strength of concrete. The compressive strength, split tensile strength and flexural strength decreased with the percentage replacements of plastic waste increases at the age of 14 days.

The compressive strength, split tensile strength and flexural strength of cement, Fine aggregate and Coarse aggregate decreased is very less and hence can be used less important work, utilizing the waste material which is produced in large quantities.

IV. CONCLUSION

The use of waste plastic in cement based composite can significantly reduce cost of construction through full or partial replacement of aggregates. The used of waste plastics in constructions will grossly reduce rate of solid waste accumulation in the environment and income will be generated from its utilization.

Detectable reductions in compressive strengths are observed with increasing the percentage of plastic. The percentage expansions of the specimens cast with partial replacement of plastic are within the permissible limits; hence the materials are safe for construction purpose. Use of plastic increases the strength and durability of concrete for construction.

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