Behaviour of Concrete By Replacement of Fine Aggregate with Recycled Plastic Granules

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Abstract- *This paper represents a novel design and control The disposal of used plastics is one of the major problems faced in the present era of the world. The usage of plastic is growing day by day. The non-biodegradability of plastic makes it very harmful to the environment. Plastic is a non-biodegradable material and the degradation of plastic is a very long process. In this work, partial replacement of fine aggregate by recycled plastic granules at 5%, 10%, 15%, and 20%inM20 grade concrete containingPolypropylene Raffia Granules was done. The Workability and compressive strength are determined after 7 days, 14 days, and 28 days of water curing.*

Keywords- Objective1, Behaviour of concrete2, Properties of plastic granules3, Properties of plastic granules3, Test on cement4, Test on sand5, Test on aggregate6, Concrete mix design7, Test on concrete8 etc.

I. INTRODUCTION

The problem of disposing and managing solid waste materials in all countries has become one of the major environmental, economic, and social issues. A complete waste management system including source reduction, reuse, recycling, landfilling, and incineration needs to be implemented to control the increasing waste disposal problems. Typically plastic is not recycled into the same type of plastic products made from recycled plastics are often not recyclable. The use of biodegradable plastics is increasing. If some of these get mixed with the other plastics for recycling, the reclaimed plastic is not recyclable because of the variance in properties and melt temperatures. The purpose of this project is to evaluate the possibility of using granulated plastic waste materials to partially substitute for the fine aggregate in concrete composites.

Among different waste fractions, plastic waste deserves special attention on account of its non-biodegradable properties which are creating a lot of problems in the environment. In India, approximately 40 million tons of solid waste is produced annually. This is increasing at a rate of 1.5 to 2% every year. Plastics constitute 12.3% of total waste produced most of which is from discarded water bottles. Plastic waste cannot be disposed of by dumping or burning, as they produce uncontrolled fire or contaminate the soil and vegetation. Considerable research and studies were carried out in some countries like the USA and UK on this topic. However, there have been very limited studies in India on plastics in concrete. Hence an attempt on the utilization of waste Low-Density Polyethylene (LDPE) granules as partial replacement of coarse aggregate is made and its mechanical behaviors are investigated.

1.1PROBLEMS OF THE PLASTIC

Plastic waste is essentially garbage. It is the sum total of all the solid waste produced in our homes, businesses, and some industrial sources. As plastic is not a biodegradable material it cannot be decomposed. As waste production is increasing the disposal of waste is one of the major problems. The waste is sent to the landfills which causes the land to be polluted as the waste material is contacting plastic which is non-biodegradable and causes many problems. The percentage of plastic waste in solid waste is growing in volume and in toxicity. More and more everyday plastic bottle products contain toxic chemicals and these toxic products are combined with a plethora of other chemicals, which eventually impact public health and the environment. This has necessitated the importance of studying on disposal of plastic waste otherwise it will create very serious health issues and problems.

1.2THE PROBLEM IN CONCRETE

The Indian construction industry today is amongst the five largest in the world. The demand for new construction ever increasing with the rise in population. Hence concrete is the most widely used construction material in the world estimated at up to 11 billion metric tons every year and in India currently, approximately 370 million cubic meters of concrete are consumed every year, and it is expected to reach approximately 580 million cubic meters by 2022. Concrete plays an important role in the beneficial use of these materials in construction. All the materials required to produce such a huge quantity of concrete confirm the earth's crust depleting its resources every year creating ecological strength. Hence the non-renewable aggregate supply has emerged as a problem

in India and the world with the shortage as seen today, the future seems to be in the dark for the construction sector. Seeking aggregates for concrete focusing on the environment and safeguarding natural resources, new materials have been used in the construction field, and new waste materials have been used in the construction industry. Most of the failures in concrete structures occurs due to the failure of concrete crushing of aggregates.

1.3 OBJECTIVES

a) To compare the compressive strength of recycled plastic used as fine aggregate for construction concrete with conventional concrete
b) The utilization of plastic waste in construction work.
c) To compare the physical characteristics of artificial aggregate with plastic aggregate.
d) To reduce the overall weight of the structure.

II. METHODOLOGY

PP RAFFIA PLASTIC GRANULES

Introduction and Properties

PP Raffia granules refer to the raw material used in the production of Polypropylene (PP) Raffia bags. Polypropylene is a thermoplastic polymer that is widely used in various industries due to its durability, flexibility, and resistance to moisture, chemicals, and UV radiation.

These granules are the initial form of polypropylene before being melted and extruded into long fibers, which are then woven into a fabric known as raffia. The raffia fabric is commonly used to make bags, sacks, and other packaging materials.

The production process of PP Raffia granules involves polymerization, which converts propylene monomers into polypropylene. The polypropylene is then cooled and cut into small granules for easy handling and transportation. These granules can be further processed through melting, extrusion, and weaving to create raffia fabric.

PP Raffia Granules are made from PP Raffia Bags, Jumbo Bags, and Plant waste.

Cement

Cement is a binding agent, a substance that solidifies and hardens, enabling the adhesion of various materials. The term “cement” has its origins in Roman terminology, specifically the phrase Opus compendious. In the realm of construction, cement can be classified as either hydraulic or non-hydraulic, contingent upon its capacity to function in the presence of water. Non-hydraulic cement will not set in damp conditions or underwater; rather, it hardens as it dries and reacts with carbon dioxide in the atmosphere. Furthermore, once set, it may be susceptible to attack from certain aggressive chemicals.

FINE AGGREGATES

Crushed sand is used as fine aggregate. The crushed sand is artificial sand which is manufactured by crushing granite stone. It is manufactured artificially, so it is also called M sand or manufactured sand.

The crushed sand is the best substitute for river sand. The strength of the concrete is increasing while using crushed sand instead of river sand. The river sand is in very short supply, and also the excavation of river sand causes the groundwater level, and it is very harmful to the environment.

COARSE AGGREGATES

Coarse aggregates refer to irregular and granular materials such as sand, gravel, or crushed stone, and are used for making concrete. In most cases, Coarse is naturally occurring and can be obtained by blasting quarries or crushing them by hand or crushers.

It is imperative to wash them before using them for producing concrete. Their angularity and strength affect the concrete in numerous ways. Needless to say, the selection of these aggregates is very important.

TESTS ON CEMENT RESULT

STANDARD CONSISTENCY OF CEMENT-30%
INITIAL SETTING TIME -30 mins
Final setting time- 580 mins

TESTS ON FINE AGGREGATES RESULT

The average specific gravity of fine aggregate - 2.65
Percentage of water absorption -1.01 %

PROPERTIES OF LOW-DENSITY POLYETHYLENE (LDPE):

Properties	**Values**
Physical state	Solid
Appearance	Granules

Grain size 2.36mm
Density 900kg/m^3

Fig -1: **LOW-DENSITY POLY ETHYLENE**

Experimental Plan

a. In this work, 5%, 10%, 15%, and 20% of fine aggregate is replaced by recycled plastic aggregate for M20 grade concrete.
b. Cube specimens of size 150 mm x 150 mm x 150 mm were cast for the properties of concrete prepared without recycled plastic aggregate.
c. Compression test was performed on the concrete after 7, 14 and 28 days of curing.

CONCRETE MIX DESIGN

1. Cement = 383 kg/m3
2. Water = 192 kg/m3
3. Fine aggregate = 727 kg/m3
4. Coarse aggregates = 1103 kg/m3
5. Water cement ratio = 0.50
6. Yield =2404.6 kg

Table -1: MIX PROPORTION

Recycled plastic aggregate (%)	Cement (Kg)	Fine aggregate (Kg)	Coarse Aggregate (Kg)	W/C ratio
0	1.38	2.48	4.18	0.55
5	1.38	2.356	4.18	0.55
10	1.38	2.232	4.18	0.55
15	1.38	2.108	4.18	0.55
20	1.38	1.984	4.18	0.55

III. RESULT AND DISCUSSION

In this section the result of the compressive test, the replacement of fine aggregate by recycled plastic is tabulated.

Table -2: Compressive strength test

% Replacement of PP granules	7 days	14 days	28 days
0	13.5	17.3	20
5	14.33	18.33	22.22
10	13.82	17.77	21.15
15	12.9	16.33	19.7
20	10.3	14.5	18.3

From the above result Comparison of compressive strength value

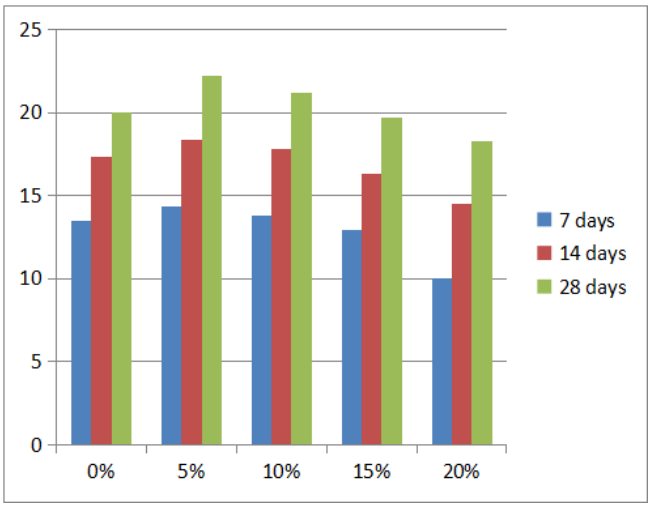

Chart-1:Comparison of compressive strength value

IV. CONCLUSIONS

The experimental results have shown the use of waste plastic material in making concrete/mortar can provide an alternative solution to minimize the environmental impact due to unscientific disposal of waste plastic. The following conclusions were drawn:

- The properties of concrete containing various percentages of plastic (5%, 10%, 15%, and 20%) were tested for its workability and compressive strength.
- The waste plastic used for experiments is of raffia recycled plastic granules 2.36mm in size. The

compressive strength of the concrete increases up to 10% replacement of recycled plastic granules and then gradually decreases with the increase of recycled plastic aggregate.

- The workability of the concrete increases with the increase in the percentage of plastic granules.

REFERENCES

[1] Environmental Protection Agency (EPA), 2014, Facts and Figures about Materials, Waste, and Recycling - Plastics: Material-Specific Data [Online] Available at: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data [Accessed 2018]. M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] Galvão, J. C. A., Portella, K. F., Joukoski, A., Mendes, R., and Ferreira, E. S 2011, 'Use of waste polymers in concrete for the repair of dam hydraulic surfaces', Construction and Building Materials, Vol. 25, No. 2, pp. 1049–1055. doi:10.1016/j.conbuildmat.2010.06.073.

[3] Frigione, M 2010, 'Recycling of PET bottles as fine aggregate in concrete', Waste Management. Elsevier Ltd,Vol.30,No.6,pp.1101–1106.doi: 10.1016/j.wasman.2010.01.030.

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