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Experimental Study on Plastic Waste Material in Concrete and their applications

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ABSTRACT

In this paper, the author has studied and tried out to find the possibility of re-cycling a plastic bag waste material (BBW) that is now produced in large quantities in the formulation of concrete as fine aggregate by substitution of a variable percentage of sand (10, 20, 30 and 40 %). Disposal of plastic waste in an environment is considered to be a big problem due to its very low biodegradability and presence in large quantities. In recent time use of such, Industrial wastes from polypropylene (PP) and polyethylene terephthalate (PET) were studied as alternative replacements of a part of the conventional aggregates of concrete. Plastic recycling was taking place on a significant scale in an India. As much as 60 % of both industrial and urban plastic waste is recycled which obtained from various sources. People in India have released plastic wastes on large scale have huge economic value, as a result of this, recycling of waste plastics plays a major role in providing employment.

Keywords: plastic bags, wastes, concrete, use, applications, cement.

INTRODUCTION

Plastic has become the most common material since the beginning of the 20th century and modern life is unthinkable without it. Unfortunately, what makes it so useful, such as its durability, light weight and low cost, also makes it problematic when it comes to its end of life phase. Dozens of millions of tonnes of plastic debris end up floating in world oceans broken into microplastic, the so-called plastic soup. Microplastics are found in the most remote parts of our oceans. Entanglement of turtles by floating plastic bags, sea mammals and birds that die from eating plastic debris and ghost fishing through derelict fishing gear produce shocking pictures. Moreover, plastic is not inert and chemical additives, some of them endocrine disruptors, can migrate into body tissue and enter the food chain. The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

Generation of plastic waste is one of the fastest growing areas. Every year more than 500 billion plastic bags are used (nearly one million bag per minute). Hundreds of thousands of sea turtles, whales and other marine mammals die every year from eating discarded plastic bag for mistaken food. On land many animals suffer from similar fate to marine life. Collection, hauling ad disposal of plastic bag waste creates an additional environmental impact. In a landfill or in environment, Plastic bags take up to 1000 year to degrade.

Several studies have been conducted on the use of plastic waste in concrete. The works of Rebeiz showed that the resins based on recycled PET can be used to produce a good quality of precast concrete (Rebeiz 2007). Many studies have been conducted on the use of scrap tire/rubber in mortar and concrete, and a research work has been published by Siddique a review paper (2008) on the use of recycled plastic in concrete (Siddique, Khatib & Kaur 2008). In the other study, Choi et al. (2005) investigated the effect of plastic waste (PET bottles) as aggregate on properties of concrete. The present study focused on the use of plastic fines aggregates resulting from the crushing of plastic bags waste rejected into nature and to find new ways of valorization in the field of construction.

Problem Statement

One of the main environmental problems today is the disposal of the waste plastics. The use of plastics in various places as packing materials and the products such as bottles, polythene sheets, containers, packing strips etc., are increasing day by day. This results in production of plastic wastes from all sorts of livings from industrial manufacturers to domestic users. To circumvent this pollution crisis, many products are being produced from reusable waste plastics. On the other side, the Indian construction industry is facing problems due to insufficient and unavailability of construction materials. So, we need to search for new construction materials as well as a method to dispose the plastic waste. To find a solution to the above problems, one of them can be used to solve the other. In this experimental study, an attempt has been made to use the waste plastics in concrete and studies have been conducted to focus particularly on the behaviour of compression members with various proportions of plastic wastes.

Proposed Methodology

The plastic waste is cut into small pieces and mixed with sand, aggregate, cement and water. The concrete mix block is made and different types of test are done to the block. Some of the test are compression strength test and flexural strength test. Aggregate (PA) in concrete is acceptable there are for the making of concrete used coarse aggregate having size 20mm, natural river sand used for making a concrete and plastic aggregate used in crushed concrete from the tested cubes. Test carried out on these aggregate specific gravity and Bulk density, and sieve analysis. a mix design is produced in accordance with the properties obtained from test results. Concrete is then produced with replacement of 10%, 20%, 30%, 40% and 50% of plastic aggregate replacement of plastic aggregate with the same mix proportion.

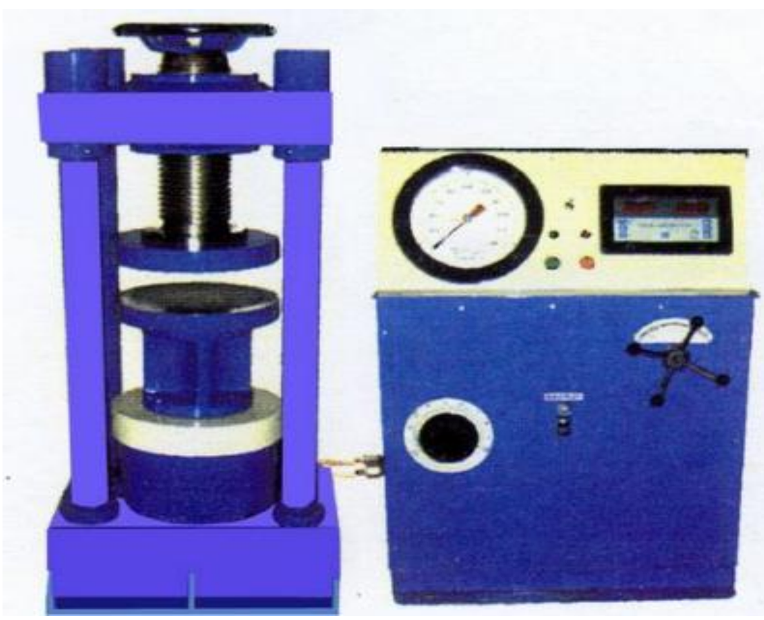

Fig. 1: Compression Testing Machine

RESULTS AND DISCUSSIONS

A comparative study of concrete mix is carried out to find the effect of replacing fine sand by plastic pallets, without super plasticizer and with super plasticizer. Properties of waste plastic mix concrete, namely, fresh density, dry density workability and compressive strength have been studied and the results are as follows.

Fresh Density

Figure indicates that the fresh density tends to decrease by 5%, 8.7%, and 10.75% for 5%, 10%, and 13%, respectively, below the reference mixtures, that is, 0%. This trend may be attributed to the density of the waste plastic being lower than the sand by 70%, which leads to a reduction in the fresh density.

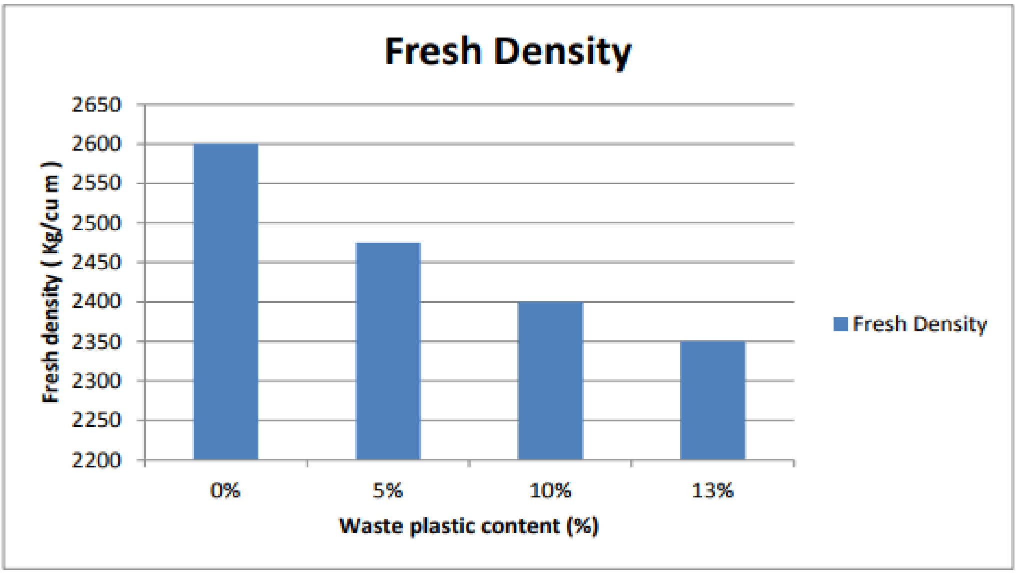

Fig. 2: Graph for fresh density.

Dry Density

The dry density values for waste plastic mix concrete are shown in Figure Dry densities at each curing age tend to decrease with increasing waste plastic ratio in each concrete mixture. It is clear that, at 28 days curing age, the lowest dry density (2225 kg/m3) exceeds the range of the dry density for structural light weight concrete. The use of waste plastic for each curing age reduced the dry densities of all mixtures with increasing the waste plastic ratio, because the density of plastic is lower than that of sand by 70%.

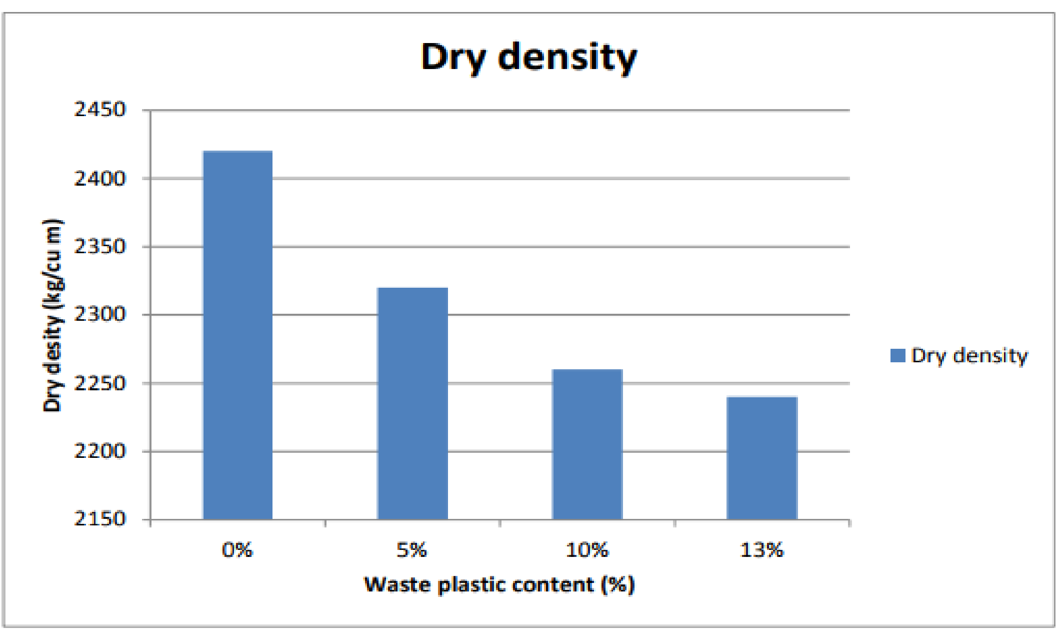

Fig. 3: Dry density after 28 days.

Compressive Strength

By increasing the waste plastic ratio, the compressive strength values of waste plastic concrete mixtures decrease at each curing age. This trend can be attributed to the decrease in adhesive strength between the surface of the waste plastic and the cement paste, as well as the particles size of the waste plastic increase It is observed here that, with increasing amount of waste plastic, the rate of reduction in strength gets flatter and the maximum reduction is only about 15%. It is interesting to note here that, when 20% waste plastic was partially replaced with fine aggregate, the compressive strength at 28 days was well below the strength of reference mix concrete. Therefore the variation was limited to only up to 13%.

Compressive strength at 7 days:- (N/MM2)

Avg comp. st at 0% = 17.03

Avg comp. st. at 5% = 9.70

Avg comp. st. at 10% = 7.47

Avg comp. st. at 13% = 8.74

Compressive strength at 28 days:- (N/MM2)

Avg comp. st at 0% = 21.25

Avg comp. st. at 5% = 15.152

Avg comp. st. at 10% = 12.96

Avg comp. st. at 13% = 11.55

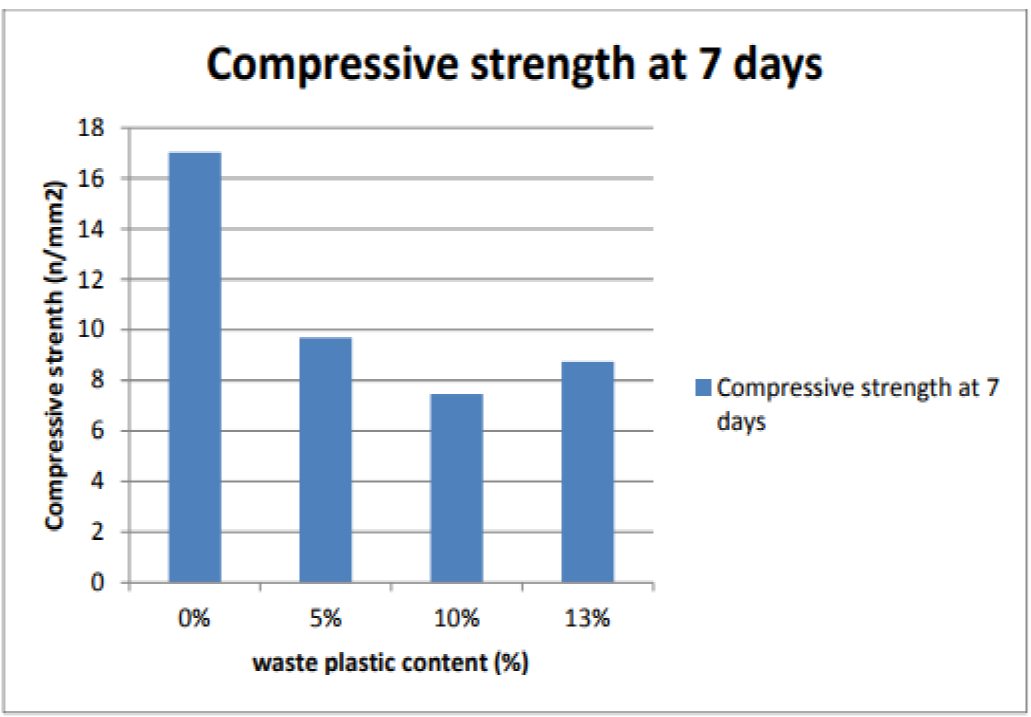

Fig. 4: Compressive strength at 7 days

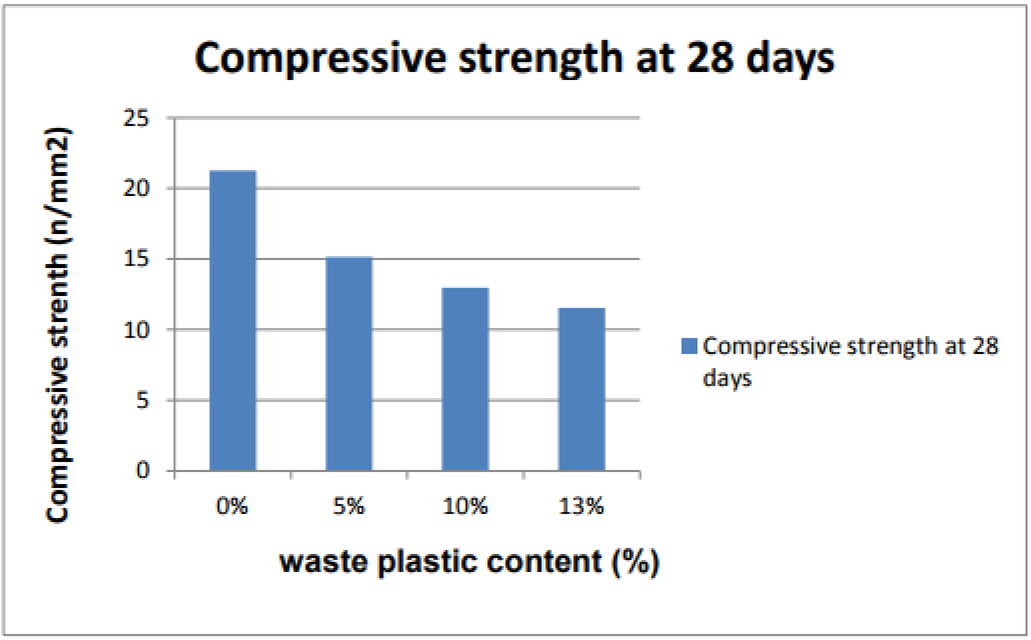

Fig. 5: Compressive strength at 28 days

CONCLUSIONS

The reduced slump values of waste plastic concrete mixes show that it can be used only in situations that required low-degree workability. Such situations are numerous in civil engineering applications, namely, precast bricks, partition wall panels, canal linings, and so forth. However, the workability increases by about 10 to 13% when super plasticizer is added to the waste plastic mix concrete. The comprehensive strength decreases with increasing waste plastic ratios at all curing ages. This may be attributed to the decrease in the adhesive strength between the waste plastic and the cement paste. It seems that the bonding between the plastic particles and the cement paste is weak. With increasing amount of waste plastic, the rate of reduction in strength gets flatter and the maximum reduction is only about 13% for all grades of concrete.

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