Study on Partial Replacement of Cement by Waste Plastic in Concrete Tiles

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Abstract ***The safe disposal of plastic is the most challenging issue for the solid waste management across the globe. Concrete is one of the best choices of construction material in many countries today. This has increased the fast vanishing of natural resources. It could be worth experimenting the use of plastic waste in concrete to overcome the duel issues of shortage of raw material and safe disposal of plastic waste. An attempt has been made to study the possibility of disposing waste plastic as cement in concrete. In this study waste plastic mix concrete is also used to get the advantages of plastic in concrete. An experimental study was carried out with concrete tiles to evaluate mechanical properties of waste plastic mix concrete with and without the addition of fiber. Cement is replaced with plastic waste at a dosage of 10% to 15% by mass which is the optimum percentage without considerable reduction in strength. Thus, it is inferred that replacement of cement by plastic waste up to 35% can be adopted so that disposal of used plastic can be done as well as deficiency of natural aggregate can be managed effectively. As the volume of waste plastic in concrete increases there was increase in compressive strength, hence observed that upto 35% of replacement of waste plastic by cement in concrete tiles increases compressive strength.***

Index Terms- Compressive strength, mechanical properties, plastic waste disposal and plastic fiber.

I. INTRODUCTION

The increase of population in world has led to the generation of large amount of waste products such as waste plastic. These waste plastics will remain in the environment for hundreds of years, this has become inevitable problem in the present world. There is an immediate need for solution for such problem. To bring down the waste products many methods has been proposed and one of them is usage of these waste plastic in concrete which may reduce the environmental problems up to certain extent.

It is possibility of disposal of these wastages in mass concrete such as in heavy mass concreting in PCC in pavements where the strength of concrete is not a major criterion under consideration. The waste plastic is one component of Municipal Solid Waste (MSW). Since the plastic is very low biodegradable material the disposal of the waste plastic causes big problems to the environment. As from many years the research concern that the use of by-products from industry may augment the properties of concrete. In the modern decades, the use of by-products such as silica fume, glass culvert, fly ash, ground granulated blast furnace slag (GGBS) etc., efforts have been made to use in civil construction. The application of the industrial by-products in concrete is as partial replacement of cement or partial replacement of aggregate. The use of these waste plastic in concrete can control the environmental problems or constraints if safe disposal of these products. In the present study the waste plastic used to prepare the paved Tiles by replacing cement with heated plastic waste gel.

II. LITERATURE REVIEW

The present chapter discusses some of the earlier investigation carried out by other various authors on the waste plastic concrete.

M. Kumaran, M. Nidhi, Bini P.R

The work aims to study the possibility of disposing waste plastic as fine aggregate in concrete. In this study waste plastic mix concrete is also reinforced with polypropylene fiber to get the advantages of fiber reinforced concrete. For this, an experimental study was carried out with three different grades of concrete (M20, M25 & M30) to evaluate mechanical and durability properties of waste plastic mix concrete with and without the addition of fiber. Sand is substituted with plastic waste at a dosage of 15% by

volume which is the optimum percentage without considerable reduction in strength. Results show that adding polypropylene fiber we can improve the quality of waste plastic mix concrete. The compressive strength of WPC was lowered by the addition of plastic, the reduction being in the range 4 to 7 %. But this loss was compensated to a certain extent by the addition of polypropylene fibers to WPC whereby the loss percent reduced to around 3 %. The flexural strength of WPC was lowered by the addition of plastic, the reduction being in the range 10 to 18 %. But this loss was compensated to a certain extent by the addition of polypropylene fibers to WPC. There will be an increase in flexural strength around 25 % when compared to Normal concrete. These results suggest that plastic waste mix concrete may be a useful cementitious composite with better durability characteristics than normal concrete.

Lakshmi and S. Nagan,

The paper presents the results of an investigation to study the performance of concrete prepared with E-plastic waste as part of coarse aggregate. An effort has been made to detail a systematic study of compressive strength of concrete with various proportions of E-waste as coarse aggregate in concrete. The test results showed that a significant improvement in compressive strength was achieved in the E-plastic concrete compared to conventional concrete. The tests were also designed to evaluate the internal pore structure, its chemical resistance to environmental agents and reactivity with some components of the cement. The results indicated that the E-plastic aggregate up to 15% weight of the coarse aggregate and replacement of cement with fly ash (10% by weight) can be used effectively in concrete and thus results in waste reduction and resources conservation.

Sabarinathan. A, Dr.Suresh.S,

This article focuses on the use of plastic fibers and m-sand as replacement materials in concrete. In this work, an attempt has been made to replace the coarse aggregate with plastic fibers and m-sand with river sand to study the behavioral changes in concrete with varying proportions. The fresh properties of concrete are studied to ensure that the workability of concrete is not affected or reduced. Specimens such as cubes, cylinders and prisms has been casted and tested at the age of 28 days to study the strength of concrete with and without replacement materials. From fresh concrete test results, it can be observed that the workability of concrete reduces as the percentage of plastic fiber increase. Ductility in concrete can be improved by the addition of plastic fibers with optimum volume content. Toughness and impact load is also increased to a greater extent.

A.S.Balaji and D.Mohan Kumar

Experimental investigation was done using M20 mix and tests were carried out as per recommended procedures by relevant codes and also Hair is used as a fibred reinforcing material in concrete as partial replacement of cement. Tests were conducted to determine the properties of plastic aggregate and human hair such as density, specific gravity and crushing value. Experiments were conducted on concrete cubes with various percentages of human hair i.e. 0%, 0.5%, 1%, 1.5%, 2%, and 3% by weight of cement and with constant percentage of plastic aggregate as 20%. The percentage of human hair were taken as 1%, 1.5%, 2%, 2.5%, 3%The percentage of human hair were taken as 1%, 1.5%, 2%, 2.5%, 3% it was found that the compressive strength was increased for 3% compared to normal concrete.

Nabajyoti Saikia, Jorge de Brito,

This paper presents a review on the recycling plastic waste as aggregate in cement mortar and concrete production, In the first section, types of plastics and types of methods used to prepare plastic aggregate as well as the methods of evaluation of various properties of aggregate and concrete were briefly discussed In the next two sections, the properties of plastic aggregates and the various fresh and hardened concrete properties of cement mortar and concrete in presence of plastic aggregate are discussed. The fourth section focus on the practical implications of the use of plastic waste in concrete production and future research needs. The incorporation of plastic aggregate can reduce the density of resulting concrete and cement mortar and therefore several studies were undertaken to prepare lightweight concrete by using various types of plastic aggregates.

Brahimsafi Mohammed Saidi

The work aims to study the possibility of recycling waste plastic (polyethylene terephthalate (PET) used for the bags manufacture) as a fine aggregate instead of sand in the manufacturing of the self-compacting mortars. For this, an experimental study was carried out to evaluate physical and mechanical properties of the self-compacting mortars (SCMs) with plastic wastes. The sand is substituted with the plastic waste at dosages (0%, 10%, 20%, 30% and 50% by weight of the sand).The physical (bulk density, porosity, water absorption and ultrasonic pulse velocity testing) and mechanical (bulk compressive and flexural strength) properties of SCMs were evaluated and a complementary study on micro-structural of the interface of cementations matrix and plastic waste. The measurements of physical and mechanical properties show that, in term of the density for materials, the mortars with 50% of plastic waste give better results than other proportion of the waste. Those mortars have a mechanical strength acceptable for lightweight materials. According to results obtained a reduction of 15% and 33% for mortar containing 20–50% plastic waste.

Sukamal Kanta Ghosh, Ananya Chaudhury

The paper illustrates the performance of pervious concrete with these sustainable materials replacing or partially replacing cement & aggregate. It is observed from the study that compressive strength of pervious concrete is increasing by introducing fly ash, furnace slag, and rice husk ash, silica fume, and solid waste (glass powder, ceramic waste, bottom ash). Whereas compressive strength is decreasing by addition of rubberized materials. Permeability is increasing with furnace slag, ceramic waste but glass powder, silica fume has no effect on permeability. Though rubberized materials decrease the tensile strength and compressive strength of pervious concrete, it increases the abrasion resistance & freezing–thawing resistance. Partial addition of rice husk ash, furnace slag, silica fume, glass powder also enhances tensile strength of pervious concrete.

Rafat Siddique, Jamal Khatib

This paper presents a detailed review about waste and recycled plastics, waste management options, and research published on the effect of recycled plastic on the fresh and hardened properties of concrete. The effect of recycled and waste plastic on bulk density, air content, workability, and compressive strength, splitting tensile strength, modulus of elasticity, impact resistance, permeability, and abrasion resistance is discussed in this paper. In general, the rate of reduction in strength was found to decrease with the increase in plastic aggregates content's. The use of the recycled plastic in the concrete reduced the overall concrete bulk density. When compared to conventional concrete, with the inclusion of 0.5% polypropylene fibers enhanced the impact resistance of concrete significantly.

Charudatta P. Thosar, Dr.M.Husain

Industrial wastes from polypropylene (PP) and polyethylene terephthalate (PET) were studied as alternative replacement of a part of a conventional fine sand of concrete. Four replacement levels, 20%, 40% & 60% by volume of aggregates were used for the preparation of the concretes. The results of this research suggested that PP and PET can be used in concrete containing 40% by volume of PP and PET as fine sand replacement give satisfactory result. The concrete for M20 grade has a nominal compressive strength is 20 N/mm2. Replacement of natural river sand by plastic waste material in 20% and 40% increase in the compressive strength of concrete up to acceptable limit.

Arivalagan.S

In their study, Tests were conducted to determine the properties of plastic aggregate such as density and specific gravity. As 100% replacement of natural fine aggregate with plastic fine aggregate is not feasible, partial replacement at various percentage were examined. The percentage substitution that gave higher compressive strength was used for determining the other properties such as modulus of elasticity, split tensile strength and flexural strength. Higher compressive strength was found with 10% natural fine aggregate replaced concrete.

III. EXPERIMENTAL PROGRAM

This chapter describes an experimental program on the partial replacement of natural cement by waste plastic. Two tests were performed in the experimental

program, namely Slump test and Compressive strength test.

Cement and sand are tested as per IS standards and verified. he recycled plastic was used with partial replacement of fine aggregate at 5%, 10%, and 15% for making the concrete specimen. The plastic aggregate with size of less than 4.75mm are used.

To accomplish the above set objectives in the present study the mix design for strength was developed based on trial batches. Numbers of tiles each with 15%, 20% and 25% 30% 35%, replacement of cement by waste plastic have been cast for assessing the compressive strength of concrete. Then six numbers of tiles should be with the replacement of cement by waste plastic have been cast for assessing the compressive strength of concrete tiles. The Table 3.1 represents the concrete mix proportion. Figure 3.1 and 3.2 represents the waste plastic and plastic hot gel used in the present investigation.

Compressive strength of the cubes containing waste plastic for 15%, 20%and 25% is first evaluated using compressive testing machine and then compressive strength of tiles containing waste plastic

Table 3.1 concrete mix proportion

Name of ingredients	Cement	Fine aggregate
Proportion	1	1.70

Fig 3.1: Grinded waste plastic

Fig 3.2: Boiling of waste plastic

IV. RESULTS AND DISCUSSIONS

The average of three samples was taken as the representative value of compressive strength of concrete tiles for each batch and is tabulated in Table 4.1. From the Table 4.1 it can be concluded the compressive strength of normal concrete tiles as when waste plastic is replaced with cement in percentages, the compressive strength increases with increase in percentage of replacement of waste plastic. Up to the replacement of 35% of waste plastic by cement the compressive strength increase. Further the replacement of waste plastic there no formation of tiles take place.

Fig 4.1: Compressive testing of specimen

Fig 4.1: Failure of specimen under compression

Table 4.1: Compressive Strength Results.

SL.NO	SPECIMEN	COMPRESSIVE STRENGTH IN N/mm2.
01	Control Specimen	0.85N/mm^2
02	15%.	0.85 N/mm^2
03	20%	0.937 N/mm^2
04	25%	0.992 N/mm^2
05	30%	1.09 N/mm^2
06	35%.	1.210 N/mm^2
07	40%.	1.289 N/mm^2
08	45%	1.132 N/mm^2

V. CONCLUSION

The compressive strength and workability of waste plastic mix concrete with and without addition of waste plastic was investigated and the following conclusions were obtained,

1. Addition of waste plastic gives high compressive strength as compared to normal tiles
2. The compressive strength increases up to 45% by replacement of cement by waste Plastic and voids should be partially filled
3. It was found that workability with 5% & 10% of replacement of cement by waste plastic was not possible.
4. It was noticed that there was reduction of compressive strength in waste plastic concrete tiles of about 45% above compared to normal concrete tiles.
5. There was increase in compressive strength up to 35% of replacement of waste plastic by cement in concrete tiles.

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REFERENCES

[1] M. Kumaran1, M. Nidhi, Bini P. R;"Evaluation of strength and durability of waste plastic mix concrete", Vol 10-11 June 2015 International journal of research in advent technology PP.34-39.

[2] A.S.Balaji and D.MohanKumar;"Laboratory Investigation of Partial Replacement of Coarse Aggregate by Plastic Chips and Cement", Vol. 4, Issue 4(Version 9), April 2014, pp.94-98, Int. Journal of Engineering Research and Applications.

[3] M.Muzzaffar.Ahmed,Dr.S.SiddiRaju: "Use of waste plastic in production of light weight concrete", Vol no.2 (2015), issue no: 04(April) International journal and magazine of Engineering, technology, management and research.

[4] PromodS.,J.R.Mali,GaneshV.tapakire, H.R.Kumavat;"Innovative techniques of waste plastic used in concrete mixture", Vol: 03 special Issue: 09 International journal of research in Engineering and technology.

[5] Raghatate AtulM.," Use of plastic in a concrete to improve its properties" Vol: 01/Issue 3/April-June, 2012/ pp.109-111, International journal of advanced engineering research and studies.

[6] R. Lakshmi and S. Nagan:" Investigations on durability characteristics of e-plastic waste incorporated concrete" vol. 12, no. 6 march-April 2011 Asian journal of civil engineering (building and housing) pages 773-787

[7] Nabajyoti Saikia, Jorge de Brito: "Use of plastic waste as aggregate in cement mortar and concrete", Feb 2012 Construction and Building Materials by elvier page 386-400

[8] Rafat Siddique and Jamal Khatib: "Use of recycled plastic in concrete" 17 December 2013Elsevier Ltd.

[9] Safi, B.; Saidi, M and Aboutaleb: "The use of plastic waste as fine aggregate in the self-compacting mortars: Effect on physical and mechanical properties", Construction and Building Materials, ELSEVIER, 43, pp. 436-442

[10] Sabarinathan.A, Dr.Suresh.S: "an investigation on fresh and hardened properties of m30 concrete with plastic fibers and m – sand", Volume: 02, International Journal of Research and Innovation in Engineering Technology Pages: 64 – 69.

[11] IS 10262:2009-Concrete mix design.

[12] IS 516: 1959- "Method of test for strength of concrete".

[13] IS 5816: 1999- "Method of test for splitting tensile strength of concrete".

[14] IS 10262: 2009- "Guideline for concrete mix proportioning".