Study on Plastic Waste for Replacement of Coarse Aggregate With Soft and Hard Plastic in Concrete

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Abstract

There is an enormous issue of plastic in environment. Disposal of waste plastic from households has become a big problem for agencies in cities. Plastic waste management can be an international problem as plastic is a non-perishable substance. Plastic waste includes single use plastic such as plastic bottles, single use straw, food containers, and alternative plastic materials. Plastic cannot be burnt by burning, as a result it causes major pollution and releases harmful gases like dioxide, dioxins ,furans, and metals. These emissions cause metabolic process issues. Dumping huge amount of plastic onto land reduces the fertility of soil and causes soil pollution. Plastic waste primarily consists of Low Density Polyethylene (LDPE). Plastic waste is placed within the ash can and plastic bear evacuation blocksitor the area units are burnt on the margin, which produces pollution. Industrial waste from polypropene (PP) and polythene terephthalate (PET) were studied at various replacements in the vicinity of the standard aggregates of concrete. Polypropene is a powerful, rigid, and crystalline thermoplastic which is known as exhausting plastic. Polythene terephthalate is a soft ,flexible plastic that is usually used for plastic bottles. In our analysis, the only aim is to study the suitability of plastic as a replacement of coarse mixture in concrete with soft and exhausting plastic each, and to get the replacement with maximum compressive strength in concrete. Suitable mixtures were used for the preparations of the concrete.

Keywords : Coarse aggregate, Hard plastic, Soft plastic

I. INTRODUCTION

Concrete is a mixture of binding material like lime or cement (well graded coarse and fine combination), water, and some admixtures. Keeping this in mind, we decided that we are going to replace the coarse combination with plastic combination and also save the natural aggregate. Plastic that is discharged in great amount as waste hasn't helped in disposal. As plastic has some good properties, can help in viable replacement of

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coarse combination in concrete. This is why concrete combined with soft and hard plastic were studied during this project. First, we studied about polythene terephthalate (PET) and polypropylene (PP), that is soft plastic and hard plastic. Soft plastic accommodates single use plastic like plastic bottles, straws, and light-weight density plastic skinny sheets. There is an enormous amount of plastic bottles widely used for drinking purpose that creates tons of plastic waste and it is terribly troublesome to dispose. Hard plastic is one whose thickness is 5 mm. It has totally different chemical composition. We have a tendency to use each hard and soft plastic in concrete and check the variation in strength of concrete by using each of them. We replace 0% 5% 10% 15% & 20% hard plastic with coarse combination (natural combination). Then we exchange the soft plastic 5%10%15% & 20% with coarse aggregate. We prepare the specimen and conduct compressive strength, workability tests and take a look at concrete of M20 grade with replacement of coarse combination by plastic waste.

II. METHODOLOGY

The main purpose of the project is to utilize plastic waste properly, which partially replaces coarse aggregate with plastic aggregate. In making of concrete cube, we used coarse aggregate having size of 10 mm for soft plastic and 12 mm for hard plastic aggregate, fine aggregate(sand) cement water, and then we carried out the test.

A mix design is produced in accordance with the normal properties of concrete and then replacement of 5% 10% 15% & 20% of soft and hard plastic of plastic aggregate in the same mix proportion. All the tests were conducted for 7 days and 28 days.

Plastic is added in concrete as a percentage replacement of coarse aggregate in terms of weight of plastic of total NCA quantity.

A mix proportion was selected to ensure the workability of the fresh concrete so that when the concrete hardens, it has the required strength, durability, and surface finish.

III. LITERATURE REVIEW

This analysis paper relies on the impact of electronic waste (e-plastic) on the mechanical property of concrete. Plastic was used as a filling material to get chemical compound and use it as a binder in cement. Cement is replaced by this chemical compound. Cement is an expansive binding material and is widely employed in development works. The chemical composition of this cement may be quite varied. However, the way most and greatest portion is employed in construction is normal hydraulic cement. During this investigation, fifty three grade OPC was used as conformist IS 8112:1989 [1].

Osei [2] used substitute material of coarse mixture like industrial waste and different plastic material area unit was a significant concern. The aim of this study was to work out the compressive strength of sunshine concrete of (PET) plastic waste as coarse mixture and influence of mixture gradation on compressive strength of concrete as material. Material testing with numerous fines modulus was done.

Tajne and Bhandari [3] analyzed waste plastic and investigated the employment of waste plastic as coarse mixture in concrete with the addition of plastics. They noticed that the compressive strength of concrete and durability of concrete gets reduced by addition of plastic waste in concrete. The main aim of the experiment was to check the properties of concrete with plastic and concrete without plastic.

Shukla, Rajput, Jain, Gurjar, and Awasthi [4] conducted a research on the effect of plastic as an alternative aggregate on various properties of fresh and hardened concrete. The plastic used was polyethylene terephthalate The workability of plastic concrete did not differ 9% and w/c ratio was 0.42%. PET is a semi crystalline polymer with high mechanical strength and toughness. The material strength for cement was 42.9 mpa, brick coarse aggregate with PET coarse aggregate were used, the water cement ration was 0.42, 0.48, and 0.57. The slump test was conducted for each category of the sample to measure workability.

Harnadh, Kashyap, Gupta, and Sekhar [5] used crushed plastic in concrete which is generated from industrial waste which is brittle. The compressive strength of concrete made by replacement of coarse aggregate in concrete with hard plastic was checked and various tests on concrete like tensile test, compressive test, and flexural test of concrete were conductedz. The strengths were based on the plastic which came from industrial waste.

Lakshmi and Nagan [6] used waste plastic of dense polyethylene as replacement of coarse mixture to see its

viable application in industry and to check the behavior of contemporary and hardened concrete properties. Totally different concrete combines were ready with variable proportions (0%, 20%, 30% & 40%) of recycle plastic mixture obtained by heat treatment of plastic waste (160-200 centigrade) in plastic granular employment machine. A concrete combine style with 1: 1.5: 3 proportions were used having 0.5 water/cement magnitude relation and having variable proportion of plastic mixture as replacement of crushed stone.

Ahmed and Raju [7] replaced coarse aggregate with hard plastic with different volumes (10% 20% 30% 40% 50%) and conducted different types of tests such as Compressive strength, Tensile strength, and Flexural strength tests. They also checked the physical properties of cement, specific gravity water absorption, abrasion value, crushing strength, and impact test.

IV. MATERIALS USED

The general materials used in this project are :

Cement - OPC (43grade)
Fine aggregate - River sand
Coarse aggregate - 12 to 20 mm
Soft plastic aggregate - 10 mm
Hard plastic aggregate - 12 mm

Several tests were carried out to know about the physical and chemical properties of the selected raw materials. These raw materials undergo their respective test and were thus, selected for further process.

Total 40 cubes and workability test for M20 grade of concrete with soft and hard plastic with five different volumes, percentage of plastic (0% 5% 10% 15% & 20%) and cube were cast with recommendation of IS 10262 -2000.

MIX PROPORTION

Water	w/c ratio	cement	Fine aggregate	Coarse aggregate
197 kg/m^3	0.45	437.77 kg/m^3	838.16 kg/m^3	1093.25 kg/m^3

V. TESTS CONDUCTED ON CONCRETE

The tests were carried out in two stages :

1. Fresh concrete
2. Hardened concrete

(1) Fresh concrete test :

Fresh concrete remains in its recent state from the time it is mixed till its sets. Workability means ease to work the mix, transport, and place in an exceedingly homogenous state. The workability of concrete can be tested by Slump Cone, Flow Table test, Vee Bee test, and Compaction factor.

(2) Hardened concrete test :

The test is carried out for concrete after it reaches its final setting time. The test carried out for hardened concrete are:

Compressive strength test: Compressive strength is the ability of concrete to carry the load on its surface without cracks, and deflection. It gives an idea about characteristic strength of concrete which is found by load applied per unit area of concrete

TABLE I.

WORKABILITY OF CONCRETE WITH HARD PLASTIC

Replacement %	Slump value (mm)	Remarks
0	70	Workable
5	66	Workable
10	74	Workable
15	79	Workable
20	85	Workable

TABLE II.

WORKABILITY OF CONCRETE OF SOFT PLASTIC

Replacement %	Slump value (mm)	Remarks
0	70	Workable
5	73	Workable
10	78	Workable
15	84	Workable
20	88	Workable

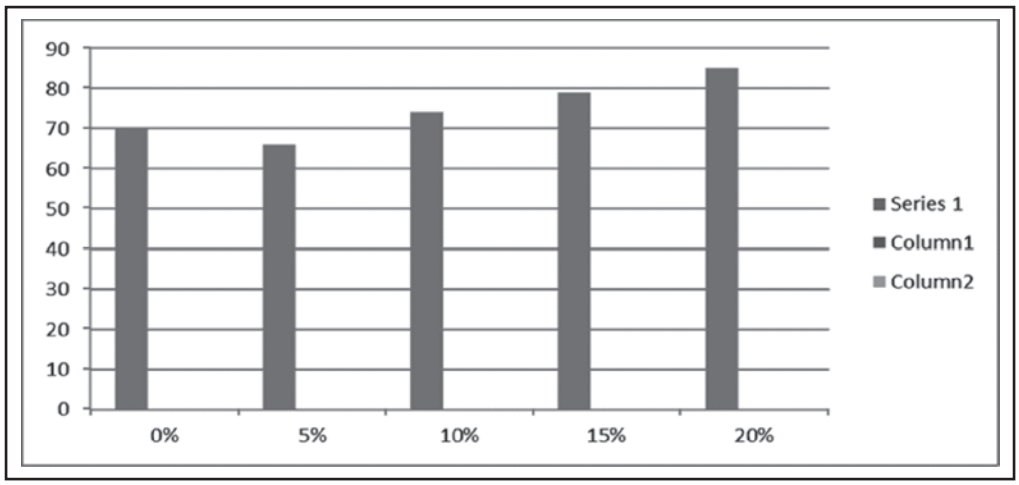

Fig. 1. Graph of Workability of Hard Plastic in Concrete

$F=P/A\ N/mm^2$

The slump value in table I shows the hard plastic replacement result of workability test.

The slump value in table II shows the results of conventional concrete, plastic waste concrete 0% 5% 10% 15% & 20% replacement of coarse aggregate for soft plastic.

Table III represents the 7 days and 28 days of compressive strength of replacement of coarse aggregate with hard plastic. Table IV represents the 7 days and 28 days of compressive strength of replacement of coarse aggregate by soft plastic.

TABLE III.

COMPRESSIVE STRENGTH TEST RESULTS WITH HARD PLASTIC

% of hard plastic (replacement for coarse aggregate)	7 days (N/mm^2)	28 days (N/mm^2)
0	14	20.12
5	13.34	19.77
10	9.26	18.32
15	7.6	17.14
20	6.58	16.70

VI. USES OF PLASTIC MIX CONCRETE

- Plastic mix concrete is used as a light weight

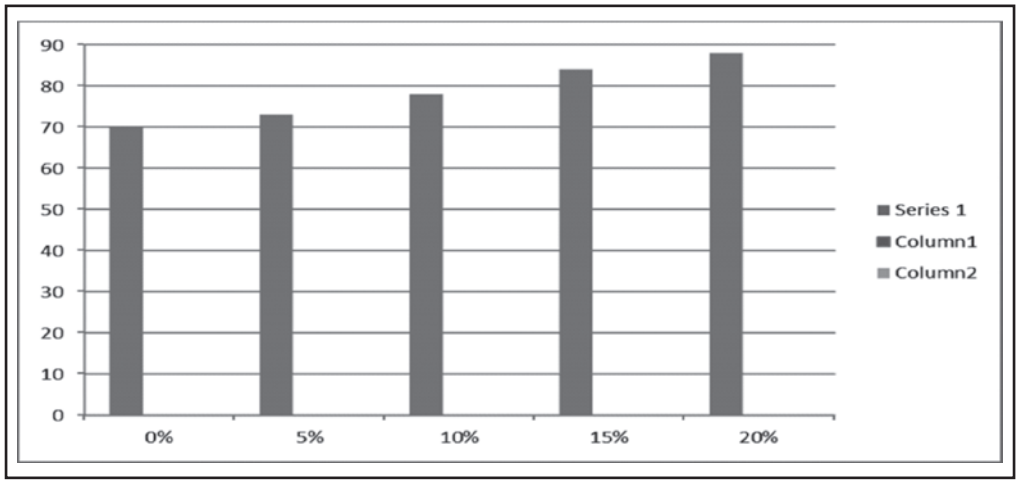

Fig. 2. Graph of Workability With Soft Plastic in Concrete

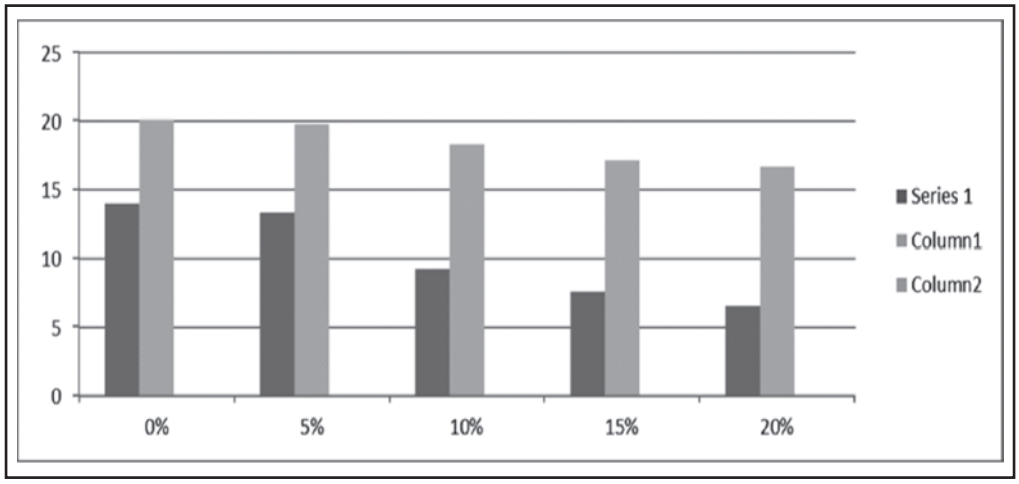

Fig. 3. Shows the Comparison of 7 days & 28 days Compressive Strength in Various Percentage of Replacement

TABLE IV.

COMPRESSIVE STRENGTH TEST RESULTS WITH SOFT PLASTIC

% of soft plastic (replacement for coarse aggregate)	7 days (N/mm^2)	28 days (N/mm^2)
0	14	20.12
5	10.28	17.19
10	8.54	16.25
15	7.16	16.16
20	5.4	15.56

concrete because by replacing stone aggregate, the concrete becomes light weight and by testing we found that the strength of concrete does not show much variation with 5% replacement of PCA. So, we can use plastic concrete in crash barriers and kerb stones in the construction of highways and roads.

- Plastic mix concrete is used for making bricks and the strength of such bricks is more than that of normal bricks, and they are also light in weight.
- Plastic mix concrete is suitable for RCC construction. Therefore, small storage tanks and RCC trenches can also be constructed.
- Plastic mix concrete can be used as a lean concrete and PCC works in footings.
- Plastic mix concrete with replacement of coarse

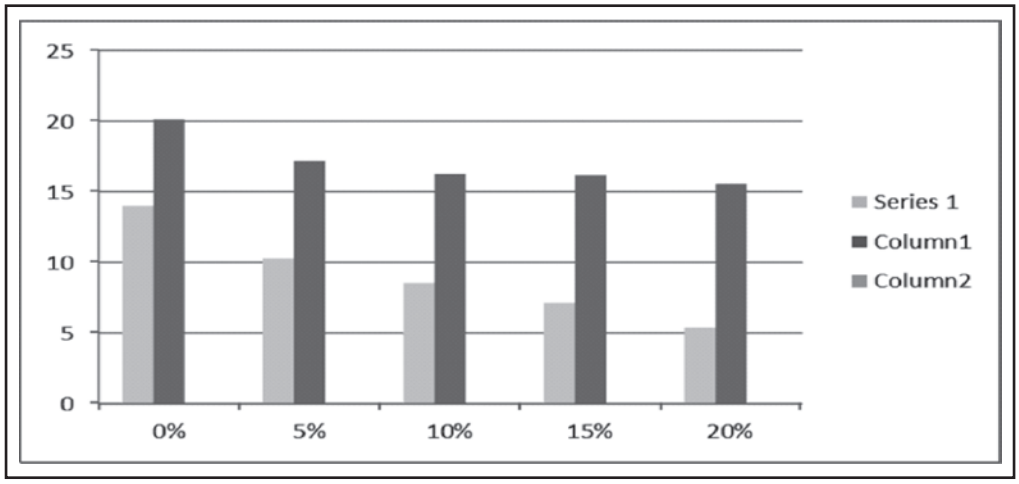

Fig. 4. Compressive Strength of Concrete With Soft Plastic

Fig. 5. Hard Plastic

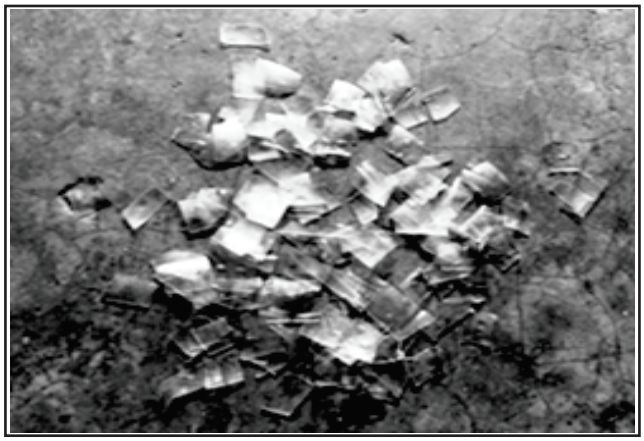

Fig. 6. Soft Plastic

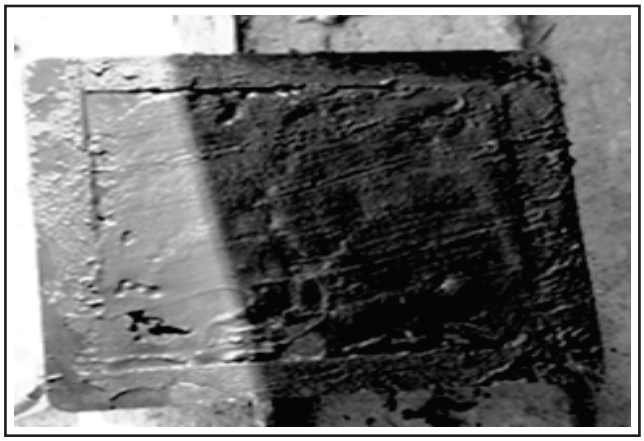

Fig. 7. Casting of Cube

aggregate shows better behavior in expansion and contraction with temperature variation due to natural causes.

VII. CONCLUSION

It was found that 5% replacement of plastic aggregate by weight in concrete is acceptable because the compressive strength of hard plastic mix concrete in 7 days is found to be 13.34N/mm^2 which is very close to the normal concrete strength that is 14 N/mm^2 which shows that there is no more variation in strength of concrete by replacement with hard plastic. Workability will increase due to less bonding of plastic coarse aggregate with concrete. For soft plastic, there is sudden variation in strength of concrete, soft plastic having 5% replacement with NCA has compressive strength 10.28 N/mm^2, while for normal concrete with 0% replacement, the strength is 14 N/mm^2 in 7 days. The strength decreases if soft plastic is used because soft plastic is thin and flexible. The bonding becomes less in concrete while mixing, so 10 mm size soft plastic aggregate is used. The strength found is moderate and it can be concluded that plastic mix concrete is suitable as a light weight concrete with both soft and hard plastic in suitable quantity in concrete. Soft plastic aggregate can give maximum strength the size of aggregate I reduced. The size of soft plastic aggregate should be equal to or less than 10 mm for maximum compressive strength of soft plastic (plastic bottles) mix concrete. By workability test, we can conclude that the workability of concrete will increase if we add plastic as an aggregate in concrete due to low binding capability than stone aggregate. This shows that we can use plastic concrete as a ready mix concrete because ready mix concrete needs more workability. So, plastic mix concrete with replacement of coarse aggregate is suitable in light concrete works in the construction industry.

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