AN EXPERIMENTAL STUDY ON EFFECT OF PLASTIC ON FRESH & HARDNED PROPERTIES OF CONCRETE & STUDY OF COST EFFICTIVENESS

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Abstract

Concrete is the most undisputable material being used in infrastructure development throughout world. The reduction in the source of natural sand, then the requirement for reduction in the cost of concrete production has resulted in the increased need to find new alternative materials to replace river sand. Now-a-days we observed that the consumption of plastic is very high, but the re-production of plastic is very less. So, this unnecessary material present in excess on earth which is causing environmental pollution this paper focus on utilization of plastic as partial replacement for sand and fly ash for cement.

The proposed concrete which is made up by partially replacing sand with plastic and cement with fly ash in concrete may help to reuse the plastic as one of the constituent's material of concrete and also to improve the certain properties of concrete. The properties of concrete containing varying percentages of plastic were tested for compressive strength and Split tensile strength and the result obtained regards the variation of strength of concrete for different percentages of plastic. Also studied the cost effectiveness of plastic induced in concrete.

Key points: Plastic, Fly ash, Fresh & Hardened properties of concrete and Cost effectiveness.

Introduction

Plastics are normally stable and not biodegradable. So, their disposal poses problems. Research works are going on in making use of plastics wastes effectively as additives in bitumen mixes for the road pavements. Reengineered plastics are used for solving the solid waste management problems to great extent. This study attempts to give a contribution to the effective use of waste plastics in concrete in order to prevent the ecological and environmental strains caused by them, also to limit the high amount of environmental degradation. This usage of plastic in concrete also has an advantage of low cost of material.

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Literature review:

Amalu.R. G et.al (April-2018 from UKF College of Engineering and Technology, Kollam, Kerala, India.) carried out an experiment on **use of waste plastic as fine aggregate substitute in concrete**. M20 grade of concrete is adopted for investigation and replacement of plastic with 5% - 25%. They concluded that the compressive strength and flexural strength value of concrete mix is increased initially and then decreased, with the addition of waste plastics. But workability of the concrete mixture is increasing because of the less absorption of water.

Umadevi.R et.al (2013 from Flexible Pavement Division, CSIR- Central Road Research Institute, New Delhi 110025, India.) **Investigation in laboratory on use of fly ash plastic waste composite in bituminous concrete mixtures**.Based on theirs experiment, the test results were observed that Fly ash can be used as filler in bituminous concrete mixture. Properties of bituminous concrete can be further improved by coating of fly ash with plastic waste and plastic waste composite reduced rutting in bituminous concrete mixture during wheel track testing.

chien-chung chen et.al(August-2015 from Purdue University Calumet, Missouri University of Science and Technology)**investigate the effectiveness of using waste plastic as fine aggregate replacement in concrete mixtures** . they observed that as the percent replacement increased, the compressive strength of the concrete decreased. More than 50% strength loss was observed for specimens with the percent replacement beyond 30%.

Materials Used:

1) Cement: Ordinary Portland cement (OPC) of grade 43 conforming to IS 8112-1989 is used . Various lab tests conforming to 4031-1996(part-1) carried out.

2) Fly Ash: Fly ash (classF) obtained from NTPC Visakhapatnam is used. Fly ash is not processed and used as received.

Sl no.	Physical Properties	Observed value for cement	Observed values for fly ash
1	Specific Gravity	3.14	2.2
2	Initial Setting (minutes)	30 min	45 min
3	Final Setting (minutes)	600 min	280 min
4	Consistency (%)	30%	35
5	Fineness (m2/kg)	225 /kg	368 /kg

Table 1: Physical properties of Cement and Fly ash

Sl. No.	Test Conducted	Observed Values (%)	Requirement as per IS:3812 (Part- I):2003 Reaffirmed: 2013
1	Loss of Ignition	2.53	5.0(max)
2	Silica as SiO2	59.51	35 (min)
3	SiO2+Al2O3+Fe2 O3	86.85	70(min)
4	Available alkalis as Na2O	0.43	1.5 (max)
5	Reactive silica	29.32	20(min)
6	Magnesium as MgO	1.97	5.0 (max)
7	Sulphate as SO3	2.07	3.0 (max)
8	Total Chloride	0.032	0.05 (max)
9	Lime Reactivity	4.9 N/mm2	4.5(min)

Table 2: Chemical properties of Fly ash

3) **Admixture:**Super plasticizers are usually the chemical compounds like Sulphonated Melamine Formaldehyde(SMF), Sulphonated Naphthalene Formaldehyde(SNF) and Modified Lignosulphonates.SMF and SNF based admixtures are the most commonly used. The admixture used is a super plasticizer CONPLAST SP 430.

Properties: a) Specific gravity: 1.22 at 30^{o}c
b) Chloride content: Nil as per IS: 9103:1999 and BS: 5075
c) Air entrainment: Approximately 1% additional air over control.

4) Aggregates: Coarse aggregate: Locally available crushed stone of 20mm graded size has been used as coarse aggregate.

Sl.no	Physical properties	Observed value	Standard value
1	Specific Gravity	2.81	2.6-2.9
2	Fineness Modulus	4.79	4-8

Table 3

5) Fine aggregate: River sand from river bed having following characteristics.

a)Specific gravity - 2.63

b) Fineness - 2.60

c) Water absorption- 2.56

6) Plastic powder:

Plastic wastes i.e bottles, bags etc are grinded into fine powder is used .

Sl.no	Physical properties	Observed value	Standard value
1	Specific Gravity	2.59	2.1-3.0
2	Fineness Modulus	18%	<40%

Table 4

7) water:

Portable water free from impurities and salt used for casting and curing the concrete blocks as per IS –456-2000.

Fresh concrete tests:

1. **Slump cone test**: It is a measure of consistency, or relative ability of the concrete to flow. . For the present work, slump tests were conducted as per IS 1199-1959 for all mixes. The target slump was taken from IS 456-2000. A concrete mix M20 with partially replacement of 30% fly ash for cement and plastic with different percentages (5, 10, 15, 20,25) for sand by weight with suitable water/ cement ratio is prepaid in the laboratory and required for casting 6 cubes after conducting Slump test.

Sl.no	Percentage of plastic replacement	Slump value (drop)
1	5%	2.19 cm
2	10%	2.58 cm
3	15%	2.98 cm
4	20%	3.41 cm
5	25%	3.78 cm

Table 5 Slump Cone Test on Replaced Concrete

2. **Compaction factor test:** The compaction factor is the ratio of weights of partially compacted to fully compacted concrete. The test was conducted as per IS 1199-1959. The Compaction factor values ranges from 0.7 to 0.95.

Sl.no	Percentage of plastic replacement	Compaction factor
1	5%	0.764
2	10%	0.752
3	15%	0.749

4	20%	0.738
5	25%	0.710

Table 6 Compaction Factor Test on Replaced Concrete

Concrete Mixes:

Control mix concrete and modified concrete with varying percentages of waste plastic were presented in Table. All the mixes prepared are M 20 grade of concrete with w/c ratio 0.45 according to IS456:2000.

Cement Required for 1m3 of Concrete = 400Kgs

Assume W/C ratio = 0.42 (42% of cement)

Water required for 1m3 of Concrete. = 400 x 0.42

Amount of Water Required for 1m3 of Concrete = 168kgs = 168 liters.

Hardened concrete tests:

1. Compressive strength:

Compressive strength test were carried out on 150mm X 150 mm X 150 mm specimen for that three cube were prepared for each mix. Strength of each cube was evaluated after 3, 7 and 28 days respectively. Test was carried out as per IS 14858:2000. Result of compressive strength test was

Presented in Table.

sno	%plastic	**3 Days (N/mm^2)**	**7 Days (N/mm^2)**	**28 Days (N/mm^2)**
1	0	10.84	16.27	22.16
2	5	12.64	16.57	22.34
3	10	10.57	15.07	21.09
4	15	10.37	16.76	20.53
5	20	9.76	14.16	20.13
6	25	10.73	13.33	19.53

Table 7

2. Split Tensile Strength:

Tensile strength is one of the basic and important properties of concrete. Concrete is very good in compression but weak in tension and this is one of the drawbacks of concrete. Split tensile strength test were carried out on a cylindrical specimen 150 mm in mm in diameter and 300 m long. Specimen shall be tested after 3, 7, and 28 days respectively. Result of split tensile test was presented in Table.

sno	%plastic	**3 Days (N/mm^2)**	**7 Days (N/mm^2)**	**28 Days (N/mm^2)**
1	0	2.24	2.83	3.16
2	5	2.36	2.83	3.38
3	10	2.60	2.26	3.11
4	15	2.86	3.13	3.19
5	20	2.29	2.97	3.27
6	25	2.14	2.63	2.57

Table 8

Cost effectiveness:

Rate analysis or coast analysis is the estimation of total expenditure or the rates of the individual items used in the construction project. It also gives an idea of total quantity of material and the total coast of the project.

In this paper the replaced concrete mix, it is observed the maximum compression and tensile strength at 20% replacement of plastic. So that for the cost analysis 20% replaced concrete mix was considered.

Sl.no	Description	Quantity	Unit Rate	Amount
1	Cement	1.10 bags	300/bag	330
2	Sand	0.05118	920	47.09
3	Coarse Aggregate	0.10057	1170	117.67
TOTAL				**495rupees**

Table 9 Rate Analysis for Design Mix M-20 Grade Nominal concrete mix

Table 10 Analysis for Design Mix M-20 Grade Replaced concrete mix

Sl.no	Description	Quantity	Unit Rate	Amount
1	Cement	0.76526 bags	300/bag	229.58
2	Elyash	16.39854 kgs	1/kg	16.40
3	Sand	0.04094	920	37.67
4	Plastic	16.39845 kgs	1/kg	16.40
5	Coarse Aggregate	0.10057	1170	117.67
TOTAL				**420rupees**

It can be seen that for M20grade concrete mix the total cost of materials used is 495 rupees and that of M20 Fly ash and plastic induced concrete is 420 rupees respectively which is less with a difference of **75** rupees. Therefore, it can be concluded that usage of fly ash and plastic in concrete is recommended as it results in cost-effective concrete.

Result and discussion:

Compressive Strength

The 3 days, 7 days and 28 days compressive strength result were presented in Table.7.As shown in fig 1. & fig 2 the compressive strength of concrete goes on reducing with increase in percentage of plastic pieces but the rate of reducing compressive strength is very low. This reduction in strength is may be due reduction in bonding due introduction of plastic pieces.

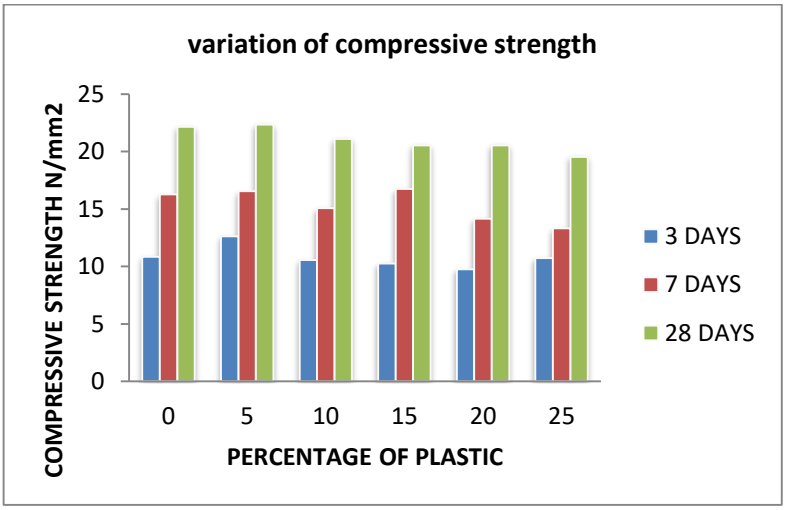

Fig 1 Variation of compressive strength

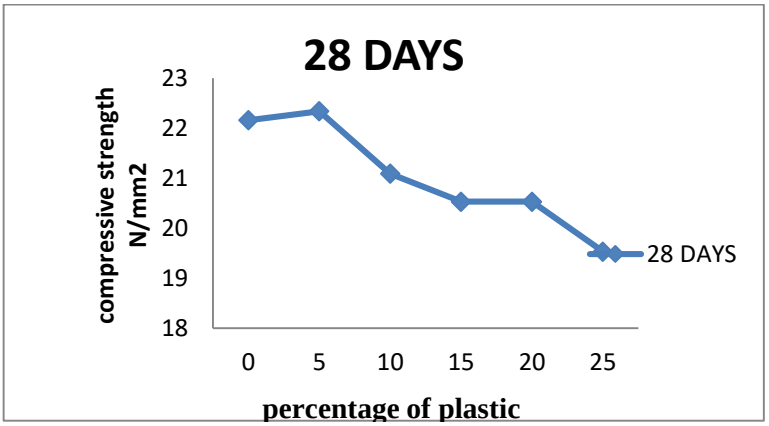

Fig 2 Variation of 28 days compressive strength with
Various percentage of plastic

Split Tensile Strength

Result of Split tensile strength after 3 days, 7 days and 28 days were presented in Table 8.Improvement in splitting tensile strength after addition of plastic up to 20% in concrete was
Observed which show in graph, beyond which there is decrease in strength.

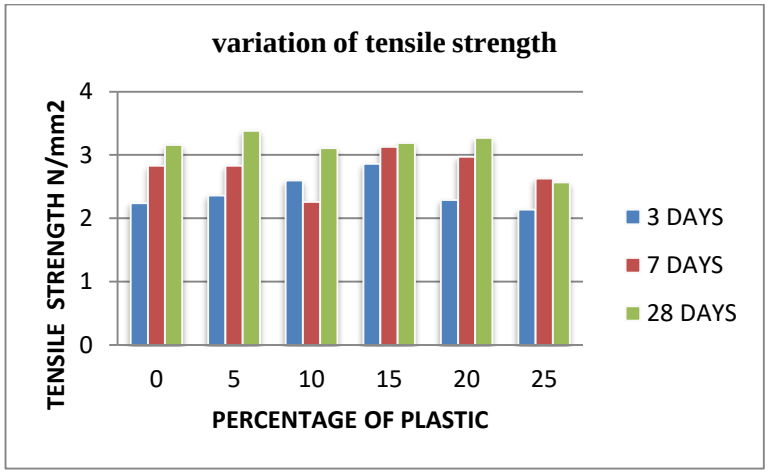

Fig 3 Variation of tensile strength

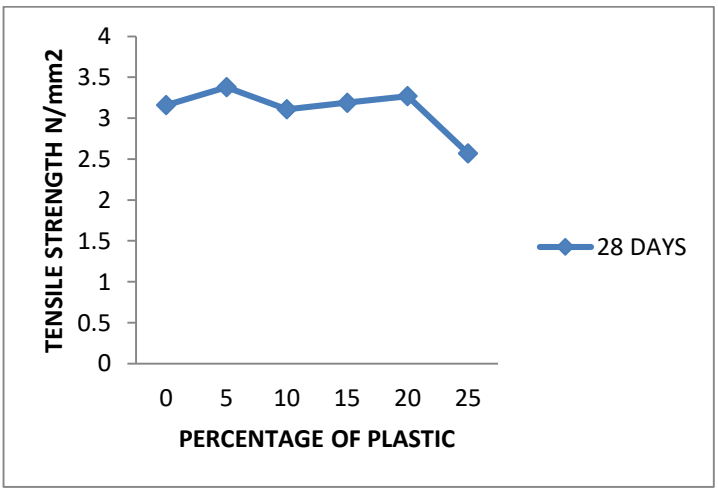

Fig 4 Variation of 28 days tensile strength with

Various percentage of plastic

Conclusions:

Based on the Experimental result following points are summarized with regard to effect of plastic and fly ash on the properties of concrete.

1. The compressive strength values of all waste plastic concrete mixtures tend to decrease below the values for the reference concrete mixtures with increasing the percentage of plastic at all curing ages. This may be attributed to the decrease in the adhesive strength between the surface of the plastic and cement paste. In addition, plastic is hydrophobic material which may restrict the hydration of cement.
2. The splitting tensile strength observation shows the improvement of tensile strength of concrete. Up to 20 % of plastic, improvement of strength recorded after that, strength of concrete decreases with addition of plastic.
3. The use of more than 20% plastic based mixtures is responsible for minor strength loss.
4. The slump values of plastic concrete mixtures showed a tendency to decrease below the slump of the reference concrete mixture. In spite of this decline in the slump of these mixtures, they are easy to work based on the consideration that workability has a broad range from very low to high workability for different applications.
5. By using the fly ash as a replacement for cement and plastic as replacement for sand there is a decrease in 12% overall cost of concrete.
6. From the above discussion it is identified that the use of plastic can be possible to improve the properties of concrete which can act as a one of the plastic disposal method.

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