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Non-Destructive Test and Durability Studies of Self Compacting Concrete Using Plastic Aggregate

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Abstract:

Present-day self-compacting concrete (SCC) can be classified as an advanced construction material. In this present study the plastic aggregate obtained from E-waste is used as a partial replacement of coarse aggregate in self compacting concrete. An experimental investigation on the durability characteristics of concrete using M40 grade of Self compacting concrete are carried out by casting standard concrete with various volume fractions of plastic aggregate such as 0%, 10%, 20%, 30%, 40%, 50% to determine optimum dosage. Non destructive test such as Schmidt Rebound hammer test and Ultra Sonic pulse velocity reveals that strength of concrete decreases for all replacement levels of plastic aggregate. Durability properties such as Abrasion resistance, Water absorption, and Sulphate resistance are enhanced by using plastic aggregate at all replacement levels.

Keywords — **Non destructive test, Schmidt Rebound hammer test, Ultra Sonic pulse velocity, Abrasion resistance, Water absorption, and Sulphate resistance**.

I. INTRODUCTION

The properties of plastic waste to be used as an aggregate in concrete preparations such as size distribution, bulk density, specific gravity, and water absorption were generally evaluated in the majority of the reported studies. Plastic aggregates are generally produced from big sized plastic waste materials. Therefore both coarse and fine sized natural aggregate can be replaced by plastic aggregates. Both partial and full substitutions of natural aggregates by plastic aggregates were reported in various references.

The compressive strength of concrete and cement mortar is a fundamental property that is thoroughly studied in almost all research works related to plastic aggregate. In all of these studies it was found that the incorporation of plastic as aggregate decreased the compressive strength of the resulting concrete/mortar

The factors that may be responsible for low compressive strength of concrete containing plastic aggregate are:

(I) The very low bond strength between the surface of the plastic waste and the cement paste.

(II) The hydrophobic nature of plastic waste, which can inhibit cement hydration reaction by restricting water movement.

Albano et al. [1], Hannawi et al. [10] reported higher water absorption for concrete containing Plastic aggregate than for concrete containing natural aggregate only. According to the authors, the difference in size distribution as well as in shape of plastic aggregate from the fine natural aggregate was responsible for this behaviour.

Marzouk et al. [21] reported that volumetric substitutions of plastic aggregate lower than 100% decreased the rate of water adsorption with respect to the reference mortar that contained no waste [27].

Fraj et al.[8] recorded a higher value of the water accessible porosity of cement mortar containing polyurethane (PUR) foam aggregate than that of mortar containing no plastic aggregate. The authors also reported that pre-wetting of PUR foam aggregate further increased the porosity. However the addition of a super plasticizer to the cement mortar containing pre-wetted PUR foam aggregate can decrease its porosity.

Kou et al.[20] indicated that the resistance of chloride ion penetrability of concrete increased with an increase in PVC content as well as with longer curing. They found reduction of about 36% in the total charges passed through the 28-day cured concrete, prepared by replacing 45% of natural aggregate by PVC granules in comparison with the concrete containing no waste PVC granules and the same curing age is because of the impervious PVC

II. MATERIAL INVESTIGATION

A. Cement

Ordinary Portland cement of 53 grades is used in this project work. The physical properties of cement are given in Table.1

Table 1.Physical properties of Cement (OPC 53 grade)

Sl.no	Property	Value
1	Standard Consistency	31%
2	Initial setting time	137min
3	Final setting time	303 min
4	Specific gravity	3.11

B. Fine Aggregate

Good quality river sand free from silt and other impurities passing through 4.75 mm sieve is used in this study. The physical properties of fine aggregate are shown in Table.2

Table 2. Physical properties of Fine aggregate

Sl.no	Description	Results
1	Specific gravity	2.7
2	Water absorption (%)	1.05
3	Bulk density(g/cm^3)	1.560
4	Fineness modulus	2.99
5	Zone	I

C. Coarse aggregate:

Coarse aggregate is passing through 20 mm and retaining on 10mm sieves are used for experimental Work. The physical properties of coarse aggregate are given in Table 3

Table 3. Physical properties of Coarse aggregate

Sl.no	Description	Results
1	Specific gravity	2.78
2	Water absorption (%)	0.6
3	Loose Bulk density(g/cm^3)	1.386
4	Rodded Bulk density (g/cm^3)	1.430
5	Impact value (%)	22.54
6	Fineness modulus	7.17

D. Plastic Aggregate

The polystyrene waste material collected from Lotus plastic Pvt.Ltd. Mettupalayam Puducherry. The physical properties of plastic aggregates are given in Table. 4

Table 4. Physical properties of Plastic aggregate

Sl.no	Description	Plastic
1	Specific gravity	1.08
2	Water absorption (%)	0.4
3	Loose Bulk density(g/cm^3)	0.583
4	Rodded Bulk density(g/cm^3)	0.616
5	Impact value (%)	4.4
6	Crushing value (%)	4.94
7	Fineness modulus	6.86

Fig 1. Plastic Aggregate

E. Fly ash

Class F is fly ash normally produced from burning anthracite or bituminous coal and is procured from Ennore, Chennai and is used for this project work. Specific gravity of Fly-ash is 2.05

F.Silica Fume

However, silica fume is also very effective in reducing or eliminating bleed and this can give rise to problems of rapid surface crusting.

G. Super Plasticizer

In this project SP with higher specific gravity, named Supaflo SPL for attaining the required flow characteristics is used. Specific gravity of Super Plasticizer is 1.21

H. Water

Potable drinking water with pH value ranging between 6 to 7 available within the Pondicherry Engineering College Campus has been used for making Self Compacting concrete.

III. NON-DESTRUCTIVE TESTING

1. Schmidt Rebound hammer test:

The rebound number was measured on the cube specimens using digital Schmidt hammer was given in the Table 5

Table 5 Rebound Number

Sl.No	Mix ID	Rebound Number	Compressive strength (MPa)
1	RSCC	44	49
2	P10SCC	44	51.9
3	P20SCC	42	48.8
4	P30SCC	40	45.2
5	P40SCC	38	42.5
6	P50SCC	36	36.9

2. Ultrasonic Pulse velocity test (UPV)

Also as it is seen from the results, up to 30% of plastic waste, the sound velocity is not affecting the quality of concrete

Table 6 Pulse velocity (m/sec)

Sl.No	Mix Id	Pulse velocity(m/sec)
1	RSCC	4350
2	P10SCC	4410
3	P20SCC	4310
4	P30SCC	4260
5	P40SCC	4150
6	P50SCC	4050

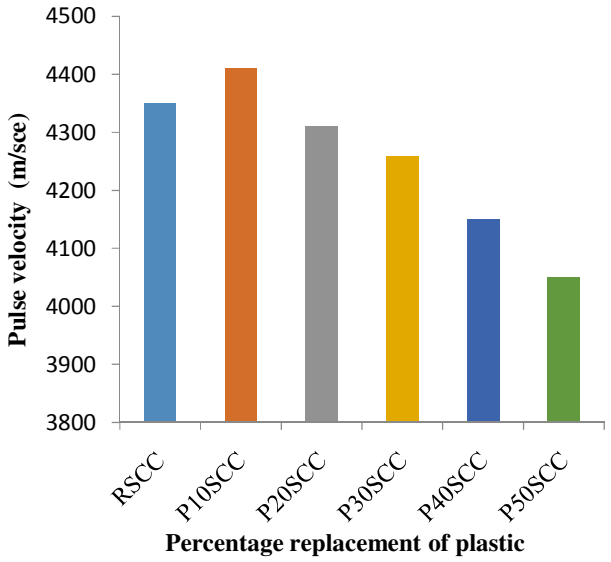

Fig2. Pulse velocity (m/sec)

IV.DURABILITY CHARACTERISTICS

1. Water Absorption

The water absorption of concrete containing plastic aggregate was found out at 28days. It is expressed in terms of percentage. It is found that the percentage of water absorption is lower for concrete containing 50% replacement by plastic aggregate than the concrete containing natural aggregate. The results of variation are shown in Fig 3

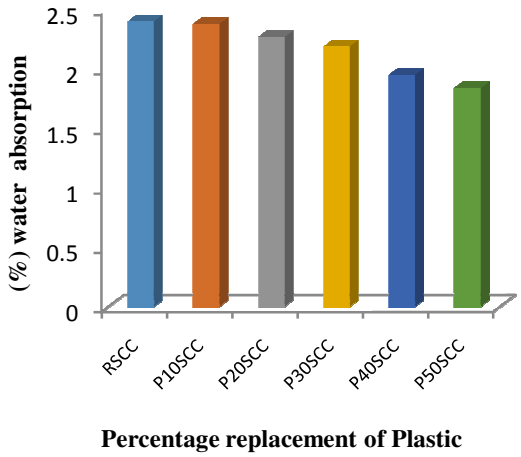

Fig3. Water absorption (%)

2 Abrasion Resistances

In this method the abrasion resistance is expressed in terms of wear thickness. Following are the results obtained from

the tile abrasion test. It is found that the concrete made with 50% replacement of plastic aggregate shows least tear value when compared to concrete made with natural coarse aggregate. The results of variation is shown in Fig.4

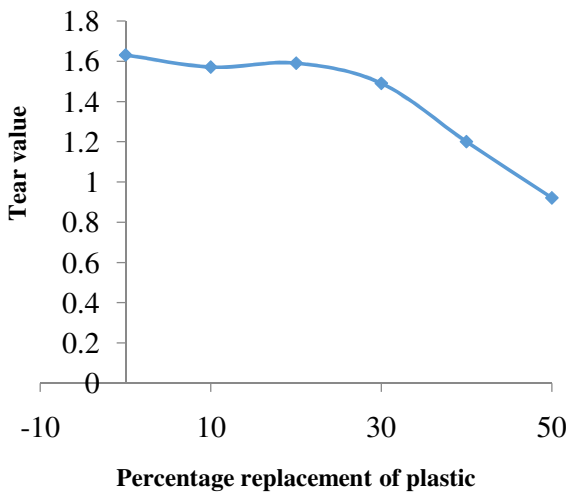

Fig4. Abrasion Resistances

3. Sulphate resistance

The effect on percentage of weight loss of SCC using plastic aggregate exposed to sulphate solution for a period of 56 days are given the Table5.13 and its variation is shown in Fig5.9. It is observed that the percentage of weight loss decreases for 50 % plastic aggregate than normal concrete Also the original strength and residual strength after sulphate exposure at 56 days are presented in the Table 8

Table 7 Sulphate resistance

Sl.No	Mix Id	Weight loss (%)
1	RSCC	0.36
2	P10SCC	0.32
3	P20SCC	0.25
4	P30SCC	0.20
5	P40SCC	0.17
6	P50SCC	0.13

Table 8 The original and residual strength of concrete after sulphate attack

Sl.no	Mix Id	Original strength (MPa)	Residual strength(MPa)
1	RSCC	49.8	46.2
2	P10SCC	50.2	48.1
3	P20SCC	48	46
4	P30SCC	46.3	43.2
5	P40SCC	42.4	40.4
6	P50SCC	37	35

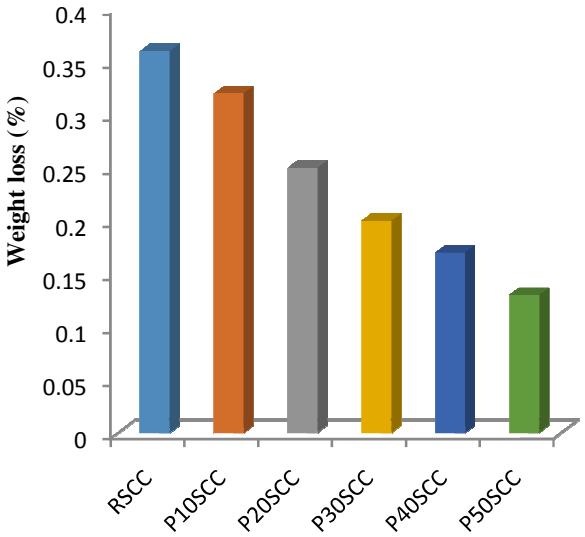

Fig 5.Effect of Plastic aggregate on Sulphate resistance of concrete

V .CONCLUSIONS

a. The results of Schmidt Rebound hammer test shows the quality of concrete plastic incorporated decreases strength.
b. The results of Ultra sonic pulse velocity shows pulse velocity of concrete decreases as plastic aggregate content increases.
c. Water absorption of concrete decreases as percentage of plastic aggregate increases.
d. The Abrasion resistance of concrete has enhanced at all replacement of plastic aggregate.
e. The percentage loss in weight of concrete after sulphate attack is minimum in concrete containing plastic than normal concrete.

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