International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.8, pp 634-644, 2017

Durability Studies on Concrete by using Plastic Waste

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Abstract : Solid waste management is one of the major environmental concerns in our country now days. The present study covers the recycled plastics as a partial replacement of cement in concrete. The main aim of this project is that effective usage of plastic waste.
It is found that the use of plastic waste as a partial replacement of cement results in the increase of compressive strength of concrete. The workability of concrete reduces with the introduction of plastics[1]. The most important change brought about by the use of plastics is that the increase of compressive strength of concrete, reduce in permeability, increase in acid resistance, increase in corrosion resistance and also the resistance of thermal conductivity performs better.
Keywords : component; formatting; style; styling; insert (key words).

1.0 Introduction

To determine the durability of concrete with plastics and to determine the acid resistance value, corrosion resistance value, permeability value, fire resistance value of concrete with plastic waste.

Comparison of the above results of concrete with waste plastics and conventional concrete

2.0 Experimental Programme

2.1 Compressive strength test

Cubical specimens of size 150 mm were cast for conducting compressive strength test for each mix. The compressive strength test was carried out as per IS: 516-1979.

This test was carried at the end of 28 days of curing. The compressive strength of any mix was taken as the average of strength of three cubes.

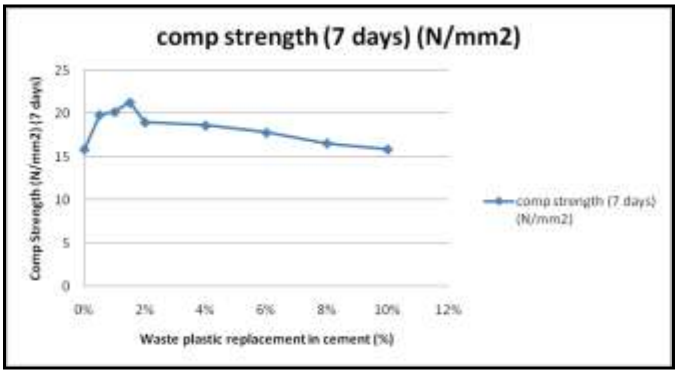
Compressive Strength of Normal Concrete and Plastic Added Concrete

S.No	Name of the Specimen	Percentage of Replacement (%) (Plastic Waste)	Compressive Strength (N/mm2) (7 day's strength)
1.	Cube 1	0	16.45
	Cube 2		16
	Cube 3		15.2
2.	Cube 1	0.5	20
	Cube 2		19.4
	Cube 3		19.1
3.	Cube 1	1	20.1
	Cube 2		20.5
	Cube 3		20
4.	Cube 1	1.5	21.3
	Cube 2		21
	Cube 3		21.6
5.	Cube 1	2	19
	Cube 2		18.8
	Cube 3		19.2
6.	Cube 1	4	18.6
	Cube 2		18.5
	Cube 3		18.8
7.	Cube 1	6	18
	Cube 2		17.6
	Cube 3		17.8
8.	Cube 1	8	16.5
	Cube 2		16.8
	Cube 3		16.4
9.	Cube 1	10	15.5
	Cube 2		16
	Cube 3		16.1

2.2 Average compressive Strength of Normal Concrete and Plastic Added Concrete

S.No	% of replacement	Avg comp strength (7 days) (N/mm2)
1	0%	15.86
2	0.50%	19.85
3	1%	20.2
4	1.50%	21.3
5	2%	19
6	4%	18.63
7	6%	17.8
8	8%	16.56
9	10%	15.86

Graph to find optimum percentage for plastic added concrete



3.0 Corrosion Test

Set-Ups Used for Inducing Reinforcement Corrosion through Impressed Current

Set-ups used for inducing reinforcement corrosion through impressed current consist of a DC power source, a counter electrode, and an electrolyte [2].

The positive terminal of the DC power source is connected to the steel bars (anode) and the negative terminal is connected to the counter electrode (cathode).

The current is impressed from counter electrode to the rebars through concrete with the help of the electrolyte (normally sodium chloride solution).

Calculation of Degree of Induced Corrosion

The degree of induced corrosion is also expressed in terms of the percentage weight loss (ρ) calculated as

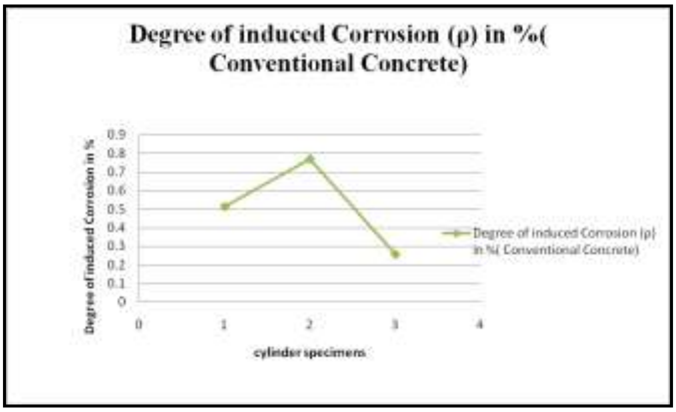
$\rho =((Wi-Wf) / Wi)* 100$

The equivalent corrosion current density (Icorr) can be determined by assuming that the theoretical and actual mass of rust are equal as

$Icorr =((Wi-Wf)F) / \pi DLWT)$
Where, Wi = initial weight of the bar before corrosion (g)
Wf = weight after corrosion (g) for a given duration of induced corrosion (T)f
F = Faraday's constant (96487 Amp-sec)
D = diameter of the rebar (cm)
L = length of the rebar sample (cm)
W= equivalent weight of steel which is taken as the ratio of atomic weight of iron to the valence of iron (27.925 g)
T = duration of induced corrosion (sec)

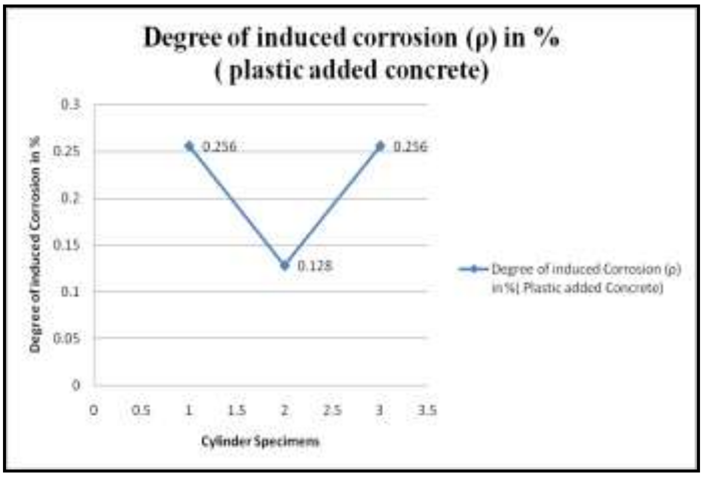
Corrosion Test for ordinary concrete

S.No	**Specimens**	**Degree of induced Corrosion (ρ) in %(Conventional Concrete)**
1	Cylinder 1	0.513
2	Cylinder 2	0.769
3	Cylinder 3	0.256



Corrosion Test for concrete with waste plastics

S.No	Specimens	Degree of induced Corrosion (ρ) in % (Plastic added Concrete)
1	Cylinder 1	0.256
2	Cylinder 2	0.128
3	Cylinder 3	0.256



Permeability Test as per IS 3085-1965

Preparing the Specimen

The specimen shall be thoroughly cleaned with a stiff wire brush to remove all laitance. The end faces shall then be sand-blasted or lightly chiseled.

Sealing the Specimen

The specimen shall be surface-dried and the dimensions measured to the nearest 0.5 mm. It shall then be centered in that cell, with the lower end resting on the ledge. The annular space between the specimen and the cell shall be tightly caulked to a depth of about 10 mm using cotton or hemp cord soaked in a suitable molten sealing compound [4]. The rest of the space shall be carefully filled with the molten sealing compound, level with the top of the specimen.

Any drop in the level due to cooling shall be made up, using a heated rod to remelt the solidified, compound before pouring fresh material over it.

A mixture of bees-wax and rosin, applied smoking hot, forms an effective seal. The proper proportions are best chosen by trial[5]. Other suitable materials are stearine pitch, marine glue, and various asphaltic compounds.

Testing the Seal

It is essential that the seal is, watertight. This may be checked very conveniently by bolting on the top cover plate, inverting the cell and applying an air pressure of 1 to 2 kg/cm2 from below.

A little water poured on the exposed face of the specimen is used to detect any leaks through the seal, which would show up as bubbles along the ledge. In case of leaks the specimen shall be taken out and resealed.

Assembling the Apparatus

After a satisfactory seal has been obtained, the funnel shall be secured in position and the cell assembly connected to the water reservoir.

With the air bleeder valve, the valve between the reservoir and the cell, and the drain-cock in the cell open, de-aired water shall be allowed to enter the reservoir.

When water issues freely through the drain-cock, it shall be closed and the water reservoir filled. The reservoir water inlet and air bleeder valves shall then be closed.

Running the Test

With the system completely filled with water, the desired test pressure shall be applied to the water reservoir and the initial reading of the gauge-glass recorded [7]. At the same time a clean collection bottle shall be weighed and placed in position to collect the water percolating through the specimen.

The quantity of percolate and the gauge-glass readings shall be recorded at periodic intervals. In the beginning, the rate of water intake is larger than the rate of outflow.

As the steady state of flow is approached, the two rates tend to become equal and the outflow reaches a maximum and stabilizes. With further passage of time, both the inflow and outflow generally register a gradual drop [8].

Permeability test shall be continued for about 100 hours after the steady state of flow has been reached and the outflow shall be considered as average of all the outflows measured during this period of 100 hours.

Calculation

The coefficient of permeability shall be calculated as follows:

$K=(Q)/(AT(H/L))$

where

K = coefficient of permeability in cm/sec;

Q = quantity of water in millilitres percolating over the entire period of test after the steady state has been reached;

A = area of the specimen face in cm*;
T = time in seconds over which Q is measured; and
(H/L)= ratio of the pressure head to thickness of specimen, both expressed in the same units.

Permeability Test for ordinary concrete

S.No	Specimens	Permeability Coefficient ×10-7 cm/sec (Conventional Concrete)
1	Cube 1	6.01
2	Cube 2	6.25
3	Cube 3	6

Permeability Test for concrete with waste plastics

S.No	Specimens	Permeability Coefficient ×10-7 cm/sec (plastic added Concrete)
1	Cube 1	5.09
2	Cube 2	4.98
3	Cube 3	5.25

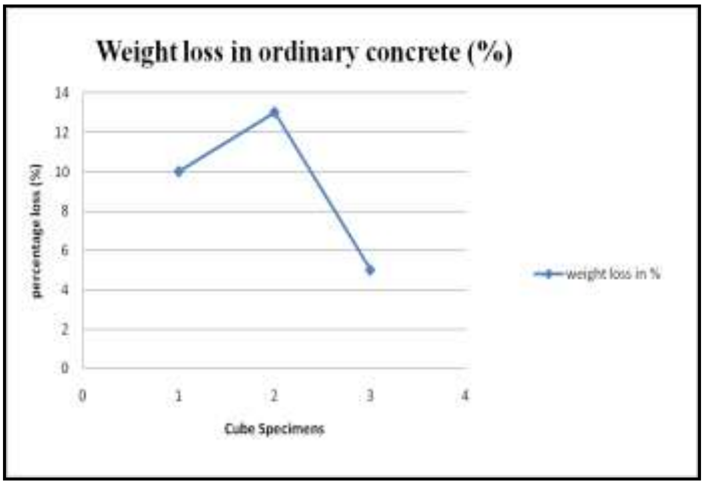
Acid Resistance Test on Concrete

At an age of 28 days, concrete cubes were immersed in 10% sulphuric acid solution based on a modified ASTM C267 test.

A 10% (by mass) sulphuric acid solution was directly diluted from 98% concentrated sulphuric acid with tap water. The 10% sulphuric acid does not represent the actual service condition encountered in sewer pipes, but such a concentration of acid has been used by the Los Angles County for 15 years to test the sulphuric acid resistance of products[10] . The use of a 10% sulphuric acid environment provides accelerated experimental data within 8 weeks. The ratio of the sulphuric acid volume to specimen exposure area was fixed at 8 ml/cm2. The acid concentration was monitored via titration and refreshed weekly.

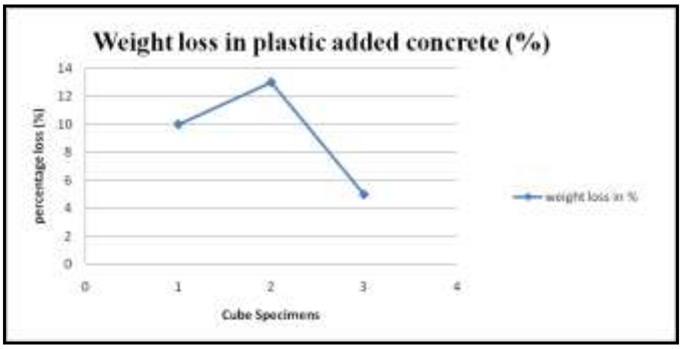
Acid Resistance Test for Conventional Concrete

S.No	Initial Weight of Cube (Kg)	Final Weight of Cube (kg)	Weight Loss (%)
1	8.6	8.5	10
2	8.43	8.3	13
3	8.25	8.2	5



Acid Resistance Test for Plastic Added Concrete

S.No	Initial Weight of Cube (Kg)	Final Weight of Cube (kg)	Weight Loss (%)
1	8.4	8.32	8
2	8.3	8.22	8
3	8.5	8.44	6

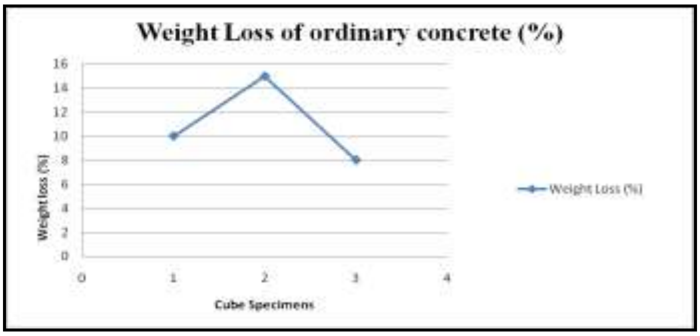


Fire Resistance Test

The fire resistance of concrete members and assemblies designed in accordance with ACI 318 for reinforced and plain structural concrete shall be determined based on the provisions of this chapter. Concrete walls, floors, and roofs shall meet minimum thickness requirements for purposes of barrier fire resistance. Concrete containing steel reinforcement shall additionally meet cover protection requirements in this chapter for purposes of maintaining structural fire resistance. In some cases distinctions are made between normal weight concretes made with carbonate and siliceous aggregates. If the type of aggregate is not known, the value for the aggregate resulting in the greatest required member thickness or cover to the reinforcement shall be used.

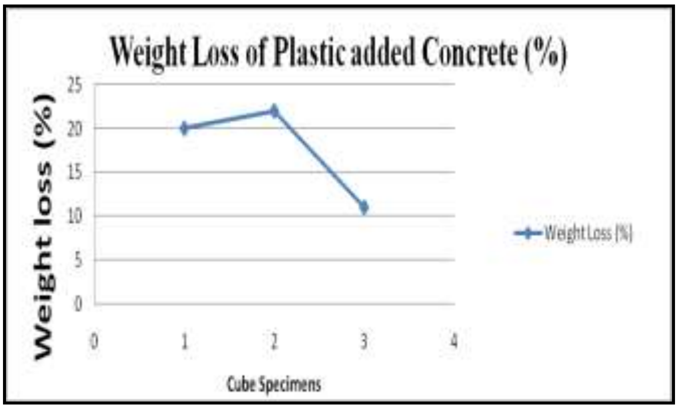
Fire Resistance Test for Ordinary Concrete

S.No	Initial Weight of Cube (Kg)	Final Weight of Cube (kg)	Weight Loss (%)
1	8.2	8.10	10
2	8.3	8.15	15
3	8.16	8.08	8



Fire Resistance Test for Plastic Added Concrete

S.No	Initial Weight of Cube (Kg)	Final Weight of Cube (kg)	Weight Loss (%)
1	8.6	8.4	20
2	8.82	8.6	22
3	8.55	8.44	11

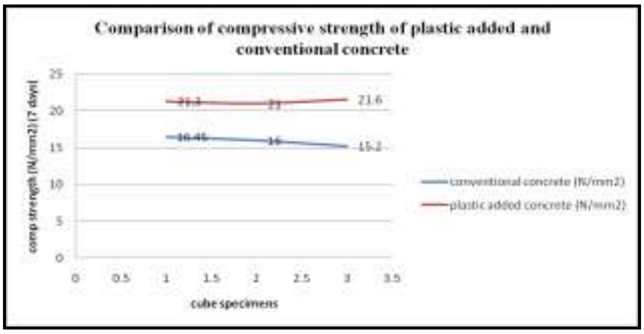


4.0 Comparison of Results

Comparison of compressive strength of conventional concrete and concrete with waste plastics

S.No	Specimens	Comp. strength for Ordinary Concrete (N/mm2) (7 days)	Comp. strength for Plastic added concrete (N/mm2)
1	Cube 1	16.45	21.3
2	Cube 2	16	21
3	Cube 3	15.2	21.6

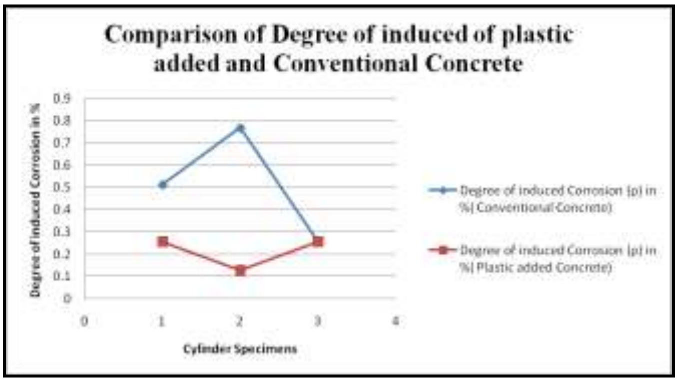
Comparison between compressive strength of Normal concrete and Plastic added Concrete



From the above graph it is very clear that the compressive strength of plastic added concrete is more when compare to conventional concrete[1]. It is determined that the compressive strength of plastic added concrete is increased by 34.55% when compared to conventional concrete.

Comparison of Corrosion Resistance value of conventional concrete and concrete with waste plastics

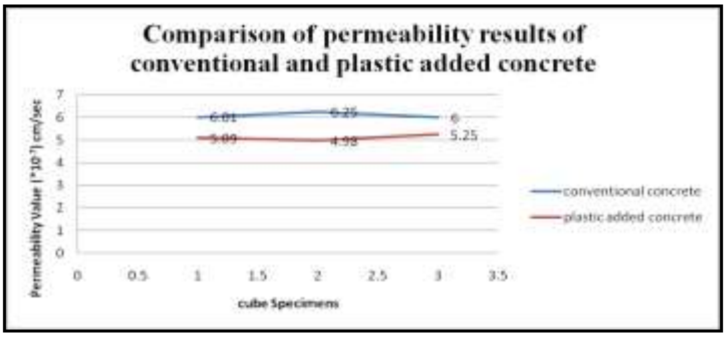
S.No	Specimens	Degree of induced corrosion for Ordinary Concrete in %	Degree of induced corrosion for Plastic added concrete in %
1	Cube 1	0.513	0.256
2	Cube 2	0.769	0.128
3	Cube 3	0.256	0.256



From the above graph it is very clear that the degree of induced corrosion of plastic added concrete is less when compare to degree of induced corrosion of conventional concrete. It is determined that the degree of induced corrosion of plastic added concrete is decreased by 58.47% when compared to conventional concrete.

Comparison of Permeability value of conventional concrete and concrete with waste plastics

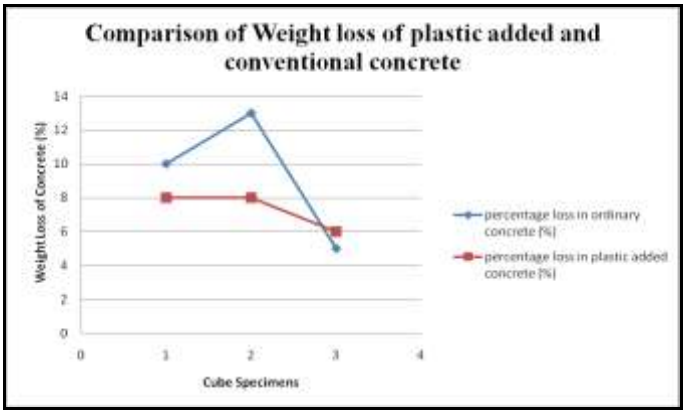
S.No	Specimens	Permeability Coefficient ×10-7 cm/sec (Conventional Concrete)	Permeability Coefficient ×10-7 cm/sec (plastic added Concrete)
1	Cube 1	6.01	5.09
2	Cube 2	6.25	4.98
3	Cube 3	6	5.25



From the above graph it is very clear that the Permeability resistance value of plastic added concrete is more when compare to Permeability resistance value of conventional concrete. It is determined that the Permeability resistance value of plastic added concrete is increased by 16.099% when compared to conventional concrete.

Comparison of Acid Resistance value of conventional concrete and concrete with waste plastics

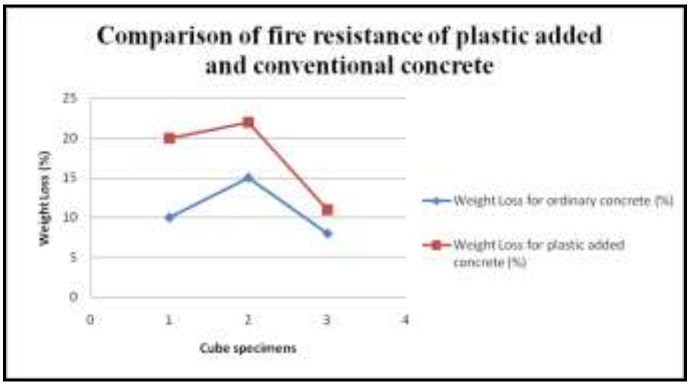
S.No	Specimens	Weight Loss for Conventional concrete (%)	Weight Loss for Plastic added concrete (%)
1	Cube 1	10	8
2	Cube 2	13	8
3	Cube 3	5	6



From the above graph it is very clear that the Weight loss due to acid resistance of plastic added concrete is less when compare to Weight loss due to acid resistance of conventional concrete. It is determined that the Weight loss due to acid resistance of plastic added concrete is decreased by 21.43% when compared to conventional concrete.

Comparison of Fire Resistance value of conventional concrete and concrete with waste plastics

S. No	Specimens	Weight Loss for Conventional concrete (%)	Weight Loss for Plastic added concrete (%)
1	Cube 1	10	20
2	Cube 2	15	22
3	Cube 3	8	11



From the above graph it is very clear that the Weight loss due to fire resistance of plastic added concrete is more when compare to Weight loss due to fire resistance of conventional concrete. It is determined that the Weight loss due to fire resistance of plastic added concrete is increased by 60.63% when compared to conventional concrete.

5.0 Conclusion

It has been studied that the Compressive strength of Plastic added concrete has increased when compared to the Conventional concrete. It has been found out the optimum percentage as 1.5% to replace cement with the plastic waste.

It has been studied the durabilities of plastic added concrete and conventional concrete, and the comparison were also made. It has been found out the permeability, corrosion resistance, and acid resistance of plastic added concrete performs better when compare to conventional concrete.It has been found out that the weight losses due to fire resistance of plastic waste added concrete were increased when compared to the conventional concrete.

6.0 References

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