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Study on Recycled Waste Plastic Concrete

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ABSTRACT

Utilization of waste materials and byproducts is a partial solution for environmental and ecological problems. Here Plastics are the most important and toxic waste materials compare to other wastes. Use of these plastic materials are not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. Plastic wastes consist of the waste of plastics bags, water bottles, drums, straws and some polythene sheets. An experimental study is made on the utilization of plastic waste particles as coarse aggregates in concrete with a percentage replacement ranging from 0 % to 20% on the strength criteria of M25 Concrete. This project gives the basic mechanical properties and strength of conventional concrete M25 grade.

KEYWORDS : Concrete, Environment, Plastic, Waste materials.

1. INTRODUCTION

Generation of plastic waste is one of the fastest growing areas. Because the usage of plastics are increasing day by day in domestic and industrial wise. In Tamil nadu per day 3,400 tons of plastics are generated in each cities, 35 to 45 tons is plastic wastes and most of that is plastic bags. Each year 500 billion to trillion plastics are generated in world wide. . It estimated that the rate of expansion is doubled every year. This wastes produced today will remain in the environment hundreds and perhaps thousands of years. It estimated that the rate of expansion is doubled every year. This wastes produced today will remain in the environment hundreds and perhaps thousands of years. As landfill areas are rapidly depleting the cost of solid waste disposal is rapidly increasing. One solution to this crisis lies in recycling wastes into useful processes. So these types of plastic wastes are used in construction process.

Research into new and innovative use of waste materials being undertaken world-wide and innovative ideas that are expressed are worthy of this important subject. Many highway agencies, private organizations and individuals have completed or are in the process of completing a wide variety of studies and research projects concerning the feasibility, environmental suitability and performance of using waste plastics in highway construction. These studies try to match societal need for safe and economic disposal of waste materials with the help of environmental friendly highway industries, which needs better and cost-effective construction materials.

1.1 OBJECTIVE

The objectives of this research are to reduce the usage of coarse aggregate in concrete. In this manner it can satisfy the conditions of green buildings.It is also carried out to make a comparative study of compressive strength, split tensile strength and modulus of elasticity of concrete using ordinary Portland cement.

1.2 SCOPE

1) To introduce the plastic waste as a replacement such as, coarse aggregate in concrete.
2) Studies on mechanical properties of recycled waste plastic concrete such as, compressive strength, split tensile strength, and modulus of elasticity.

0.3SIGNIFICANCE OF RESEARCH

Now a days the plastics usage is high so the quantity plastic waste is high. This study to check the efficiency of concrete by using the plastic waste in it and to improve the strength of concrete using Portland cement.

2. METHODS AND MATERIALS

2.1 MATERIALS

The materials used for this study includes cement, fine aggregate, coarse aggregate and waste plastics.

2.2 PROPERTIES OF PLASTICS

Now a days the plastics usage is high so the quantity plastic waste is high. This study to check the efficiency of concrete by using the plastic waste in it and to improve the strength of concrete using Portland cement.

Table.2.1 Properties of plastics

Properties	Values
Specific gravity	1.04
Density (g/cc)	0.945 - 0.962
Melting point	75 - 100
Fineness	< 2.36

Figure 2.1 High density plastic (Polypropylene)

3. METHODOLGY

1) Literature review
2) Collecting the waste plastics to be used
3) Testing the properties of materials
4) Designing the mix
5) Casting the cubes, cylinders and beams
6) Testing of the specimens
7) Comparing the results
8) Conclusion

4. EXPERIMENTAL INVESTIGATIONS

4.1 TEST PROGRAMME

The project deals with the behaviour of recycled waste plastic concrete in partial replacement of coarse aggregate. To find out the strength parameters such as compressive strength,split tensile strength and modulus of elasticity of concrete with partial replacement of coarse aggregate is the prime concern of this study.

Seventy two cubes, hundred and eight cylinders, are tested under compression, split tensile and deflection test respectively. The M25 grade of concrete is used for this study

The investigated parameters under this study were concrete strength and the percentage of replacement plastics for the coarse aggregate. Further details of concrete specimens are as follows:

4.2 DETAILS OF SPECIMENS

4.2.1 Cube Specimens

A mould of internal dimensions of 150 X 150 X 150 mm are used for casting of cubes for compression strength for both conventional concrete and waste plastic concrete Specimens. The Fig 4.1 shows the cubes moulds.

Fig. 4.1 Cube moulds

4.2.2 Cylinder Specimens

A mould of internal dimensions of 150 mm diameter and 300 mm height are used for casting of cylinder for split tensile strength for both conventional concrete and waste plastic concrete Specimens. The Fig 4.2 shows the sample of cylinder moulds.

Fig. 4.2 Cylinder moulds

5. RESULTS AND DISCUSSIONS

5.1 COMPRESSIVE STRENGTH

Compressive strengths were measured using a compression testing machine with a maximum capacity of 2000KN. For all tests, each value was taken as the average of three samples. Test results for conventional concrete for both 14 and 28 days curing were tabulated in Table 5.1. The dimensions for the concrete cube should be in 150×150×150mm respectively. The testing arrangements are shown in Fig 5.1 and Fig 5.2

Fig. 5.1 Compressive strength testing for cube

Fig 5.2 Concrete cube specimen in after testing

The ultimate compressive load and compressive strength of the conventional and plastic concrete cubes for 14 days and 28 days curing results are tabulated in Table 5.1

Table 5.1 Compressive strength results for concrete cubes

% of Plastics	Curing days		Compressive strength(N/mm^2)	
	14days	28days	14 days	28days
0	585	665	25.22	28.22
2	612	685	27.04	30.26
4	639	692	28.15	30.33
6	655	706	28.79	30.85
8	661	782	28.88	33.95
10	683	788	30.33	34.66
12	448	456	18.55	19.30
14	428	489	16.31	21.51
16	345	444	14.16	19.24
18	318	330	13.30	14.44
20	219	303	9.50	13.33

The compressive strength for plastic concrete cubes for 14 and 28 days results are shown at the Fig 5.3.

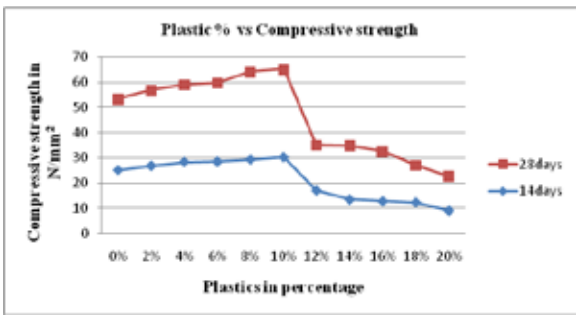

Fig. 5.3 Compressive strength for cubes

The self weight variations for plastic concrete cubes for 14 and 28 days results are shown at the Fig 5.4.

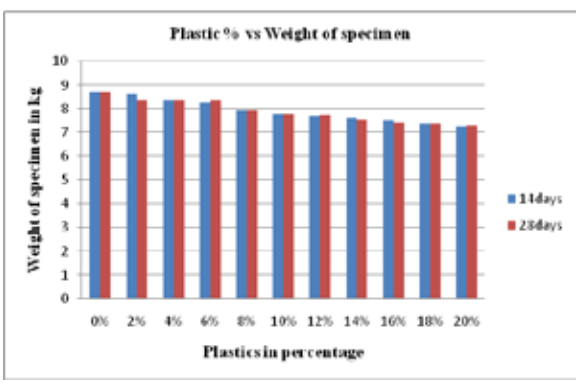

Fig. 5.4 Self weight comparison for cubes

5.2 SPLIT TENSILE STRENGTH

Split tensile strengths were measured using a compression testing machine with a maximum capacity of 2000KN. For all tests, each value was taken as the average of three samples. Test results for conventional concrete for both 14 and 28 days curing were tabulated in Table 5.2. . The dimensions for the concrete cylinder should be in 150mm dia and 300mm length respectively.

Fig.5.5 Split tensile strength testing for cylinder

Fig. 5.6 Concrete cylinder specimen in after failure

The ultimate split tensile load and tensile strength of the conventional and plastic concrete cylinders for 14 days and 28 days curing results are tabulated in Table 5.2

Table 5.2 Tensile strength result for concrete cylinders

% of Plastics	Curing days		Split tensile strength(N/mm²)	
	14days	28days	14 days	28days
0	235	286	3.27	3.97
2	229	291	3.28	4.08
4	243	318	3.39	4,45
6	257	323	3.61	4.53
8	199	247	3.24	3.42
10	193	237	2.72	3.31
12	161	220	2.23	3.09
14	169	210	2.39	2.91
16	148	201	2.06	2.8
18	179	197	2.39	2.69
20	176	189	2.49	2.55

The split tensile strength for plastic cylinder for 14 and 28 days results are shown at the Fig 5.7.

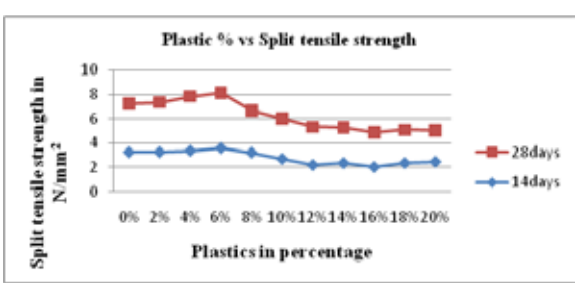

Fig. 5.7 Tensile strength for cylinder

The self weight variations for plastic cylinder for 14 and 28 days results are shown at the Fig 5.8.

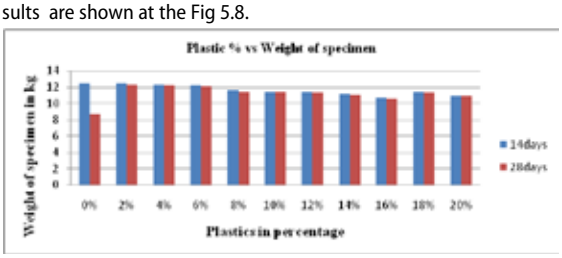

Fig. 5.8 Self weight comparison for cylinders

Fig. 5.9 Modulus of elasticity testing for cylinder

The modulus of elasticity of conventional concrete cylinder values are tabulated in Table 5.3

Table 5.3 Modulus of elasticity results for conventional concrete cylinders

Load in N P	Area in mm^2 A $\pi/4 \times 15^0 2$	Stress (N/mm^2) P/A	Compressometer reading in mm	Strain = Compressometer reading/250
0		0	0	0
5000		0.282	0.006	0.000024
10000		0.565	0.015	0.00006
15000		0.848	0.023	0.000092
20000		1.131	0.034	0.000136
25000		1.414	0.041	0.00016
30000		1.697	0.048	0.00019
35000		1.980	0.058	0.00023
40000	17.67×10^3	2.263	0.063	0.00025
45000		2.546	0.070	0.00028
50000		2.829	0.97	0.00038
55000		3.112	0.115	0.00046
60000		3.395	0.133	0.00053
65000		3.678	0.155	0.00062

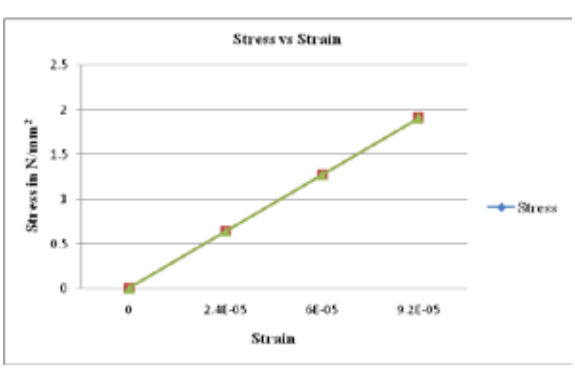

Fig. 5.10 Stress strain curve for conventional concrete cylinders

Modulus of elasticity for conventional $= 5000\sqrt{fck}$

$= 5000 \times \sqrt{32.5}$

$= 2.8 \times 10^4$ N/mm²

Modulus of elasticity $= \frac{Stress}{Strain}$

$= \frac{1}{0.0004} = 2.5 \times 10^4$ N/mm²

The modulus of elasticity of 2% of plastic concrete cylinder values are tabulated in Table 5.4

Table 5.4 Modulus of elasticity results for 2% of plastic concrete cylinders

Load in N P	Area in mm^2 A $\pi/4 \times 150^2$	Stress (N / mm^2) P/A	Compressometer reading in mm	Strain = Compressometer reading/250
0		0	0	0
5000		0.282	0.006	0.000024
10000		0.565	0.016	0.000064
15000		0.848	0.024	0.000096
20000		1.131	0.035	0.00014
25000		1.414	0.045	0.00018
30000		1.697	0.053	0.00021
35000		1.980	0.061	0.00024
40000	17.67×10^3	2.263	0.065	0.00026
45000		2.546	0.078	0.00031
50000		2.829	0.087	0.00034
55000		3.112	0.119	0.00047
60000		3.395	0.136	0.00054
65000		3.678	0.167	0.00066

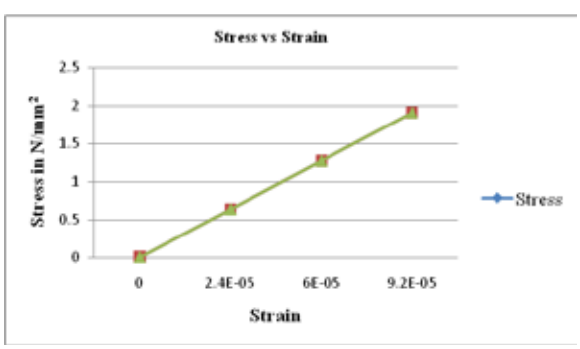

Fig. 5.11 Stress strain curve for 2% of plastic concrete cylinders

Modulus of elasticity for conventional $= 5000\sqrt{fck}$

$= 5000 \times \sqrt{32.5}$

$= 2.8 \times 10^4$ N/mm²

Modulus of elasticity $= \frac{Stress}{Strain}$

$= \frac{1.25}{0.00006} = 2.8 \times 10^4$ N/mm²

The modulus of elasticity of 4% of plastic concrete cylinder values are tabulated in Table 5.5

Table 5.5 Modulus of elasticity results for 4% of plastic concrete cylinders

Load in N P	Area in mm^2 A $\pi/4 \times 150^2$	Stress (N/mm^2) P/A	Compressometer reading in mm	Strain = Compressometer reading/250
0		0	0	0
5000		0.282	0.007	0.000028
10000		0.565	0.017	0.000068
15000		0.848	0.028	0.000112
20000		1.131	0.038	0.000152
25000		1.414	0.048	0.000192
30000		1.697	0.053	0.000212
35000		1.980	0.057	0.000228
40000	17.67×10^3	2.263	0.072	0.000288
45000		2.546	0.093	0.000372
50000		2.829	0.155	0.00062
55000		3.112	0.175	0.0007

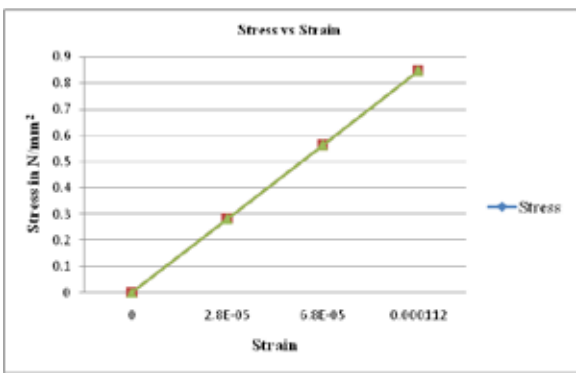

Fig. 5.12 Stress strain curve for 4% of plastic concrete cylinders

Modulus of elasticity for conventional $= 5000\sqrt{fck}$

$= 5000 \times \sqrt{32.5}$

$= 2.8 \times 10^4$ N/mm²

Modulus of elasticity $= \frac{Stress}{Strain}$

$= \frac{1}{0.0004} = 2.5 \times 10^4$ N/mm²

The modulus of elasticity of 6% of plastic concrete cylinder values are tabulated in Table 5.6

Table 5.6 Modulus of elasticity results for 6% of plastic concrete cylinders

Load in N P	Area in mm^2 A $\pi/4 \times 150^2$	Stress (N/mm^2) P/A	Compressometer reading in mm	Strain = Compressometer reading/250
0		0	0	0
5000		0.282	0.006	0.000024
10000		0.565	0.014	0.000056
15000		0.848	0.029	0.000116
20000		1.131	0.042	0.000168
25000		1.414	0.050	0.0002
30000		1.697	0.059	0.000236
35000	17.67×10^3	1.980	0.065	0.00026
40000		2.263	0.088	0.000352
45000		2.546	0.095	0.00038
50000		2.829	0.163	0.000652
55000		3.112	0.189	0.000756

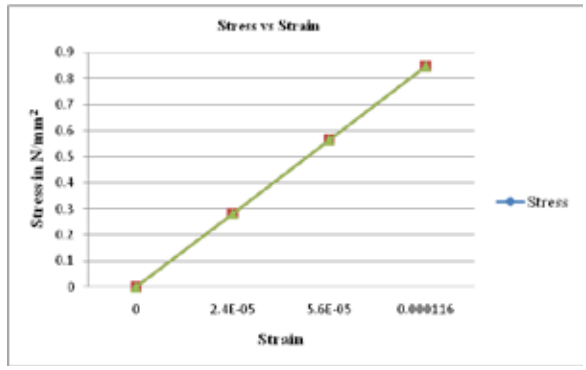

Fig. 5.13 Stress strain curve for 6% of plastic concrete cylinders

Modulus of elasticity for conventional $= 5000\sqrt{fck}$

$= 5000 \times \sqrt{32.5}$

$= 2.8 \times 10^4$ N/mm²

Modulus of elasticity $= \frac{Stress}{Strain}$

$= \frac{0.53}{0.000054} = 9.46 \times 10^3$ N/mm²

The modulus of elasticity of 8% of plastic concrete cylinder values are tabulated in Table 5.7

Table 5.7 Modulus of elasticity results for 8% of plastic concrete cylinders

Load in N P	Area in mm^2 A $\pi/4 \times 150^2$	Stress (N/mm^2) P/A	Compressometer reading in mm	Strain = Compressometer reading/250
0		0	0	0
5000		0.282	0.006	0.000024
10000		0.565	0.014	0.000056
15000		0.848	0.027	0.0000108
20000		1.131	0.035	0.00014
25000		1.414	0.047	0.000188
30000		1.697	0.059	0.000236
35000		1.980	0.065	0.00026
40000		2.263	0.079	0.000316
45000	17.67×10^3	2.546	0.094	0.000376
50000		2.829	0.108	0.000432
55000		3.112	0.129	0.000516
60000		3.395	0.131	0.000524
65000		3.678	0.148	0.000592

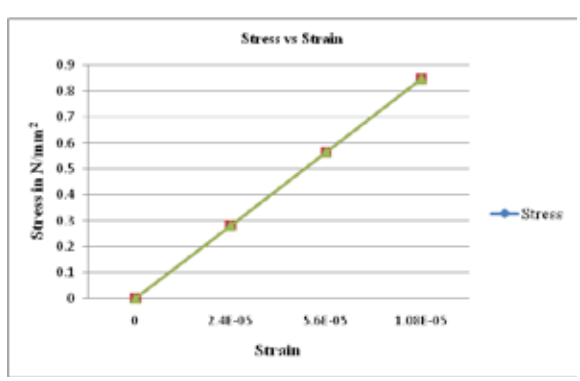

Fig. 5.14 Stress strain curve for 8% of plastic concrete cylinders

Modulus of elasticity for conventional $= 5000\sqrt{f_{ck}}$

$= 5000 \times \sqrt{32.5}$

$= 2.8 \times 10^4$ N/mm^2

Modulus of elasticity $= \frac{Stress}{Strain}$

$= \frac{0.29}{0.000024} = 1.2 \times 10^4$ N/mm^2

The modulus of elasticity of 10% of plastic concrete cylinder values are tabulated in Table 5.8

Table 5.8 Modulus of elasticity results for 10% of plastic concrete cylinders

Load in N P	Area in mm^2 A $\pi/4$ x150^2	Stress (N/mm^2) P/A	Compressometer reading in mm	Strain = Compressometer reading/250
0	17.67×10^3	0	0	0
5000		0.282	0.008	0.000032
10000		0.565	0.018	0.000072
15000		0.848	0.029	0.000116
20000		1.131	0.038	0.000152
25000		1.414	0.044	0.000176
30000		1.697	0.053	0.000212
35000		1.980	0.069	0.000276
40000		2.263	0.065	0.00026
45000		2.546	0.083	0.000332
50000		2.829	0.096	0.000384
55000		3.112	0.123	0.00049
60000		3.395	0.144	0.000576
65000		3.678	0.175	0.0007

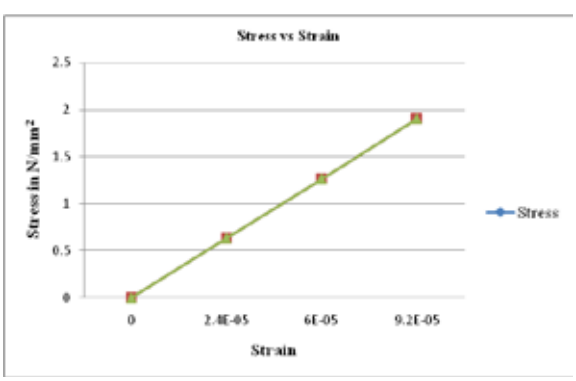

Fig. 5.15 Stress strain curve for 10% of plastic concrete cylinders

CONCLUSION

- The strength of the concrete such as compressive and tensile is increased up to 30% to 60%
- The self weight of the concrete is too low compare to conventional concrete
- While adding the plastics above 10% the concrete should be lose the compressive strength suddenly
- Uses of plastics are improving the strength of the concrete and one of the ways of disposal of waste plastics without affects any manner.

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