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Use of Waste Plastic Aggregate as Partial Replacement of Natural Aggregate in Concrete Mix

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Abstract: Due to rapid population growth and consistent use of plastic material is increasing day by day. This creates a large quantity of garbage which is unhealthy and pollutes the environment. In present scenario the management of this plastic waste is challenging in our country. This paper covers the use of recycled coarse aggregate partially in concrete mix. This will help to provide an eco-friendly and economical construction material. In this study we have study the effect of replacement of coarse aggregate by plastic aggregates has been studied by using various proportions i.e. 0%, 10%, 20%, 30% and 40%. This papers covers the study behavior of recycled plastic aggregate in concrete has been investigated compressive strength, split tensile strength and flexural strength.

Keywords: Plastic aggregate, natural coarse aggregate, fine aggregate ,cement ,mix proportion , compressive strength, split tensile strength , and flexural strength test

I. INTRODUCTION

According to Central pollution control board generation rate of plastic waste is 15342 tons per day. Due to non-biodegradability of plastic waste rise a lot of Environmental issues. Due to large quantity plastic waste increasing the load on land-filling. Hence to reduce the load on landfilling as well as reduce pollution of environment waste plastic collected, recycled and plastic coarse aggregate is prepared and used in concrete mix.

The concrete is most widely used construction material in the world. In concrete the volume of coarse aggregate is about 65% to 80%. The plastic is one of the most innovations of 20th century material. The use of plastic is increasing day by day and becomes a serious environmental problem. Due to large quantity of plastic waste there is load on the landfills. The recycled plastic is converted into coarse aggregate and used in concrete as partial replacement to the natural coarse aggregate. In this study the plastic aggregate is replaced with coarse aggregate in various percentages i.e. 0%, 10%, 20%, 30% and 40%. In this study check the behavior of concrete has been investigated compressive strength, split tensile strength and flexural strength.

II. OBJECTIVE

A. Use recycled plastic aggregate in concrete mix.
B. Determine combined effect on plastic aggregate and natural aggregate on compressive strength, split tensile strength and flexural strength of concrete.
C. Suggest suitable percentage of plastic aggregate if any.
D. Create healthy environment by utilize plastic.
E. Suggest suitable replacement of plastic aggregate if any.
F. Provide economical construction material.

III.EXPERIMENTAL PROGRAM

The experimental program is planned to cast 105 specimens (45 cube, 45 cylinder and 15 beams) with replacement of plastic aggregate with natural aggregate at various percentage to determine compressive strength, split tensile strength and flexural strength.

A. Material

1) *Cement*- Ordinary Portland cement of 43 grade of having specific gravity of 3.15 was used as per conforming to Specification as per IS 1489:1991
2) *Fine aggregate*- Locally available river sand and Conforming to specification as per IS 383:1970 having specific gravity- 2.6
3) *Coarse aggregate*- Locally available quarried and crushed granite stone conforming to specification as per IS Standards IS 383:1970
4) *Plastic aggregate*- Collected from Telvani having specific gravity 0.99

5) *Water*- Clean drinking water available in the college campus was used for mixing and curing of concrete confirming to IS: 456-2000.

B. Mix Proportion

Mix was calculated as per IS 1026:2009 to obtain M20 grade of concrete. Mix design for M20 grade concrete is carried out as 1:1.38:2.25 with water cement ratio 0.42. The mix proportion for 1cum concrete is given as,

Table No. 01 Quantity of material required for 1cum

Material	Cement	Fine aggregate	Coarse aggregate	Water content
Wt.(in kg)	469	647	1055	197
Ratio	1	1.38	2.25	0.42

C. Mixing, Casting And Curing Of Specimen

1) Mixing- A designed mix ratio of 1:1.38:2.25 was used for concrete. Batching is done by weight and water cement ratio of 0.42 used. Mixing is done by manually.
2) Casting- For casting the cubes, cylinder and beams standard cast iron metal moulds was used. Whole casting procedure is confirmed to IS: 10262-2009.
3) Curing- After castings of specimens are stored in the laboratory for 24 hour at room temperature. After period of 24 hour the specimen are removed from mould and kept in the fresh water of curing tank.

D. Testing

After the age of 7 day, 14 day and 28 day specimen are taken out for testing.

1) *Compressive strength:* Compressive strength are taken on cube size 150mmX150mmX150mm after the period of 7 day, 14 day and 28 days curing. Compressive strength was determined by,

$$F = P/A$$

P= Failure load in compression in KN,

A= Loaded area of cube in mm^2

2) *Split tensile strength:* Split tensile strength taken on cylinder have diameter 150mm and height 300mm after the period of 7 days, 14 days and 28 days curing. Split tensile strength of a cylinder was determined by,

$$FT = 2P/\Pi LD$$

FT= Tensile strength

P= Load at failure in KN,

L= Length of cylinder in m

D= Diameter of cylinder in m

3) *Flexural Strength:* Flexural strength taken on beams of size 150mm X150mm X 700mm after the period of 28 days curing. Flexural strength was determined by,

$$\text{Flexural Strength} = 3PA/BD^2$$

P= Maximum applied load

A= Material span length between points in the test setup;

B= Width of the material specimen;

D= Average depth of the specimen.

IV RESULT AND DISSCUSION

A. *Compressive Strength*

Table No 2. Compressive strength test result

Percentage of PA	Compressive Strength After (N/mm^2)		
	7 Days	14 Days	28 Days
0%	13.09	16.05	25.23
10%	11.02	14.02	23.12
20%	9.52	13.12	21.80
30%	8.90	11.07	20.02
40%	7.80	10.06	18.26

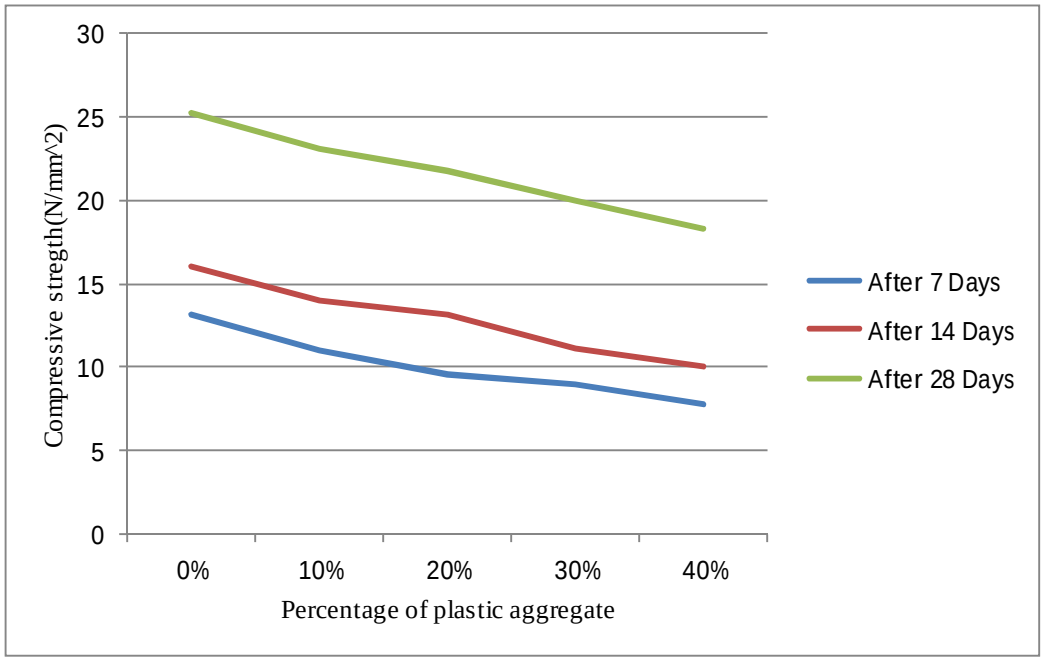

Figure 1. Compressive strength (N/mm^2) vs Percentage of aggregate

From the above result it is observed that the compressive strength of concrete is gradually reduces with increasing percentage of plastic aggregate. For 30% replacement of plastic aggregate the compressive strength is good. Beyond the 30% replacement it is observed that compressive strength reduced.

B. *Split Tensile Strength*

Table No 3 Split tensile strength result

Percentage of PA	Split Tensile Strength After (N/mm^2)		
	7 Days	14 Days	28 Days
0%	2.590	2.775	2.935
10%	1.965	2.510	2.740
20%	1.755	2.180	2.345
30%	1.665	1.970	2.075
40%	1.600	1.820	1.920

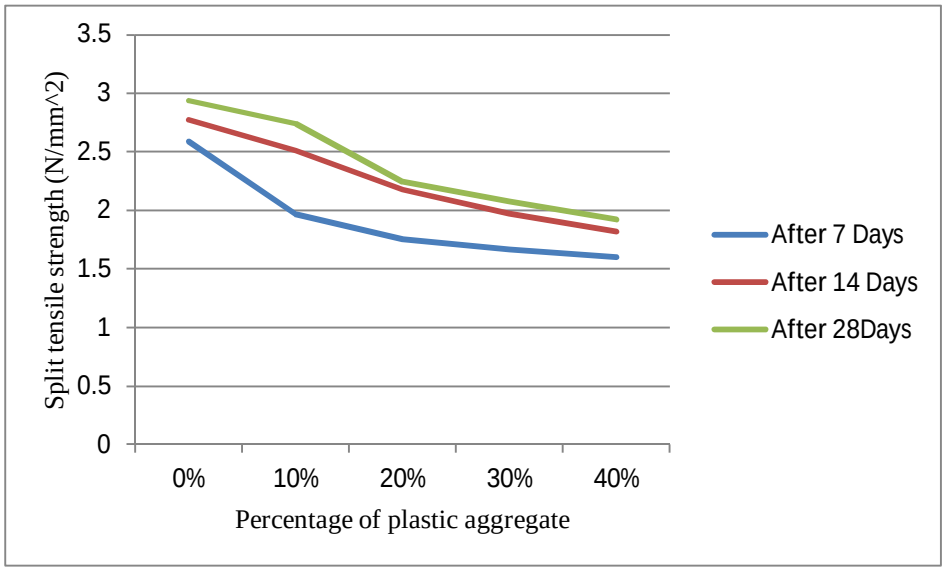

Figure 2 Split tensile strength (N/mm^2) vs Percentage of plastic aggregate

From the above result it is observed that the split tensile strength of concrete is gradually reduces with increasing percentage of plastic aggregate. For 30% replacement of plastic aggregate the compressive strength is good. Beyond the 30% replacement it is observed that split tensile strength reduced.

IV. FLEXURAL STRENGTH

Table No 4 Flexural strength test result

Percentage of PA	Flexural Strength After 28 Days (N/mm^2)
0%	8.170
10%	7.950
20%	7.730
30%	7.640
40%	7.550

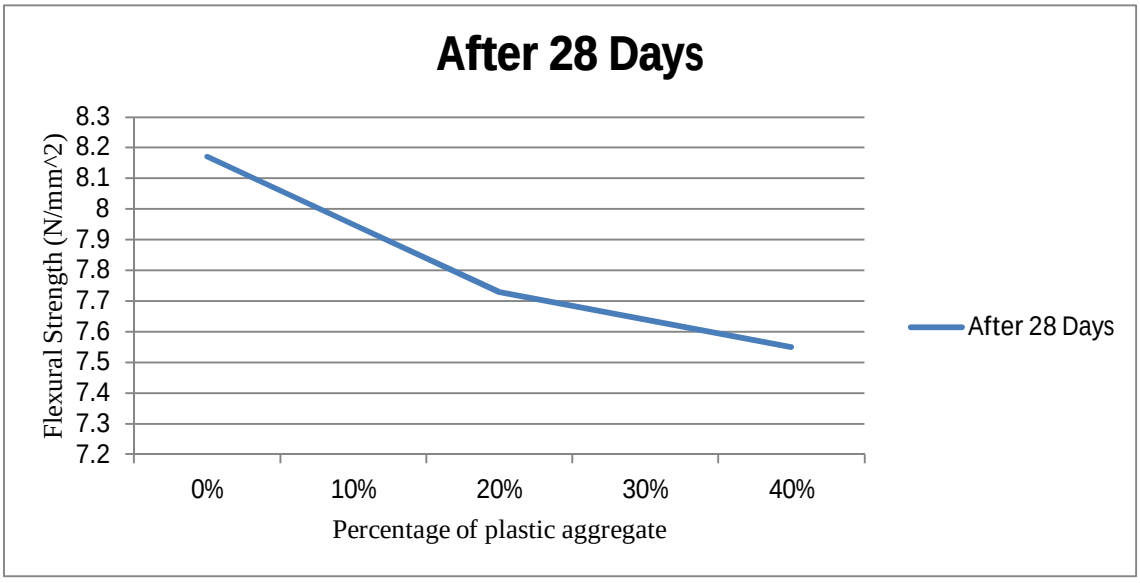

Figure 3 Flexural strength (N/mm^2) vs Percentage of plastic aggregate

From the above result it is observed that the flexural strength of concrete is gradually reduces with increasing percentage of plastic aggregate. For 30% replacement of plastic aggregate the flexural strength is good.

V. CONCLUSION

From the above observation it is possible to use the plastic in concrete mix up to 30% weight of coarse aggregate. concrete showing better strength when replaced plastic up to 30%. Looking in to above aspect we come to the conclusion that plastic can be in cement concrete mix increase the percentage in plastic to decrease the strength of concrete. By using the plastic in concrete mix to reduces the weight of cube, cylinder and beam up to 15%. Increasing recycled plastic aggregate from10% to 30% and then to 40% leads to a decrease in the slump values and the filling ability of the concrete mix. Compressive strength decreased with the increase in recycled plastic content. Reduction in the compressive strength was between 10% and 20% for concrete containing 10–40% recycled plastic aggregate. Splitting tensile strength of concrete made with plastic aggregates was found to decrease with increase in the percentage of plastic aggregates. The splitting tensile strength was found to decrease by 5%, 10%, and 30% for concrete containing 10%, 30%, and 40% plastic aggregates, respectively. Flexural strength decreases as the plastic aggregate content increases. By replacement of 10%, 30%, and 40% of natural aggregate by plastic aggregate, reduction in flexural strength were noticed by 10% to 30%. Lastly, we strongly conclude the use of Recycled plastic aggregate in concrete which is the best option for the disposal of plastic & ultimately reduces the plastic pollution in the Environment.

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