Recycled Plastics and Crushed Rock Powder As Coarse Aggregate and Fine Aggregate in Structural Concrete

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***Abstract* - The use of plastic is increasing day by day, although steps were taken to reduce its consumption. This creates substantial garbage everyday which is unhealthy. A healthy and sustainable reuse of plastics offers a host of advantages. Also because of increase in mining of stone, huge amount of crushed rock powder is released as waste. This waste was examined for various properties with respect to fine aggregates.**

The suitability of recycled plastics as coarse aggregate and crushed rock powder as fine aggregate in concrete are discussed. Tests were conducted to determine the properties of crushed rock powder and plastic coarse aggregate. As 100% replacement of natural coarse aggregate with plastic coarse aggregate is not feasible, partial replacement in various percentage was examined and the natural fine aggregate was replaced by 50 % with the crushed rock powder [3]. The percentage substitution of higher compressive strength was used for determining other properties such as split tensile strength and flexural strength. Higher compressive strength was found up to 20 % natural coarse aggregate replaced concrete.

Key words: crushed rock powder (CRP), plastic coarse aggregate (PCA), natural coarse aggregate (NCA), partial replacement.

I. INTRODUCTION (*HEADING 1*)

Concrete is most widely used man made construction material in the world and its second only to water as the most utilized substance in the planet [1]. Conventionally concrete is a mixture of cement, coarse aggregate and fine aggregate. Seeking aggregates for concrete and to dispose of the waste from various commodities is the present concern. Today, sustainability has got top priority in the construction industry.

The amount of plastic materials consumed annually has been growing steadily due to user friendly properties (low density, strength, durability and low cost) of the materials. The world's annual consumption of plastic material is increasing day by day and hence there is a considerable increase in the generation of plastic waste which is non-degradable and causes a waste disposal crisis in environmental view point. Also because of increase in mining of rocks, huge amount of stone dust is released and the disposal of the same is of great concern.

In the present study the recycled plastic were used as the coarse aggregate and the crushed rock powder was used as fine aggregate, thereby providing a sustainable option to deal with plastic and quarry waste.

II. METHODOLOGY

A. Materials used:

1. *Cement:* Ordinary Portland cement (OPC) 53 grade confirming to IS: 8112 was used.
2. *Fine Aggregate*:
   a. *River sand* confirming to grading zone II as per IS: 383:1970 was used.
   b. *Crushed rock powder* was used to replace the natural river sand by 50%.

TABLE I PROPERTIES OF FINE AGGREGATE

Properties	River sand	Crushed rock powder
Zone	***II***	***II***
Fineness modulus	2.51	3.82
Specific gravity	2.6	2.38
Water absorption (in %)	3.45	1.36

3. *Coarse Aggregate:*
   a. *Natural Coarse Aggregate* (NCA) of size 20mm down was taken for the study.
   b. Recycled Plastic Aggregates(RPA): Plastics collected from the disposal area were sorted to get the superior one. These were crushed into small fraction and washed to remove foreign particles. Then it was heated at particular temperature so that necessary brittleness was obtained. After extrusion, the molten plastic was cooled down and collected in form boulders and were crushed down to size of 20mm aggregates.

TABLE II PROPERTIES OF COARSE AGGREGATE

Properties	NCA	RPA
Impact value (in%)	16.26	1
Specific gravity	2.7	0.96
Water absorption (in %)	2.01	3.45

The mix design was adopted as per IS: 10262:2002 for the concrete mix of *M30* grade using calculated proportions of

cement, fine aggregate and coarse aggregate. The fine aggregate (natural river sand) was replaced 50% by CRP and coarse aggregate was replaced by recycled plastic aggregate at various proportions (10%, 20%, 30% and 40%).

The concrete mix was done by conventional method and specimens were casted (cubes of 150X150X150mm, cylinders of 150mm diameter and 300mm length and prism of 150X150X750mm). The specimens were tested for following properties for 7days and 28 days curing.

- Compressive strength
- Flexural strength
- Split tensile strength

III. RESULTS AND DISCUSSIONS

Tests were conducted on fine aggregates (Natural river sand and CRP) and coarse aggregate (Natural coarse aggregate and RPA) and their properties were determined as shown in tables I and II.

Tests were conducted to determine the compressive strength (Cubes), split tensile strength (Cylinders) and flexural strength (Prism) for 7 days and 28 days of curing and are tabulated in Table III.

TABLE III STRUCTURAL PROPERTIES OF CONCRETE

Particulars	Compressive strength (in Mpa)		Split tensile strength (in Mpa)		Flexural strength (in Mpa)	
Time of curing	*7Days*	*28Days*	*7Days*	*28Days*	*7Days*	*28Days*
Conventional Concrete	28.32	38.10	3.00	3.88	54.67	66.10
10% RPA	25.79	28.70	3.12	3.72	55.85	61.20
20%RPA	30.13	36.27	3.16	3.82	58.09	63.95
30%RPA	29.16	34.13	2.87	2.90	55.35	60.53
40%RPA	23.33	29.30	2.48	2.65	50.99	54.79

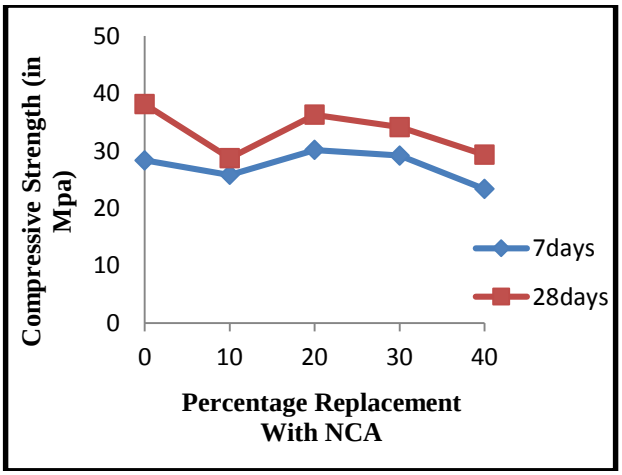

FIG. I: COMPRESSION STRENGTH CURVE

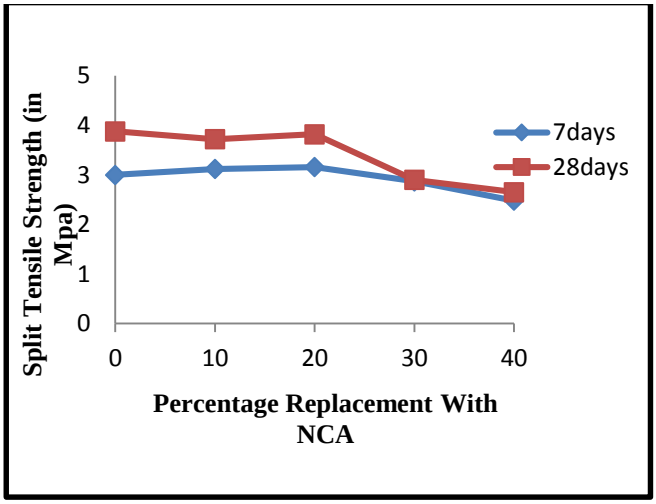

FIG. II: SPLIT TENSILE STRENGTH CURVE

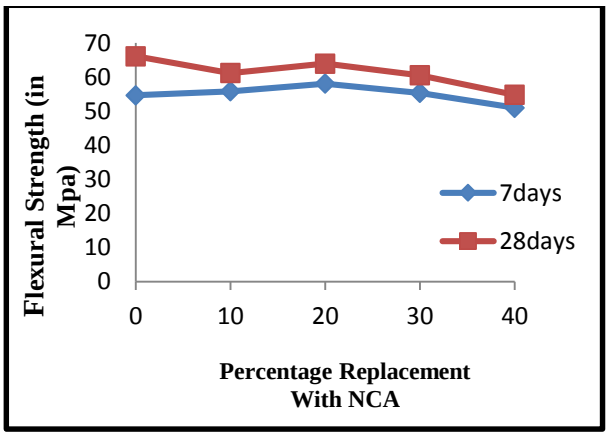

FIG. III: FLEXURAL STRENGTH CURVE

IV. CONCLUSIONS

A pilot study was conducted to determine the suitability of PCA for structural concrete. A percentage replacement of 20% NCA with PCA was found to be of superior concrete compressive strength. With regard to its tensile behaviour the bonding strength of PCA with matrix needs more attention, since PCA concrete has shown a substantial reduction in split tensile strength and flexural strength.

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