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EXPERIMENTAL AND ANALYTICAL STUDY ON CONCRETE WITH PARTIAL REPLACEMENT OF COARSE AGGREGATE BY PLASTIC WASTE

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Abstract - The utilization of waste in a concrete is major attempt in current situation, because of the pollution; there is a great harm to nature and human life. Plastic is chosen to minimize stack piling of waste in environment and to control pollution. Nowadays, in the construction industries, the availability of coarse aggregate is major problem. Thus minimizing the availability of gravel in the making of concrete, many alternatives investigations are carried out. In this research work, the coarse aggregate is partially replaced by 10% and 20% of plastic waste. The cube specimens of size 150mmx150mmx150mm were casted with the various percentage replacements of plastic wastes to determine the compressive strength and developing the linear equation to determine the predicted values using the experimental data set. The concrete mix with 10% partial replacement of coarse aggregate with plastic waste shows higher strength.

Keywords: **compressive strength plastic waste, simple linear regression**

I. INTRODUCTION

Concrete is a major construction materials, which are being used in the construction industry. The various components of concrete includes cement, fine aggregate, coarse aggregate, water and any admixtures. From these, maximum quantity of component used in the concrete is coarse aggregate. Use of the naturally available material like coarse aggregate leads to deplete the natural resources, unless there is a suitable alternative material. Plastic waste material is often used as a partial replacement of coarse aggregate reducing the cost of the construction. Hence, these plastic materials are very harmful, if we dispose in land, such as it affects the

fertility of the soil. If we burn these plastic materials, it releases the CO_2 , which affects the environments.

1.1 Generation of plastics

India generates 25,940 tonne of plastic waste every day. As per estimates by central pollution control board (CPCB), plastic waste generated per year is 660787.85 tonne. The word plastic means substances which have plasticity and accordingly anything formed in a soft state and used in solid state can be called as a plastic. Plastics can be separated into two types namely thermoplastic and thermosetting plastics. The thermoplastic are melted in plastic industry. These plastics are polyethylene, polypropylene, polyamide. The thermosetting plastics is plastic which cannot be melted because of molecular chains are bonded with meshed crosslink. These plastics are phenolic, unsaturated polyester, epoxy resin, silicone. At present these are disposed by burning or burying. Instead of burning or burying, the attempts have been made in used in construction industry

II. LITERATURE REVIEW

The introduction of plastic waste as coarse aggregate can helps in reduction of cost and increases the strength up to some extent. The introduction of plastic waste in concrete make ductile, hence develop the ability of ductility before failure [11].The addition of plastic waste into the concrete by partial replacement of coarse aggregate by 10% shows increases in compressive, tensile and flexural strength [2]. The drop in strength is due to low bond strength between cement paste and aggregate and also due low strength of plastics[10].The workability of concrete mix increases with increasing the percentage replacement of plastic waste [11].The 10%

replacement of E-Plastic waste shows good in compressive strength [1].The addition of plastics in concrete mix helps in reduction of total weight of concrete [11].The reduction of total weight is more advantages, which helps in reduction of materials like reinforcements; etc.

III. MATERIAL USED

Cement: The OPC 53 grade is used in the research work conforming to IS: 12269:1987. the specific gravity of cement is 3.15 and standard consistency of 29% and initial setting time of 30 minutes and final setting timer of 600 minutes.

Fine aggregate: Natural sand of size which passing the 4.75mm sieve is taken for research work. The specific gravity of fine aggregate is 2.65. The fine aggregate is corresponds to zone-II. The unit weight of fine aggregate is 1622 kg/m³. The fineness modulus of fine aggregate is 2.9.

Coarse Aggregate: The coarse aggregate is a crushed angular which was passing in 20mm sieve is used in the research work. The specific gravity of fine aggregate is 2.7. The unit weight of fine aggregate is 1800 kg/m³. The fineness modulus of coarse aggregate is 6.5.

Water: The portable water which is free from deleterious materials with ph of 7.

Super plasticizer: The super plasticizer is used to impart workability to concrete, because the addition of fiber affects the workability of concrete. The poly carboxylic ether form of super plasticizer named CONXL PCE DM-09 is used at 0.6% by weight of cement.

Plastic Waste: The crushed plastic waste which passing on 20mm sieve and retained on 4.75mm sieve are taken and used in this research work. The fineness modulus of plastic waste is 6.9.

IV. METHODOLOGY

4.1 Mix Design

The mix design can be done as per IS-10262:2009 for M20 Grade Concrete.The mix proportion was found to be 1:1.86:2.89 with water-cement ratio as 0.40.

Table: 1 Mix proportion for various concrete mixes

% of Plastic Waste	Cement (Kg/m ³)	Fine Aggregate (Kg/m ³)	Coarse Aggregate (Kg/m ³)	Plastic waste (Kg/m ³)	Water (gm/m ³)	Super Plasticizer (gm/m ³)
0	400	746	1156	-	160	2.4
10	400	746	1040.4	115.6	160	2.4
20	400	746	924.8	231.2	160	2.4

4.2 Casting of specimen

The concrete mix is mixed with the partial replacement of coarse aggregate with 0%, 10% and 20% of plastic waste. Then cement and fine aggregate is mixed initially, followed by addition of coarse aggregate and plastic waste. After this, super plasticizer is added in the required quantity of water. Now, the super plasticizer mixed in the water is added into the concrete. The concrete mix is filled in mould in 3 layers. Each layer is tamped by 25 blows.



Fig: 1 Cube Test Specimen

4.3 Testing of specimens: The test can be performed as per IS: 516-1959.The compressive strength of concrete was in determined by using universal testing machine. The three specimen of cube with the size of 150x150x150mm were tested for 7, 14 and 28 days of curing. Average compressive strength of concrete at each age was determined by taking the average of three specimens. The compressive strength can be computed by using the formulae;

Compressive strength= P/A

P= Load at failure of specimen in N.

A=Surface area of specimen in mm^2



Figure: 1 Compressive Strength Testing

V. RESULTS

The results are obtained by testing the test specimen in the universal testing. Three samples are tested for 0%, 10% and 20% replacement of plastic waste at 7, 14 and 28 days of curing. The average values of three samples are taken and presented below,

Table: 2 Compressive Strength for 0% Replacement of Plastic Waste at 7 Days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0%-7D - S1	512	22.72	22.5
0%-7D - S2	500	22.2	
0%-7D - S3	510	22.6	

Table: 3 Compressive Strength for 0% Replacement of Plastic Waste at 14 Days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0%-14D - S1	560	24.88	24.9
0%-14D - S2	555	24.66	
0%-14D - S3	568	25.24	

Table: 4 Compressive Strength for 0% Replacement of Plastic Waste at 28 Days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0%-28D - S1	668	29.68	29.6
0%-28D - S2	668	29.68	
0%-28D - S3	665	29.5	

Table: 5 Compressive Strength for 10% Replacement of Plastic Waste at 7 Days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
10%-7D - S1	568	25.24	25.5
10%-7D - S2	569	25.29	
10%-7D - S3	584	25.96	



Table: 6 Compressive Strength for 10% Replacement of Plastic Waste at 14 Days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm ²)	Average Compressive Strength (N/mm ²)
10%-14D -S1	624	27.73	27.42
10%-14D -S2	601	26.71	
10%-14D -S3	626	27.82	

Table: 7 Compressive Strength for 10% Replacement of Plastic Waste at 28 Days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm ²)	Average Compressive Strength (N/mm ²)
10%-14D -S1	698	31.02	31.24
10%-14D -S2	688	30.58	
10%-14D -S3	723	32.13	

Table: 8 Compressive Strength for 20% Replacement of Plastic Waste at 7 days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm ²)	Average Compressive Strength (N/mm ²)
20%-7D -S1	352	15.64	16.09
20%-7D -S2	372	16.53	
20%-7D -S3	362	16.09	

Table: 9 Compressive Strength for 20% Replacement of Plastic Waste at 14 days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm ²)	Average Compressive Strength (N/mm ²)
20%-14D -S1	524	23.29	23.27
20%-14D -S2	498	21.73	
20%-14D -S3	558	24.80	

Table: 10 Compressive Strength for 20% Replacement of Plastic Waste at 28 days

Specimen Id	Load at Failure (kN)	Compressive Strength (N/mm ²)	Average Compressive Strength (N/mm ²)
20%-28D -S1	650	28.88	28.8
20%-28D -S2	645	28.66	
20%-28D -S3	650	28.88	

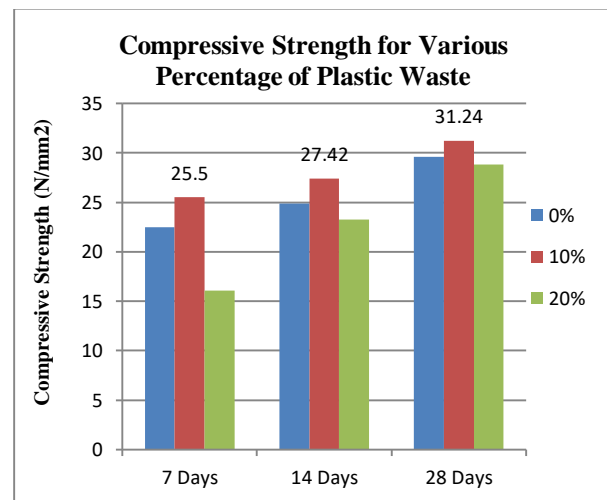


Fig: 2 Compressive Strength Vs % Replacement of Plastic Waste

6. Statistical Evaluation of results

The simple linear regression was utilized to obtain the compressive strength results for the



various partial replacement of coarse aggregate with the plastic wastes. The simple linear regression can be carried by considering the percentage replacement of coarse aggregate as independent variable and the compressive results as dependent variables. The equation obtained from the linear regression is,

$$y = -4x + 30.28 \quad \text{-equation (1)}$$

where y is the dependent variable and x is the independent variable.

With reference to the experimental results, the equation (1) can be used to determine the compressive strength for the various percentage replacement of coarse aggregate by the plastic waste concrete. The errors in predicted values is caused by the numerous reasons like physical and chemical composition of cement, aggregate, water, methods of mixing, placing and properties of plastics used.

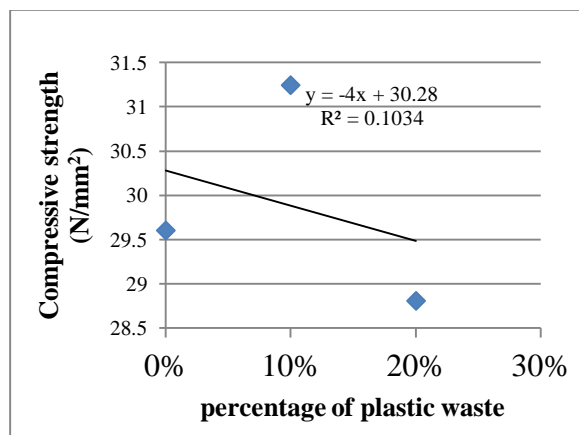


Fig: 3 Linear regression sketch

VI. CONCLUSIONS

- The addition of crushed plastic waste shows increases the compressive strength up to 10%, after 10% replacement of coarse aggregate with plastic waste show decrease in the compressive strength. These decreases of compressive strength is due to quantity of cement paste between the plastic waste is low, because the plastic waste occupies more spaces in the concrete mix, as percentage replacement increases.
- The Compressive strength increases from 0% to 10% replacement of coarse aggregate with plastic waste.
- The compressive strength decreases from 10% to 20% replacement of coarse aggregate with plastic waste.

- The optimum percentage replacement of coarse aggregate with plastic waste is to be 10%.
- The maximum percentage increase in compressive strength is 40%.
- The maximum percentage decrease in compressive strength is 8%.
- The simpler linear regression equation shows that there is good relation between the experimental and the predicted values.

VII. LIMITATIONS

In these proposed investigation, the simple linear equation gives the correlation of good. However, increasing the number of the variables the accuracy of prediction will increases.

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