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Strength and Density Characteristics of Light Weight Concrete by Using HDPE Plastic Waste

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***Abstract:** Quantities of polymer wastes have been increased these recent years due to the boost in industrialization and the rapid improvement in the standard of living. Most of polymer wastes is abandoned and not recycled. This situation causes serious problems such as wastage of natural resources and environmental pollution. Polymer products such as synthetic fibers, plastics and rubber belong to petrochemical compound and uneasily degrade in the natural environment. Plastic materials are not easily biodegradable even after a long period. In fact wide variety of waste materials can be utilized as inert in cement matrix. In this paper, T.V plastics are used as polymer wastes High Density Polyethylene (HDPE) for preparation of the polymer concrete (PC). The aim of this experimental work is to study the properties and characterization of polymer HDPE concrete (M20) with partial replacement of coarse aggregate. Utilization of waste materials and byproducts is a partial solution to environmental and ecological problems. Use of these materials 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.*
***Key words:** High Density Polyethylene (HDPE), Compression test.*

I. INTRODUCTION

Research concerning the use of by-products to augment the properties of concrete has been going on for many years. The potential applications of industry by-products in concrete are as partial aggregate replacement or as partial cement replacement, depending on their chemical composition and grain size. The use of these materials in concrete comes from the environmental constraints in the safe disposal of these products [1]. Plastic is everywhere in today's life style .It is used for packaging, protecting, serving, and even disposing of all kinds of consumer goods. With the industrial revolution, mass production of goods started and plastic seemed to be cheaper and effective raw material .Today ,every vital sector of the economy starting from agriculture to packing ,automobile, building construction, communication or info tech has been virtually revolutionized by the applications of plastic[2,3]. Use of these non-biodegradable (according to recent studies, plastics can stay unchanged for as long as 4500 years on earth) product is growing rapidly and the problem is what to do with plastic-waste. Big attention is being focused on the environment and safeguarding of natural resources and recycling of wastes materials. Actually many industries are producing a significant number of products which incorporate scrap (residues). In the last 20 years, a lot of works concerning the use of several kinds of urban wastes in building materials industrials process have been published. Many researchers have been extended to study new kinds of wastes to investigate deeply particular aspects. The addition of wastes, apart from the environmental benefits, also produces good effects on the properties of final products [4,5]. One of the new waste materials used in the concrete industry is recycled plastic. For solving the disposal of large amount of recycled plastic material, reuse of plastic in concrete industry is considered as the most feasible application. Recycled plastic can be used as coarse aggregate in concrete. However, it is important to underline that re-using of wastes is not yet economically advantageous, due to the high costs of transport and its effect on the total costs of production. Moreover, it is important not to neglect other costs, directly referable to the kind of wastes, due, in particular, to the need of measuring gas emission, during firing, and the presence of toxic and polluting elements[6,7].

A. *Materials used in the present study*

1) *Cement:* Ordinary Portland cement Zuari-53 grade conforming to IS: 12269-1987 [6] were used in concrete. The physical properties of the cement are listed in Table 1.

Table 1. Physical Properties of Zuari-53 Grade Cement

Sl. No.	1	2	3	4	5		
Properties	Specific gravity	Normal consistency	Initial setting time	Final setting time	Compressive strength (Mpa)		
Values	3.15	32%	60 min	320 min	3 days	7 days	28days
					29.4	44.8	56.5

2) *Aggregates:* A crushed granite rock with a maximum size of 20mm with specific gravity of 2.60 was used as a coarse aggregate. Natural sand from Swarnamukhi River in Srikalahasthi with specific gravity of 2.60 was used as fine aggregate conforming to zone-II of IS 383-1970 [7]. The individual aggregates were blended to get the desired combined grading.
3) *Water:* Potable water was used for mixing and curing of concrete cubes.
4) *HDPE:* HDPE was adopted to be the replacement material .This is because of easy availability of this material, its density and its workability. Development of concrete with non-conventional aggregate such as polystyrene foam wastes, HDPE, PET and others

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plastic were used in concrete to improve the properties of the concrete and reduce cost. By using these plastic wastes in concrete its will lead to sustain the concrete design and greener the environments.

Fig 1 HDPE

The sieve analysis is carried out for the hdpe to find out its fineness modulus. The results are listed in Table 2

Table 2 Sieve ananlysis of HDPE

S.No.	Sieve No.	Mass Retained (gms)	%Retained	% Passing	Cumulative % Retained
1	20 mm	0	0	100	0
2	12.5 mm	292.5	21.35	78.65	21.35
3	10 mm	398	29.06	70.94	50.41
4	5.6 mm	510	37.23	62.77	87.64
5	PAN	169	12.34	87.66	99.98

Fineness Modulus of bigger sized HDPE aggregate = 7.59

B. Mix Proportioning

For making the mixes containing plastics, the amount of plastics is calculated by using the specific gravity of plastics, in place of the specific gravity of coarse aggregates. The resultant mix proportions of M20grade controlled concrete and Different replacement levels of HDPE plastic waste of all the mixes are tabulated in Table 3 & Table 4.

Table 3 Mix Proportion for M20 Concrete

	Cement	Fine Aggregate	Coarse aggregate	water
Composition in Kg/m^3	383	664.04	1090.74	196.1
Ratio in %	1	1.74	2.8	0.5

Table 4 Different replacement levels of HDPE plastic waste

Parameter	Different replacement levels of HDPE plastic waste				
	Control Mix	5% (MIX 1)	10% (MIX 2)	15% (MIX 3)	20% (MIX 4)
W/C Ratio	0.50	0.50	0.50	0.50	0.50
Water Kg/m^3	196.1	196.1	196.1	196.1	196.1
Cement Kg/m^3	383	383	383	383	383
Fine Aggregates Kg/m^3	664.04	664.04	664.04	664.04	664.04
Coarse Aggregates Kg/m^3	1090.74	1036.203	981.666	927.129	872.592
Plastics Kg/m^3	0	54.537	109.074	163.611	218.148
Mix Proportions (C:FA:CA:P)	1 : 1.74:2.8:0	1 : 1.74: 2.66:0.14	1 : 1.74: 2.52:0.28	1 : 0.716: 2.38:0.42	1 :2.24:0.56

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II. RESULTS AND DISCUSSIONS

A. Dry Density

The dry density is measured for the cubes taken from the curing tank, just prior to compressive strength test. The value of dry densities obtained for the control mixes and for plastic concrete is shown in Table 5. It is found from the testing that the unit weight of there is considerable decrease in unit weight when compared with the control concrete without plastic replacement. Water cement ratio does not affect the unit weight that much but the quantity of plastic as aggregates can reduce the unit weight of concrete considerably. It is found that the plastics replaced with concrete reduces the unit weight of concrete and can be used as light weight concrete. For the accuracy of the results the minimum three samples of the control concrete and three samples of plastic replaced concrete were casted and tested and average of three are taken for the accuracy of results. The results of unit weight of control and plastic replaced concrete are shown in Table 5. In order to compare the effect of plastics with normal aggregates, the percentage reduction in the unit weight of concrete achieved by using plastics as aggregates is found and is presented in Table 5. It can be seen from the Table that with the use of plastics, the dry density is reduced for all mixes, at 0.50 water-cement ratio. The density is reduced for all the mixes.

B. Compressive Strength

The compressive strength test results for controlled concrete and different trial mixes were shown in Table 5. The tests were carried out as per IS: 516-1959. The 150mm cubes of various concrete mixtures were cast to test compressive strength.The bar charts of compressive strength results for 7,21and 28 days are presented in Fig 2 also the dry density for various trial mixes are indicated in Fig 3.

Table 5. Compressive strength and Density test results of various Mix proportions

HDPE replacement levels	Compressive strength N/mm^2			Density kg/m^3
	7 DAYS	21 DAYS	28 DAYS	
Controlled Mix	16.4	18.47	21.66	2366
MIX 1	17.88	19.56	23.67	2342
MIX 2	17.49	18.98	22.12	2301
MIX 3	13.67	15.78	19.56	2296
MIX 4	10.54	14.1	17.78	2290

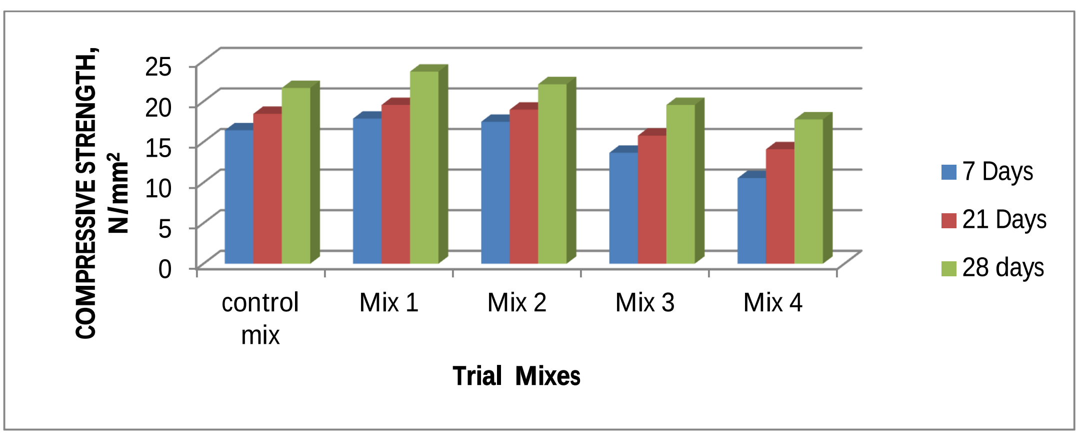

Fig 2 Variation of Compressive Strength at different Percentage replacements of HDPE

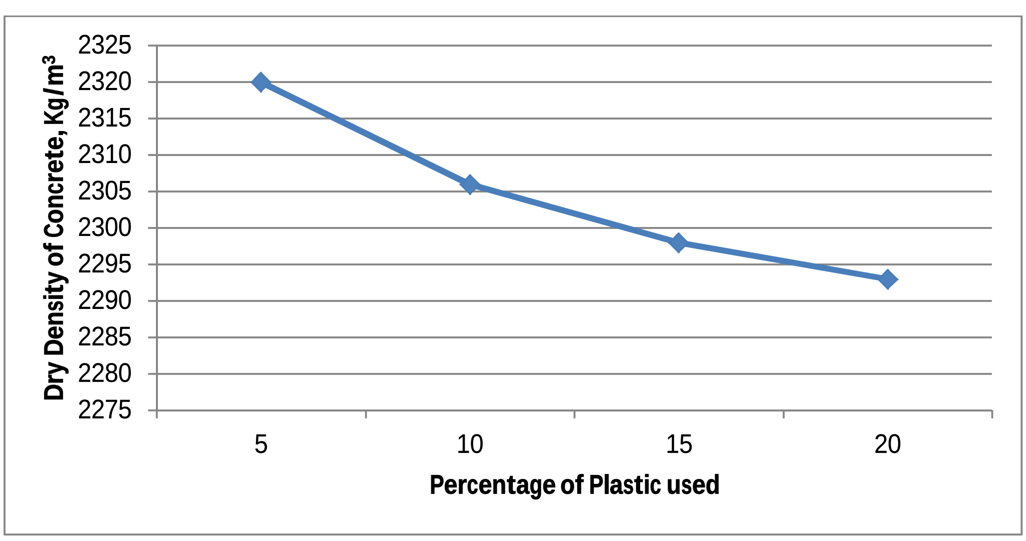

Fig 3 Percentage of Plastic used vs Dry Density (Kg/m^3)

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III. CONCLUSIONS

A. HDPE can be used to as partial replacement of coarse aggregate in developing concrete mixture. By making use of these aggregates the overall unit weight of the concrete may be substantially reduced.
B. It is observed that there is increase in the compressive strength and density of concrete compared with the conventional concrete at 5 % replacement. But with 10% to 20% HDPE plastic replacement there is gradual variation in the decreasing of density and compressive strength.
C. So the experimental study reveals that 5 % of hdpe may be partially replaced with coarse aggregate in making concrete.
D. The lightweight concrete can be found suitable in applications requiring non-bearing lightweight concrete, such as concrete panels.

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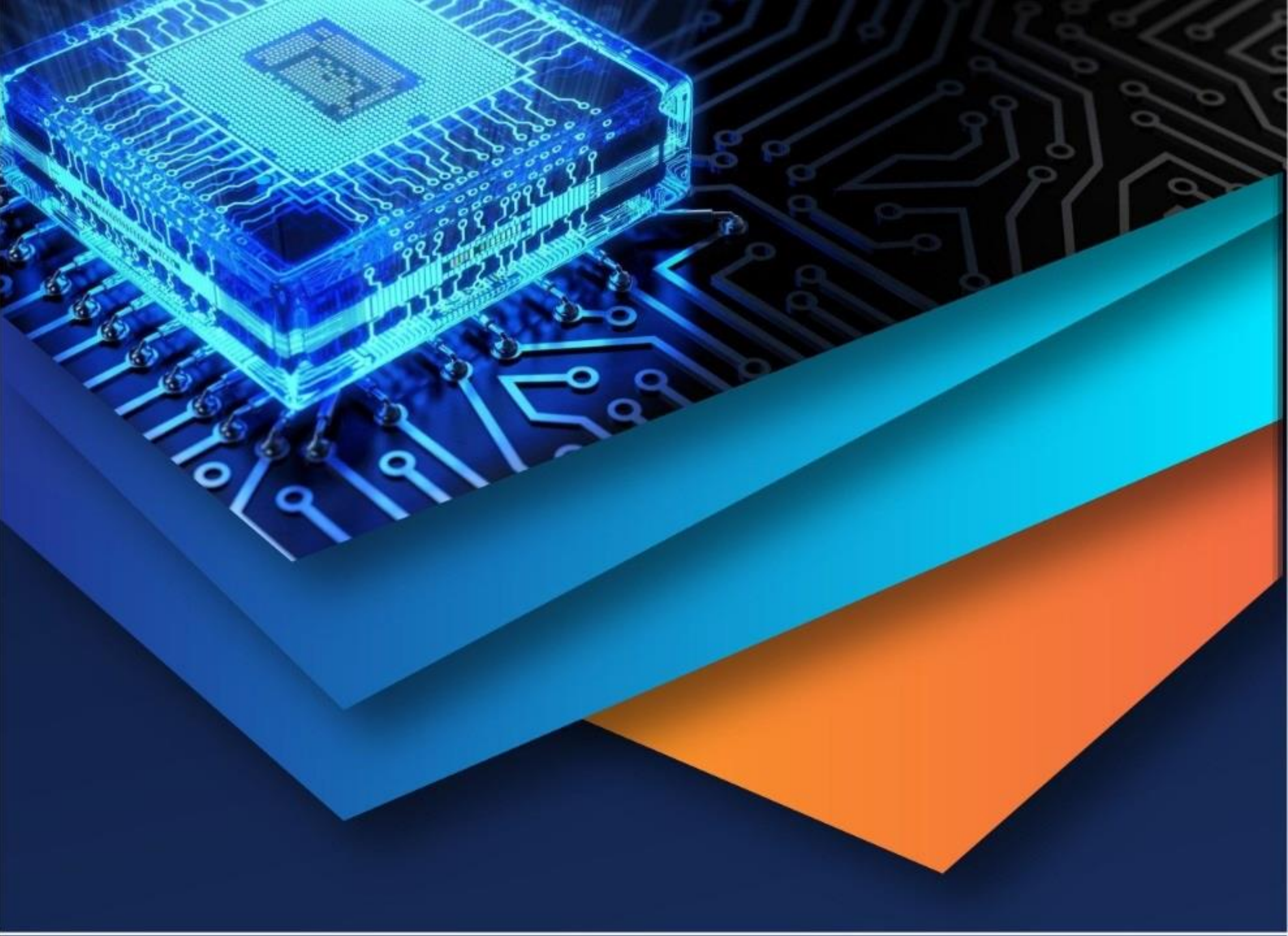

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