Hand Made Plastic Aggregates in Concrete

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Abstract—**In this work, plastic waste is considered for to check suitability in concrete by partial replacement to the naturally available granite coarse aggregates. Plastic wastes like polythene covers which are used as carry bag of less than 40 micron thickness were collected from garbage and are subjected to heating but not melting completely (temperature around 450° C to 600° C for a period of 3 to 5 seconds) and reshaping them to aggregates of size approximately 10mm were used as Hand Made Plastic Aggregates (HMPA) for partial replacement to natural granite coarse aggregates. These HMPA, were used in the controlled concrete mix of 30MPa and tested for compressive strength, split tensile strength, shear strength, flexural strength and impact energy. The experimental results shows that normal values up to 10% replacement of HMPA to natural granite coarse aggregates and beyond this strength properties got reduced gradually. Light weight concrete can also produced since, the density of HMPA were varies from 500 kg per cubic meter to 600kg per cubic meter, where as natural granite coarse aggregates were approximately 1730 kg per cubic meter.**

Keywords-Concrete;Hand Made Plastic Aggregates (HMPA); Natural Granite Coarse aggregate(NGCA);

1. INTRODUCTION

The present major problem in the environment is the plastic waste generation and its reuse with proper collection methods, separation and disposing it without affecting human beings and animals. In India, approximately 12 million tones plastic products are consumed every year and which is expected to rise further and also about 50% to 60% of its consumptions is converted in to waste [1]. The government has taking up so many steps to adopt standard methodologies to minimize the waste generation that is from the beginning of its source to proper disposal through Plastic Waste Management (PWM) system. In Karnataka about 2996 plastic industries producing about 600 metric tons of plastic per day and generates plastic wastes of 28 tons/day.

From past one decade, plastic waste became major issues in terms of collecting, separating and reusing it. Since use of plastic from industries to house hold purposes as containers to store items and up to a package to food items [2] and hence it is very difficult to segregate from other type of organic waste because of its non biodegradable property. Plastic waste that is Plastic wastes like polythene covers used as a carry bags of less than 40 micron were collected from garbage and were changed to HMPA. Because of its lower density, less porosity, similarities in shape like natural aggregates, no crushing surface HMPA were considered to be use in concrete as a partial replacement to natural granite coarse aggregates.

Some of the literatures were explained the use of waste plastic in concrete like, concrete produced by mixing at partial replacement of plastic aggregates that is plastic waste aggregates are resulted from shredding (cut in to small pieces) used pet bottles and are of three types a,b,c based on their size and concrete produced by 7.5% replacement and 15% replacement to natural aggregates these 7.5% and 15% are replaced by three different types of plastic as categorized based on the shapes that is lamellar (Pc), irregular (Pf) and regular cylindrical granular (Pp) shaped aggregates are maintained nearer to target strength of concrete made by natural aggregates only. This research is about the study of curing conditions on the mechanical performance of concrete with the replacement of plastic aggregates to the natural aggregates [3].

To minimize the plastic waste in the environment another test conducted by the Fahed K Alqhatani [4] and other three, the research work based on the plastic waste of the type manufactured by mixing 30% of recycled plastic and 70% of red dune sand filter, these two proportions mixed homogeneously and followed by compressing and heating the mix using compression molding press techniques to turn it in to solid sheets or slabs, which were used then manufactured plastic aggregates. Test conducted at a minimum slump of 100mm and a minimum compressive strength of 30MPa, replaced the plastic aggregates so obtained at a replacement level to 25, 50, 75 and 100%. This paper concludes slump values decreased by 11% to 23% (25mm-50mm) compared to light weight aggregates concrete with the increase in replacement level from 25 to 100%. The influence of replacement level on the fresh, hardened and microstructure properties of concrete was investigated. Here, compressive strength decreases with increase in replacement plastic aggregates.

Another study by F. Iucolano, B. Liguori D. Caputo, F. Colangelo, R. Cioffi [5] on waste plastic to be utilized in concrete that is as a fine aggregates replacement. Tests conducted on the effect of recycled plastic aggregates on the Chemico-Physical and functional properties of manufactured hydraulic composite mortars. Tests have been conducted on density, porosity, compressive and flexural behavior and water vapor permeability. Here fine aggregates are the plastic waste, which has been manufactured at the industry and supplied with the standard fraction of particle size and with some chemical composition.

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2. MATERIALS AND METHODOLOGY

2.1 Hand Made Plastic Aggregates (HMPA)

Polythene carry bags disposed in the environment as a waste were collected and separated of less than 40 micron thickness, cleaned to removed dust and dirt, further cut to smaller size, then it has been carried to burning flame of approximately 600ºC . Care should be taken such that plastic should not reach melting point. When the plastic is taken towards burning flame, it will get shrink to small size and by that time immediately it should compressed by hand with the help of thick cotton cloth to the required shape. Figure 2.1 shows collected waste plastic from garbage, figure 2.2 shows HMPA. Table 2.1 shows the physical properties of HMPA. Figure 2.3 shows that because of lesser density HMPA were floating on water.

2.2 Concrete Ingredients:

Here, river sand confirmed to zone-II as fine aggregates, granite stones as a coarse aggregates of max size 12mm, OPC 43 grade cement and potable water used for making concrete. Table 2.2 shows the physical properties of concrete ingredients.

Test specimens were casted with HMPA by M30 grade concrete as per IS 10262-2009 for 0%, 5% and 10% replacement to natural granite coarse aggregates. The tests were conducted for compressive strength, split tensile strength, shear strength, flexural strength and for impact strength on cylindrical samples of size 150 dia and 60mm depth.

Figure 2.1: Waste plastic collected from garbage

Figure 2.2: HMPA

Figure 2.3: HMPA floating on pycnometere.

Figure 2.4: HMPA on tested beam samples


Figure 2.5: HMPA on cube samples.


Figure 2.6: HMPA on shear samples.


Figure 2.7: HMPA on cylinder samples.


Figure 2.8: HMPA on tested impact samples.

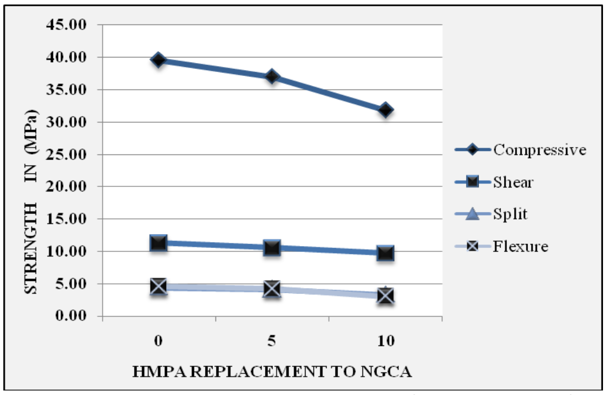

Figure 2.9: compressive, shear, split tensilee and flexural strength of M30 grade concrete.

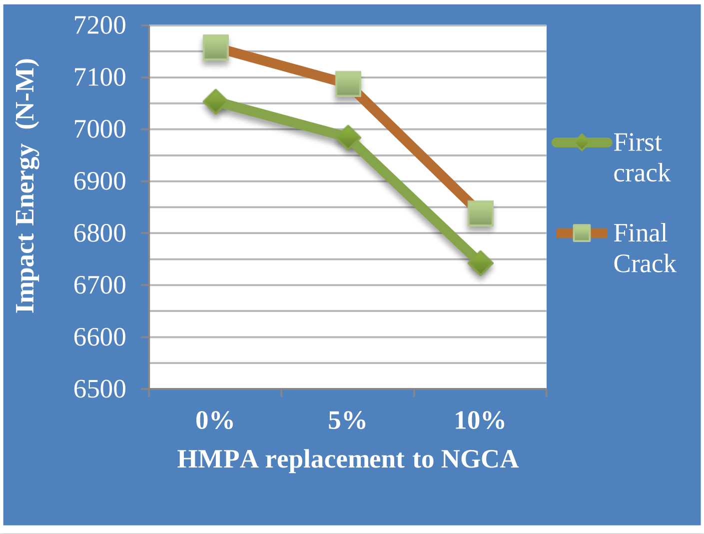

Figure 2.10: Impact load carried by M30 grade concrete.

Table-2.1: Physical properties of HMPA

Sl. No.	Test	Results
1	Specific gravity	0.79
2	Bulk density	500 to 600 Kg/Cum
3	Sieve analysis	20mm passing and 10mm retaining

Table-2.2: Physical properties of concrete ingredients.

Sl. No.	Materials	Properties	Test values
1	Cement	Grade & Brand	43Grade, Ultratech
2		Specific Gravity	3.15
3		Standard consistency	34 %
4		Initial setting time	80 minutes
5		Final setting time	480 minutes
6		Bulk density	1431 Kg/Cum
7	Fine Aggregates	Natural river sand	Zone-II
8		Bulk density	1750 Kg/Cum
9		Water absorption	1 %
10	Coarse Aggregates	Natural granite aggregates	
11		Bulk density	1730 Kg/Cum
12		Water absorption	0.7 %

Table-2.3: 28days test results for Compressive, Shear, Cylinders and Flexural members.

Sl. No.	Test	Percentage replacement of HMPA to NGCA	Result in MPa
1	Compressive strength	0	39.53
2		5	37.03
3		10	31.85
4	Shear strength	0	10.55
5		5	11.11
6		10	10.27
7	Split tensile strength of cylinders	0	4.4
8		5	4.1
9		10	3.29
10	Flexural strength of beam	0	4.58
11		5	4.2
12		10	3.06

Table-2.4: 28 days test results for Impact Specimen.

Sl. No.	First crack		Final crack	
	% replacement of HMPA to NGCA	Impact load in N-M	% replacement of HMPA to NGCA	Impact load in N-M
1	0	7054	0	7158
2	5	6985	5	7088
3	10	6743	10	6839

Table 2.3 shows 28 days test results for compressive strength of cube specimen, shear strength, split tensile strength of cylinders and flexural strength of beam members. Table 2.4 shows impact test results on impact specimens.

Figure 2.4 shows HMPA on tested beam samples, figure 2.5 shows HMPA on tested cube samples, figure 2.6 shows HMPA on tested shear samples, figure 2.7 shows HMPA on cylinder samples and figure 2.8 shows HMPA on impact samples. HMPA can be seen in figures 2.4 to 2.8 within the concrete mass of tested member and which has been highlighted with black circular portion. Figure 2.9 shows that combined graph for the obtained compressive strength, shear strength, split tensile strength and flexural strength of beam member. Here we can observe that split tensile strength and flexural strength were almost similar and hence the profile got almost overlap each other. Figure 2.10 shows tested impact samples on 30MPa concrete for to check first crack and final crack on the samples.

3. RESULTS AND DISCUSSION

Table 2.3, table 2.4 and for the same figure 2.9 and figure 2.10 shows the testing values corresponding to 0%, 5% and 10% HMPA replacements. It has been observed that up to 10% replacement, strength is almost near to nominal concrete but beyond 10% it shows decreasing rate of compressive strength that is 39.53MPa, 37.03MPa & 31.85MPa respectively. Split tensile strength shows almost gradual decrease of strength from 4.4MPa to 3.29MPa. Shear strength of concrete does not show much variation, that is 10.55MPa, 11.11MPa and 10.27MPa. Split tensile and flexural strength values were almost similar to each other. Flexural strength calculated on beam specimens by two point loading methods, here concrete shows almost gradual decrease in its flexural strength from 4.58MPa, 4.2MPa and 3.06MPa. Impact energy of the specimen when subjected to number of blows to see the first crack and final crack. Here also from 0% to 5% impact energy carried by concrete is just variable but from 5% to 10% it shows much decrease in carrying impact energy.

4. CONCLUSION

Waste plastic as a HMPA can be used up to 10% replacement to natural granite coarse aggregate in concrete. This plastic waste helps in reusing in concrete to avoid difficulties in recycling of plastic, difficulties in proper collection and disposing of waste plastic, helps to avoid death of cattle's by eating plastic covers at garbage yards and finally keeps the environment safe by reusing plastic waste. Light weight concrete can be made as the lesser density of plastic aggregates.

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