UTILIZATION OF PULVERIZED PLASTIC IN CEMENT CONCRETE AS FINE AGGREGATE

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Abstract

Disposal of used Plastics is a major problem in the present era, as the usage of plastics is growing day by day and it takes hundreds of years for plastic material to degrade. So effective ways to recycle & reuse of plastics are being formulated. According to their composition, plastics have been classified into seven types each having their own recycle rate. One such type HDPE (High Density Polyethylene) was taken into consideration as it was easily available & had higher density than other types. The used plastics were collected , ground into smaller components , melted & pulverized in order to get granules of plastic of about 1mm size. The density of the Pulverized plastic was found to be 460 kg/m^3 & its specific gravity was 0.46. Sieve analyses were carried out & about 75% of the plastics were found to be in the range of 1 -1.7mm. 45 nos. of 15cm x15cm x15cm cement concrete Cubes of 1:1:2 (M 25) mix were cast for 0% ,25% , 50% , 75% , 100 % sand being replaced with Pulverized plastic material. Volumetric proportioning was adopted instead of design mix since the density of plastic material was too low. Workability test, weight and compressive strength of the cubes were determined.

The test results revealed that the yield as well as the ultimate strength of concrete at seventh day decreased by about 3 to 3.2 N/mm^2 for 25%replacement & 4 to 6.5 N/mm^2 for higher replacements of Plastic when compared to conventional concrete The ultimate as well as the yield strength of concrete at 14th day & 28th day decreased by about 0.2 to 1 N/mm^{2}for 25%replacement & 9.1 to 14.6 N/mm^2 for higher replacements of Plastic when compared to conventional concrete The water Cement ratio was also found to increase with the proportion of Plastics for a slump of 10 mm & weight of the cube decreased with an increase in replacement of Sand by Plastic Material. Thus it is inferred that Replacement of sand by plastic up to 25% can be adopted so that disposal of used plastic can be done as well the deficiency of Natural aggregates can be managed effectively.

Index Terms: *Plastic Concrete, Replacement of Fine aggregates, waste plastics, and Pulverized Plastics in Concrete etc…*

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1. INTRODUCTION

Due to rapid industrialization & urbanization in the Country, lots of infrastructure developments are taking place. This process has in turn led questions to mankind to solve the problems generated by this growth. The problems defined are acute shortage of constructional materials, increased dumping of waste products. Hence in order to overcome the above said problems waste products should be employed as construction material. Fine aggregates used in cement concrete is replaced by fine crushed plastics in known percentages and the optimum percentage at which higher strength is obtained is being calculated.

In this investigation, we made the comparison of yield strength as well as ultimate strength for conventional concrete and concrete containing plastics at 7, 14, 28 days respectively. M25 grade concrete is chosen for the investigation. An attempt is made to find the optimum sand replacement by pulverized plastic in concrete.

2. TESTING PROGRAMME

In the present study, the various tests on material such as cement, sand, coarse aggregates and plastic wastes are performed as per the relevant IS Codes wherever available.

2.1 Materials Used:

2.1.1 Cement, Coarse aggregate & Fine aggregate

For the preparation of concrete 53grade OPC cement confining to requirements of IS 12269-1987 , Coarse aggregate of MSA 10 and 20 mm confining to requirements of IS 383-1970, locally available sand(fine aggregates) of zone III as per IS 383-1970 and Pulverized Plastics were used.

The materials were tested according to IS procedures to ascertain their properties. Consistency, setting time, fineness, Sp. Gravity tests were performed on cement and specific gravity, water absorption, sieve analysis tests were conducted on coarse aggregate .The test result is tabulated below.

Table -1: Properties of cement

S.No.	Characteristics	Values obtained	Standard value
1	Normal consistency	34%	-
2	Initial setting time (minutes)	48 min.	Not less than 30
3	Final setting time (minutes)	240 min.	Not greater than 600
4	Fineness (%)	3.5 %	<10
5	Specific gravity	3.15	-

Table -2: Properties of Coarse Aggregate

S.No.	Characteristics	Value
1	Type	Uncrushed (natural)
2	Specific gravity	2.68
3	Total water absorption	1.02 %
4	Moisture content	0.16 %
5	Net water absorption	0.86 %
6	Fineness modulus	2.507
7	Grading zone	III

Table -3: Properties of Fine Aggregate

S.No.	Characteristics	Value
1	Type	Crushed
2	Maximum size	20 mm
3	Specific gravity for 10 mm	2.704
4	Specific gravity for 20 mm	2.825
5	Total water absorption for 10 mm	1.6432 %
6	Total water absorption for 20 mm	3.645 %
7	Moisture content for 10 mm	0.806 %
8	Moisture content for 20 mm	0.7049 %
9	Fineness modulus for 10 mm	6.46
10	Fineness modulus for 20 mm	7.68

2.1.2 Plastics

Process of Plastic Pulverization:-

The seven types are PET-Polyethylene Terephthalate, HDPE-High Density Polyethylene, PVC- Polyvinyl chloride , LDPE-Low density Polyethylene , PP – Polypropylene , PS-Polystyrene , Other PC- Polycarbonate. HDPE was adopted to be the replacement material. This is mainly because of the easy availability of the plastic material, its density & workability. The various stages of processing of plastics into fine grain form is as follows.

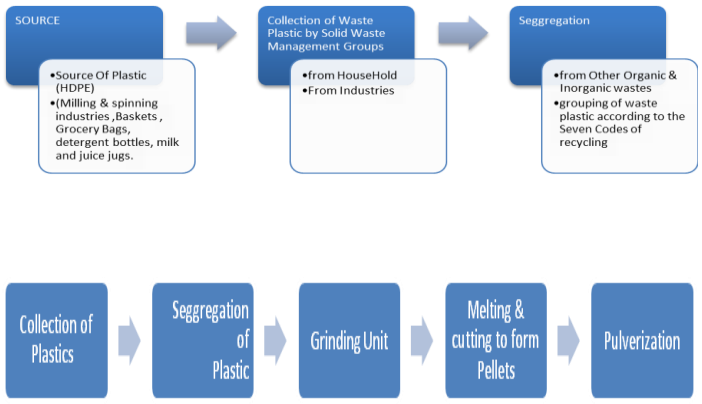

Chart -1: Flow chart showing the Process of Plastic Pulverization

Fig -1: Pulverized Plastic Material (Red Color)

Fig -2: Pulverized Plastic Material (White Color)

Sources of HDPE is from milling textiles & spinning industries, grocery bags , detergent bottles , milk & juice jugs . The investigated samples (HDPE) were collected from the sanitary inspector of Coimbatore corporation which in turn were send to grinding units for further processing, where they are broken down into flakes, strips, scraps , etc . This is the Primary process of breakdown, and then the material is transported to secondary units and made into pellets of 4-5mm by cutting and melting. These pellets are then converted into granular form or Pulverized form by tertiary units.

The Properties of plastics are then analyzed by performing density, specific gravity & sieve analysis tests. Density of the material is determined by finding the weight and volume of a specified material.

Then sieve analysis and specific gravity were done for a given amount of sample. It is also studied that there is lesser reaction between aggregate and reinforcements as the cleaned plastic material is almost inert.

Table -4: Sieve analysis of Pulverized Plastic Material

Sieve size	Wt retained(kg)	% wt retained	Cumulative %	% passing
2.36mm	0.064	6.4	6.4	93.6
1.7mm	0.047	4.7	11.10	88.9
1mm	0.743	74.3	85.40	14.6
600µm	0.076	7.6	93.00	7.00
425µm	0.042	4.2	97.20	2.80
300µm	0.017	1.7	98.90	1.10
212µm	0.008	0.8	99.70	0.3
150µm	0.0028	0.28	99.98	0.02
75µm	0.0002	0.02	100	0
Total weight of Particles=1.000kg				

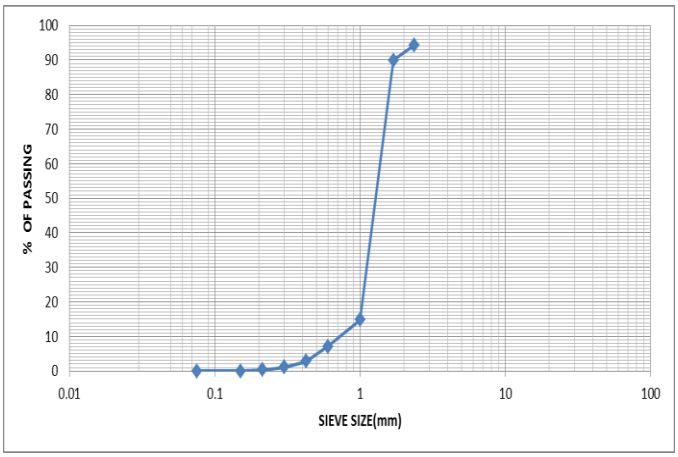

Chart -2: Semi Log graph showing sieve analysis Of Pulverized Plastics

Specific gravity of Plastic material = 0.46

3. MIX DESIGN AND CUBE TESTING

After obtaining the above results, mix design was performed using IS Code method of mix design as per IS:10262-2009 , but it was difficult to find the water absorption value of Plastic material since it had a specific gravity much lower than that of water . So Proportioning of the mix by volume was adopted & a ratio of 1:1:2 mix was adopted.

Slump test were performed for the different proportions of concrete to determine the workability for a slump of 90 mm for P.C.C & R.C.C works [5].

45 Standard concrete cubes of size 15x15x15cm were cast and cured. No admixtures were used. The cubes then were tested for 7, 14 & 28-days compressive strength on compression testing machine.

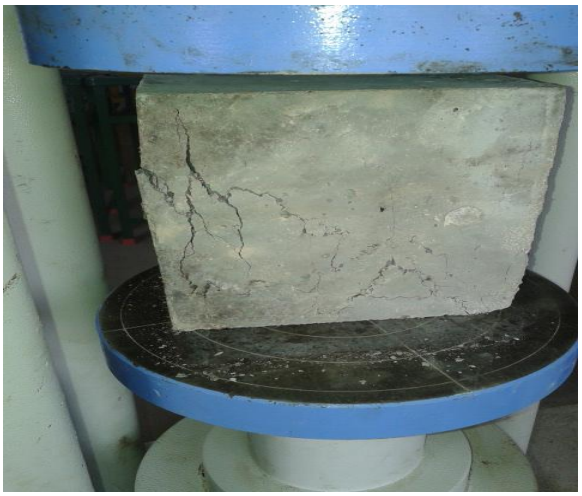

Fig -3: Cast Concrete Cubes

4. RESULTS AND DISCUSSIONS

The water cement ratio required to get a slump of 90mm in workability test were noted for different Proportions of Plastic replacement and a comparative graph was plotted.

Here the Batch-1 to Batch-5 represents Replacement of Sand by 0 %, 25 %, 50 %, 75 %, 100 % of Plastics respectively.

For obtaining the results, three cubes of same composition were tested on the particular day and the average of the 3 results is taken.

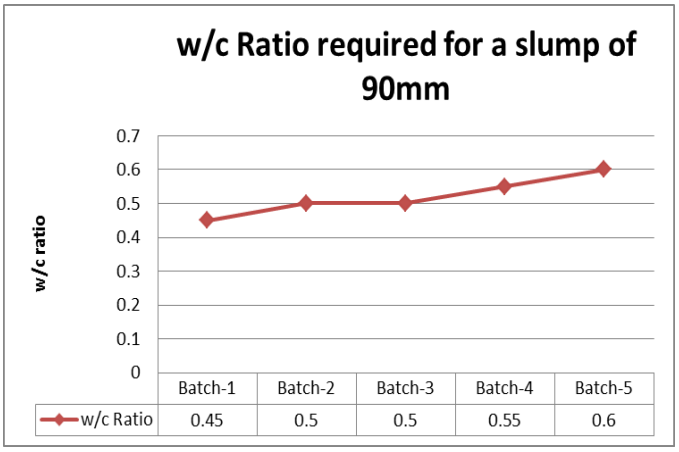

Chart -3: Comparison of Water Cement ratio of cubes having different proportions of Plastics

Next the weights of the cubes were compared.

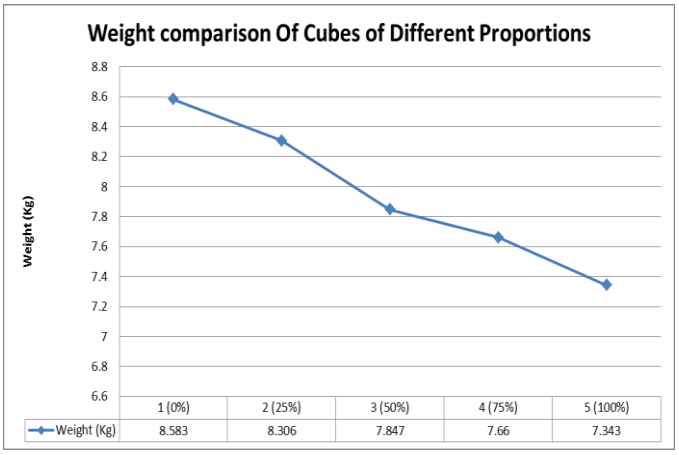

Chart -4: Comparison of Weights of cubes having different proportions of Plastics

Ultimate strength and yield strenght of cubes having different proportions of plastic as a replacement for sand were tested and the comparison of the average values of strength are as follows .

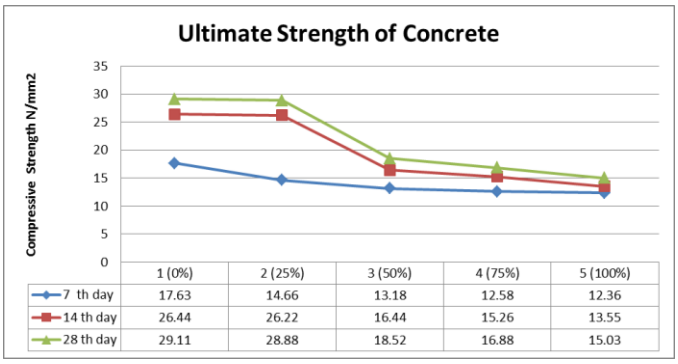

Chart -5: Comparison of Ultimate Strength of cubes having different proportions of Plastics at 7,14,28 days

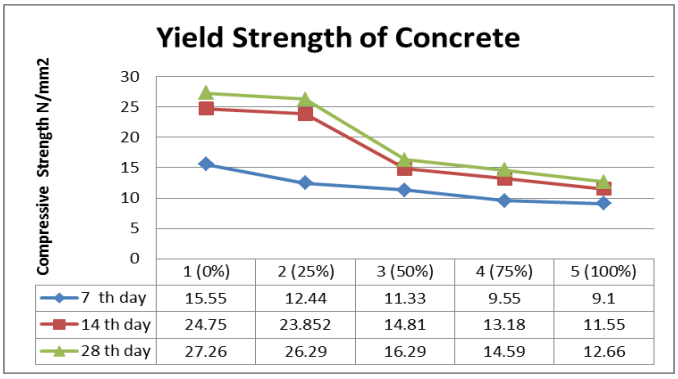

Chart -6: Comparison of Yield Strength of cubes having different proportions of Plastics at 7, 14, 28 days

5. SUMMARY

From the test results the following conclusions are made

- The water cement ratio of concrete is found to increase with increase in replacement of Sand by Plastic material.
- The Weight of the cube decreases with an increase in replacement of Sand by Plastic material. It is seen that the decrease in weight is linear with increase in replacement.
- The variation of strength with age of Conventional and concrete with 25% replacement Sand by Plastic material follows a similar pattern.
- There is not much change in strength with the age of concrete for Concrete which contains more than 25% replacement of sand by plastic material.
- There is Gradual decrease in strength for replacement up to 25% and then the strength decreases rapidly for 25% to 50% of Sand by Plastic material, after 50% the strength variation is somewhat gradual.
- The ultimate as well as the yield strength of concrete at 7th day decreased by about 3 to 3.2 $N/mm^2$for 25%replacement & 4 to 6.5 N/mm^2 for higher

replacements of Plastic when compared to conventional concrete.

- The ultimate as well as the yield strength of concrete at 14th day & 28th day decreased by about 0.2 to 1 N/mm^2 for 25%replacement & 9.1 to 14.6 N/mm^2 for higher replacements of Plastic when compared to conventional concrete

CONCLUSIONS

Keeping in view, the hazards & risk involved in the degradation/disposal of the large quantity of plastics which possess a huge threat to the environment and the problems involved in extraction of Natural sand from river basins , which tends to lower the water table and cause water shortage , usage of Cement Concrete in which less than 25% of the fine aggregate replaced with plastic material is very much recommended as there is not much difference in strength .

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