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Study on Utilization of waste polypropylene particles on the strength of concrete

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Abstract— in this analysis, evaluated the impact on the mechanical functions of concrete by using of polypropylene (PP) particles in concrete. Polypropylene waste employed in a various type of construction applications in which disposal cup is one of them. Waste plastic disposal cup is a major reason of solid waste disposal and difficult to reuse and recycle and plastic if burnt releases many harmful gases, which are dangerous for human health, but if we use waste polypropylene particles in concrete then there is no need of recycle and can be used in huge amount without any harmful effect. It's also cumbersome to biodegradation. On the other side construction organization is in the use of cost effective, material for making high quality strength of concrete structure. PP particles are added at the concrete with 1%, 2%, 3% & 4% of fine aggregates and compared with control mix. In this study experimental work was using M25 mix. Then analyze the difference between values of results with conventional concrete. Using of waste plastic particles protect natural resources and also reduce the dead load of a building as a result of its low unit weight.

Keywords— disposal cup, polypropylene, waste disposal cups, waste management.

I. INTRODUCTION

Before this study, several researches have been completed on concrete. In India, waste plastic is a major issue of solid waste disposal and also harmful for the environment the recycling of waste polypropylene particle (waste disposal cup) is finding out in various steps, including collection, separation, granulation and reuse of production, but this problem can be reduced by use a huge amount of waste P.P. Particle in concrete without any recycling process and environmental problem. Waste P.P. Particles are very cheaper as compared to other material like glass, paper, glass bottles, metal etc. in concrete, therefore use of waste PP particle as aggregate in concrete manufacturing is a more economical path of recycling waste PP particle in concrete, but by using PP particle in concrete somewhere it decreases its strength. Some other studies have explained that the utilization of super plasticizer and pozzolanic Portland cement in concrete makes better the fresh and hardened properties of concrete as a results of its pozzolanic cement functions. The main purpose of this analysis is to find out the connections involving PP particle content and the strength properties of concrete.

II. EXPERIMENTAL WORK

A. *Material Used*

1) *Cement:* Pozzolanic Portland cement is employed in this experimental work. It has various advantages like it reduces the slump loss, bleeding, increased workability and pumpability etc... It also has 10-12% more strength as compared to ordinary Portland cement. It also works as filler because of its Pozzolanic properties. There are following properties. There are following properties that are used in this investigational analysis are as follows-

Table-1: Properties of Cement

S. No.	Property	Value
1	Specific Gravity	3.10
2	Fineness	98.00
3	Initial setting time	60 minutes
4	Final setting time	395 minutes
5	Standard Consistency	35%
6	Compressive Strength	52.40

2) *Fine Aggregate:* River sand was used as fine aggregate. The sand used was having a specific gravity of 2.63 and fineness modulus of 3.37 and confirmed to grading zone 3 as per IS -383-1970 specification.

3) *Coarse Aggregate:* Machine crushed granite obtained from local quarry was used as coarse aggregate with a nominal most size of 20 mm aggregate are used in concrete to supply economy within the price of concrete. Aggregate acts as filler only and don't react with cement water. The specific gravity and water absorption are found to be 2.63 and 2.14% severally.
4) *Waste Material:* The waste polypropylene particles were (used as fine aggregate) obtained from waste disposal cups and glasses, crushed into a smaller size and passed through sieve size of 4.75mm the specific gravity and water absorption of polypropylene are 0.91 and 0.14 respectively. The particles are shown in figure 1
5) *Water:* During the investigation work ordinary portable water free from organic content, turbidity and salts was used for mixing and curing
6) *Super plasticizer:* To impart the extra desired properties, a super plasticizer (complast SP430) compiling with ASTM C494 type F range was used. Complast SP430 (G) has been specially developed to present high water reduction up to 25% without loss of workability or to supply high quality concrete of reduced permeability however during this 20% reduction of water was used. The properties are given below.

Table-2: Properties of super Plasticizer

Properties	Value
Specific gravity	1.20 to 1.22 at 30 c
Chloride content	Nil as per IS:9105-1999 and BS 5075
Air content	Approx 1% additional air over control

B. Experimental Procedure

Concrete was constructed by using design mix for M25 grade, which had proportion of 1:1.43:2.36 with a water cement ratio of .45%. The replacement ratio of fine aggregate with the same weight of waste PP particles 1%, 2%, 3%, 4% (by weight) were taken in this experimental program. The sample with no waste PP particles war considered as the control mix. Table 3 explains the concrete mix proportion of the sample. All the ingredients are weighed individually and mixed in a dry state in electric concrete mixer for 2-3 minutes, then the particular water with super plasticizer (SP430 CG).2% of the cement weight, mix completely for the next 3-4 minutes. The perfect mixer was designed into the cavities without any vibration in three layers over the length of the mould and compacted satisfactory. Standard moulds were used for casting of cube of size 150mmx150mmx150mm and casting of beam of size 500mmx100mmx100mm the excess concrete were remoulded and the top finished by trowel. Three identical samples were made of cubes and two identical samples were made of beams for each proportion of waste PP particles and also for control mix which had no waste PP particles.

Table-3: Details of Concrete Mix Proportion

Materials	Volume Fraction of polypropylene Particles				
	0.00%	1.00%	2.00%	3.00%	4.00%
Water(lt/m^3)	196.5	157.2	157.2	157.2	157.2
Cement(kg/m^3)	436.6	436.6	436.6	436.6	436.6
Fine aggregate(kg/m^3)	625	618.75	612.2	606.25	600
Coarse aggregate(kg/m^3)	1032	1032	1032	1032	1032
PP particles(kg/m^3)	-	6.25	12.5	18.75	25
Super plasticizer(lt/m^3)	-	1.30	1.30	1.30	1.30

C. Curing and Maintaining Samples

In order to find out the workability of conventional concrete, slump cone test were completed. The material elements of concrete like cement, coarse aggregate, and fine aggregate, PP particles were analyzed as per related codes of practice. Three identical samples of cubes and two identical samples of beam for each proportion of PP particles and without PP particles were demoulded

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after 24 hours of casting and were cured for 3 , 7 and 28 days in a water tank. No special care needed for curing of cubes and beams.

III. RESULT AND DISCUSSION

After the detailed investigation of different parameters has been analysed, the following result has been achieved.

A. Compressive strength

Compressive strength is that the main criteria for the purpose of structural design. Compressive strength test finds out the high amount of compressive load a material can bear below facture limit. The results of compressive strength at the age of 3, 7 and 28 days are shown in table 4. The specimen in that the waste PP particles present has a remarkable outcome over the compressive strength of concrete. The compressive strength for the specimen W1 & W2 were found to be 12% & 17.7%, respectively bigger and for specimen W3 & W4 were found to be lesser than that of conventional concrete as shown in figure 2. Thus the optimum dosage of waste PP particles, for example, 2% to attain the maximum compressive strength of the combination.

Table-4: Compressive Strength test results at different ages (N/mm^2)

Mix type	Mix Id	3- days	7- days	28- days
Control	C	13.26	21.18	31.9
PP- 1%	W1	14.92	23.65	35.72
PP- 2%	W2	15.60	25.25	37.55
PP- 3%	W3	12.68	20.10	30.42
PP- 4%	W4	11.16	17.86	26.53

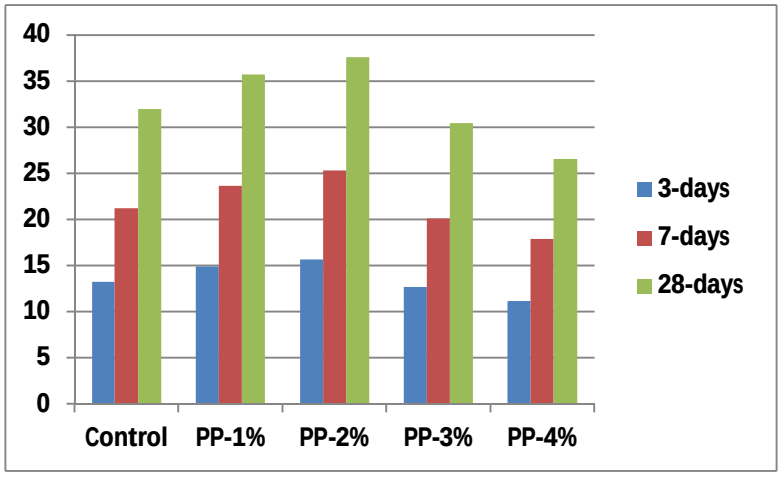

Fig-2: Variation in compressive strength at different ages (N/mm^2)

B. Flexural strength

Flexural strength also called as modulus of rupture and explained as the stress in a material just before it yields in a flexural test. The results of flexural strength at the age of 28 days are shown in table 5. Flexural strength of waste PP particles in self compacting concrete can be obtained with 2% addition of waste PP particles. Therefore the higher flexural strength can be achieved with 2% addition of waste PP particles and the percentage increase in the flexural strength is 18% more than that of conventional concrete.

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Table-5: flexural strength test results in 28 days

Mix type	Mix Id	Flexural strength(N/mm^2)
Control	C	3.7
PP-1%	W1	4.02
PP-2%	W2	4.38
PP-3%	W3	3.94
PP-4%	W4	3.50

C. Workability

A concrete mix is only being as self compacting concrete if the requirements for workability are full filled according to EFNARC 2005. The functions of fresh concrete mixes are explained in table 6 and figure. It has been found that the workability of waste PP particles itself compacting concrete as measured from slump is maximum on replacement of fine aggregate with waste PP particles. This can be because of the reason that the addition of more than 2% waste PP particles may obstruct the flowing path of concrete. Therefore the maximum workability is achieved with the adding of 2% waste PP particles**.**

Table-6 Slump Value of Concrete

Mix type	Mix ID	Slump Value
Control	C	65mm
PP-1%	W1	72mm
PP-2%	W2	78mm
PP-3%	W3	88mm
PP-4%	W4	84mm

D. Waste Management

Worldwide plastic production has been growing dramatically due to developing industry and a growing population. Some 299 million tons of plastics were produced in 2013, represent a 3.9%, increasing over 2012's output and 46.6% increasing over 2002 (204 million tons). To degrade waste plastic particles in the nature is a long time process; there also some other method for disposal of waste plastic but it causes environmental problems.

IV. CONCLUSIONS

The use of polypropylene particles in self compacting concrete is relatively a new development in the world of concrete technology. The various conclusions are presented depends on experimental results from this study.

Cost estimation between fine aggregates and polypropylene particles at different proportion which are given in table 7.

Table-7: Cost estimation at different proportion (As per market Rate)

Proportion	Cost of Fine Aggregates (Rs)	Cost of Polypropylene Particles (Rs)
1%	9	6
2%	18	12
3%	27	18
4%	36	24

A. From this investigation, the polypropylene particles (waste disposal cup) would appear to be low cost material which would help to resolve solid waste disposal problem and preventing environmental pollution

B. In this study, Pozzolana Portland cement is used instead of using ordinary Portland cement because of its high strength.

C. Using the polypropylene particles in concrete, the compressive strength of 28 days increased 17.7% as compared to the control concrete mix without PP particles.

D. The flexural strength of waste plastic concrete is also increased by 18.37 as compared to conventional concrete

E. The workability of waste plastic concrete is better than control concrete mix.

F. The remarkable improvements in strength were perceived with insertion of waste plastic particles in concrete. The optimum

strength was noticed at 2% of particle for both types of strength and the price of polypropylene at 2% is Rs12 where the price of fine aggregates at 2% is Rs18.

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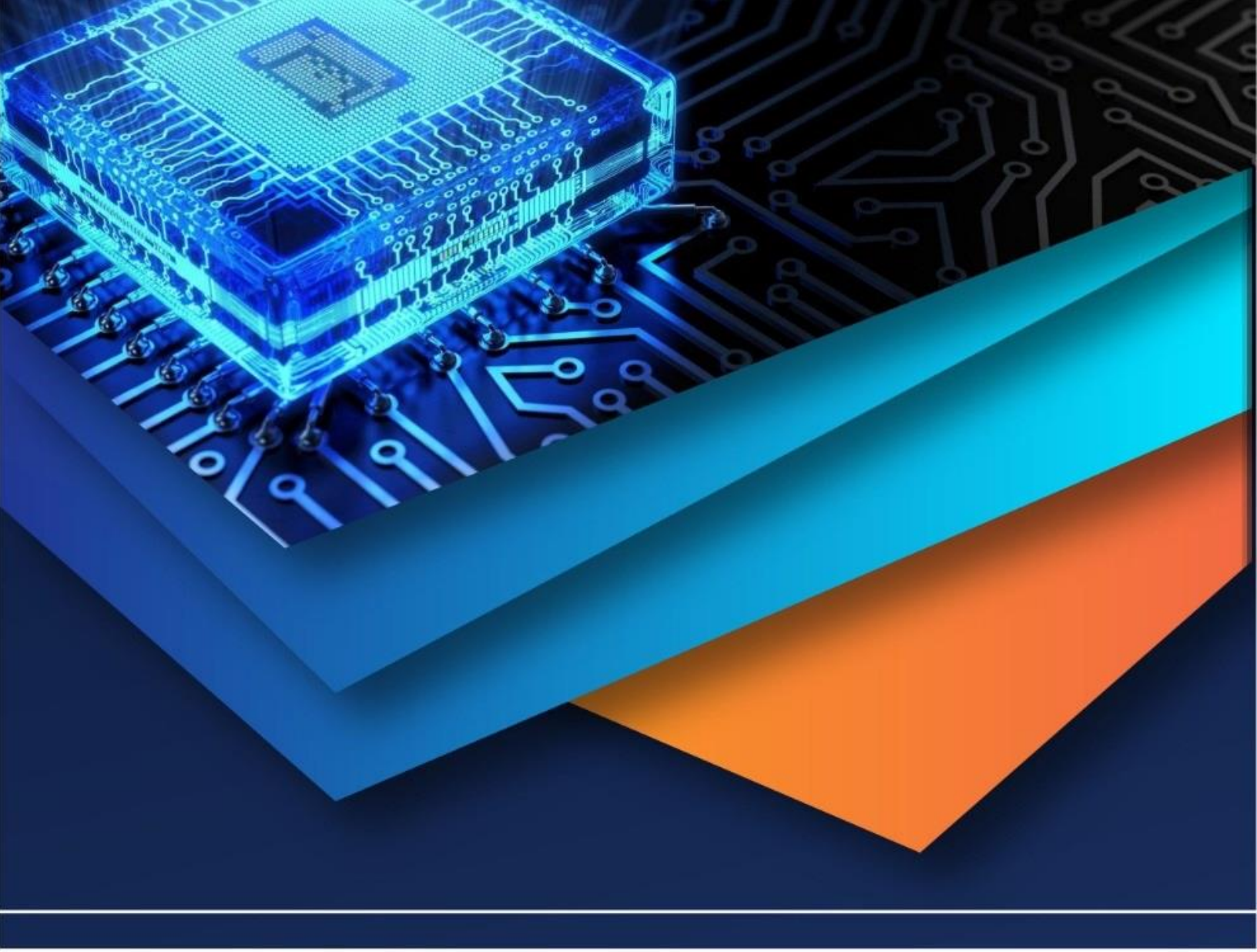

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