

EXPERIMENTAL INVESTIGATION ON UTILIZATION OF WASTE PLASTIC, PAPER WASTE, FLY ASH AND QUARRY DUST IN CONCRETE

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Abstract - In recent years, the use of plastic and paper has rapidly increased. Among the total production, very less amount is recycled and the remaining waste ends up as landfill or incinerated which causing disturbance to the environment and ecology. The best way to reduce this disposal is to use these wastes in other streams which include construction also. In this study, various mixes are prepared by conducting preliminary tests like specific gravity, water absorptions on cement, crush sand and coarse aggregate. Compressive strength and slump cone tests were conducted on the modified concrete. From the results it is concluded that the mix with 5% fly ash, 3% paper pulp as cement replacement and 5% Shredded plastic for coarse aggregate and fully replaced of sand with crushed sand shows acceptable results when compared to the other mixes. The weight of the concrete decreased with the increase in the shredded plastic in the concrete and feasibility of such concrete has discussed.

Key Words: Plastic waste, Fly ash, Paper Pulp, Coarse Aggregate, Crushed Sand,

1. INTRODUCTION

In recent years, the consumption of concrete has rapidly increased all over the world. As a developing country, India has been consuming about 400 tons of concrete and is expected to increase in the coming years [11]. The raw materials required for manufacturing such a large quantity of concrete would create a massive depletion of natural resources. On the other hand, disposal of the plastic waste and paper waste is the major problem faced by many developing countries which is causing an adverse effect on the environment and ecology.

According to the report of the CPCB (Central Pollution Control Board) for 2017-2018, India generates 26000 tons of Plastic waste every day and only 60% of the plastic is recycled and remaining ends up as land fill or incinerated which causing health problems to people. The best method to reduce disposal is to use in construction industry.

Paper waste is another big threat to the environment. To produce papers each year millions of trees are cut down which resulting in the global warming. In India 550 mills make use of paper waste as their raw materials to produce paper, paperboard. To meet the Indian demand every year 3 million tonnes of paper waste is collected, which is only 20% of the total and the remaining ends as the disposal [15].

Quarry dust is one of the by product generated while processing the aggregate in the plant. While crushing the stones into various the sizes the waste is generated which is called as quarry dust. Use of this material as the replacement as sand in the concrete helps to reduce the use of natural resources and also reduce the cost of construction.

Fly ash is a residue of the coal combustion in thermal power plant. In India around 90 million tonnes of fly ash is generated which ends up as land fill which causing different types of pollution like air pollution, land pollution and water pollution [16]. The researcher are trying to use these waste as a replacement to the cement in the concrete due to the pozzolanic properties of the fly ash.

In this study, the use of the fly ash and paper pulp as replacement for Cement and the coarse 20 mm aggregate is replaced with the plastic waste at various percentages and the quarry dust is completely replaced with the sand to create a sustainable, eco-friendly and light weight concrete and study of different properties has been carried out.

2. LITERATURE REVIEW

Azad Khajuria and Puneet Sharma (2019) had replaced natural coarse aggregate with plastic waste at 0, 2.5, 5, 7.5, and 10% and admixture like Rheoplast sp450 is been used. Compressive test, flexural test and split tensile tests were carried out and found 2.5% replacement as the optimal replacement [1]. Shyam Sand Drishya P (2018) had studied to use of the plastic waste, M sand in the concrete. Specimen were casted by replacing the M sand with plastic waste at 5, 10, 15 and 20%. Test results shows that till 5% strength increased and further addition the strength started

decreasing[2]. P.Pooja et.al (2018) had studies the behaviour of the concrete by replacing the fine aggregate with 15%,20% and 30% of plastic waste. Preliminary and mechanical tests were conducted and the test results Concludes 15% as the acceptable replacement[3]. Arvind (2018) had studied the properties of the concrete by replacing the fine aggregate with plastic waste .Initial tests like specific gravity ,fineness had carried for mix design strength parameter tests had been conducted and found 5% replacement can be done in the concrete[4].Lhakpa Wangmo Thing Tamang et.al(2017) had replaced the coarse aggregate with the plastic aggregate .Plastic wastes are melted cooled and crushed into the required size of the aggregate. The test results shows that 20% of the replacement of the plastic aggregate gave better results when compared with the other mix designs[5]. Dhaarani D Et.al(2018) had replaced the coarse aggregate with the plastic waste to study the properties. Different mixes are prepared by replacing plastic waste at 10%,20% and 30%.The test results shows 10% replacement as the optimum mix for replacement[6]. Cherian Varkey et.al (2016) had studied the use of paper pulp in the concrete by conducting different tests like compressive strength .Mixes are prepared by replacing the cement with the paper pulp at 2.5,5&7.5% .Test results show 5% of the paper waste can be replaced in the concrete[7]. Vinod Choudhary et.al (2018) had studied whether papercrete concrete has the required strength properties. Different mix designs for different grade of the concrete were prepared and replacing the sand with paper pulp at 5 ,10& 15% has been done. The strength properties started decreasing with the addition of the paper waste[8]. Lodhi Ravindra Singh et.al(2015) had done an investigation to study the properties of the concrete by addition of paper waste to the concrete. mixes were prepared by addition of paper waste as (0%,10%,15%,20%) in concrete. Results shows that 10% of paper waste in the concrete can be added in the concrete[9]. Patil Asha (2017) had carried an investigation by replacement of coarse aggregate with the paper pulp at (0%,10%,12.5%,15%,17.5% and 20%).Different tests were Conducted and the results suggests that 10-15% of the replacement can be carried out[10].

3. Materials Used

3.1 Cement: The type of cement used for the mix design is Ordinary Portland Cement with Specific gravity 3.15 (IS 4031-1988).

Table -1: Properties of Cement

Properties of cement	
Normal Consistency%	29
Initial Setting Time(Minutes)	90

Final Setting Time(Minutes)	480
Fineness of Cement (on 90Micron)(By sieve)%	4
Specific gravity of Cement	3.15

3.2 Quarry Dust: It is the waste generated by crushing the stone to various sizes in the quarry. The material is collected form the Warangal dist ,Telangana.

Table -2: Properties of Quarry Dust

Property	Obtained
Specific Gravity	2.57
Water absorption	0.3
Fineness Modulus	2.8
Surface texture	Rough

3.3 Paper Pulp : The waste paper are collected form the local book binding shops . The paper which are collected are soaked in water for 1-2 days and then is blending in mixer to form pulp.

3.4 Plastic Waste: The Polypropylene plastic are collected and then shredded into small pieces .The shredded plastic was collected from the local vendor. The material is washed and dried to remove the dirt particle before use in the Concrete.

3.5 Coarse Aggregate: Coarse Aggregate of 20m m size is collected from the local Quarry and preliminary tests were performed before using in the concrete.

Table-3: Properties of Coarse Aggregate

Property	Obtained
Specific Gravity of 20mm Aggregate	2.68
Specific Gravity of Plastic	0.905

4. Mix Design

The Design Mix used for the study is M30 Grade. Five Different mix proportions are prepared by replacing the cement with 5% fly ash and 3% Paper Pulp ,20 mm Coarse Aggregate is replaced with the Shredded plastic at 0%,5%,10% and 15%.Kuna Plast Pc 30 admixture is used.

Table -4: Mix Proportion percentages

Specimen	Cement (%)	Fly Ash(%)	Paper Pulp(%)	Crush Sand(%)	20mm Coarse Aggregate(%)	Plastic Waste(%)
SP1	95	5	-	100	100	-
SP 2	92	5	3	100	100	-
SP 3	92	5	3	100	95	5
SP 4	92	5	3	100	90	10
SP 5	92	5	3	100	85	15

5. Results and Discussions

Concrete specimens are prepared with proper precautions and quantities according to the mix design. The quantities are weighed first and then mixed with the help of mechanical mixer. Cubes of Sizes 150MMX150MMX150MM are casted. Total 30 cubes are casted that includes 6 cubes for each percentage replacement.



Fig -1: paper Pulp



Fig -2: Casted cubes

5.1 Slump Cone Test

Slump Cone test was performed for the samples to know the workability of the concrete. The results show that initially slump started increasing with the addition of plastic up to 5% and further addition of the plastic results in the decrease in the slump.

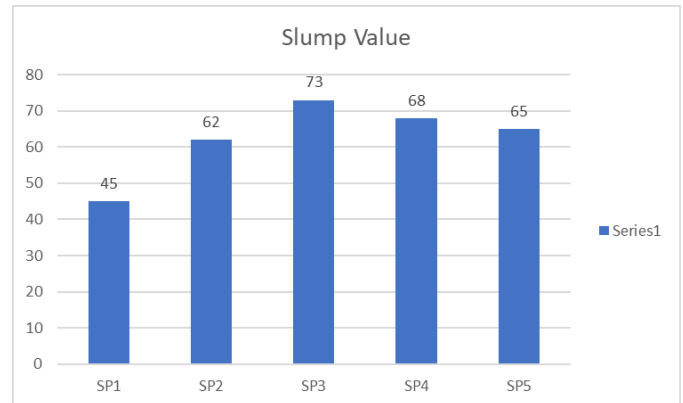


Chart-1 : Slump Cone Test values

The Slump cone results show that the modified mix design falls under medium slump value range which tells that the concrete can be used for Medium workability mixes; manually compacted flat slabs using crushed aggregates. Normal reinforced concrete manually compacted and heavily reinforced sections with vibrations.

5.2 Weight of Cube

Specimens are casted and cured and the weight were taken after the curing period. Three cubes of each samples are weighed. The results show that initially by addition of paper the weight has increased and with the increase in the Plastic content in the concrete the weight started decreasing. Plastic being light in weight proves to be more beneficial for the light weight concrete.

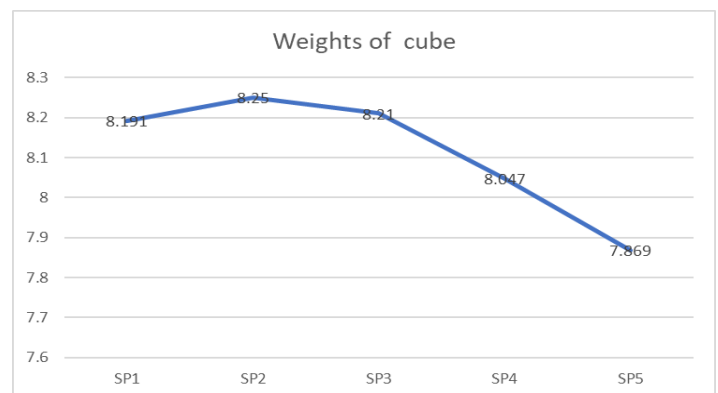


Chart -2 : Weight of the cube

5.3 Compressive Strength

After the 24 hours the specimens are removed from the moulds and then placed in the curing tank for the curing. The compressive tests were performed after 7 days and 28 days. The test procedure for conducting test was followed as per IS 516:1959.

Table -5: Compressive strength

Compressives strength		
Specimes	7days	28 days
SP 1	26.73	32.21
SP 2	26.28	31.51
SP 3	25.53	30.71
SP 4	20.5	25.89
SP 5	15.46	23.59

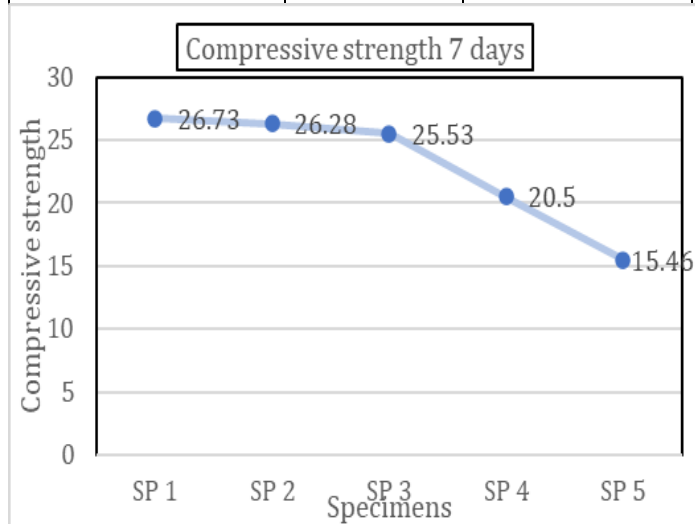


Chart -3: Compressive strength 7 days

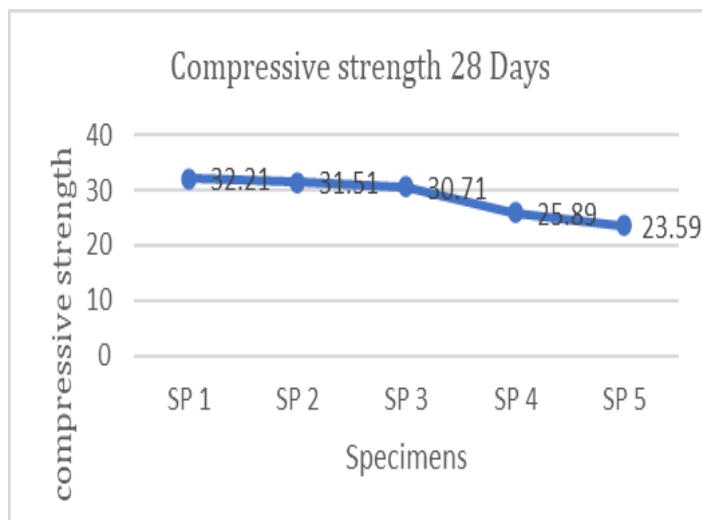


Chart -4: Compressive strength 28 days

The compressive strength tests was conducted for 7 days and 28 days . the test results shows that with paper as 3% and Fly ash 5% in concrete shown a strength of 30.51 n/mm2 . The replacement of the coarse aggregate with 5% shredded plastic shows a strength value of 30.71 which are in the acceptable limits.

3. CONCLUSIONS

Based on the results and observations on the experimental work conducted, The following conclusions are made.

- By additon of the paper pulp and plastic waste the weight of the concrete decreasing which results as lghtweight concrete.
- The optimum mix for modified concrete can be 5% of fly ash and 3% of paper pulp as partial replacement for the cement and 5% replacement of the shredded plastic for coarse aggregate.
- By additon of waste material in the concerte the use of the natural resources may be reduced.
- It is observed that the plastic wastes and paper waste can be used as the construction material.
- The use of these waste in concrete reduces the use of the natural raw materials.

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