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A Study on Partial Replacement of Coarse Aggregate by Plastic Waste and Cement by Saw Dust Ash in Standard Grade Concrete

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Abstract – The use of plastic and wood based materials increasing day to day, the pollution to the environment is enormous. Since the plastic is a non-biodegradable material. Although steps were taken to reduce its consumption. Globally, the cement manufacturing industries contributes 7% of green-house gas emission to earth atmosphere. The sawdust is a byproduct of cutting or otherwise pulverizing wood with saw tool. This process is a daily activity causing heaps of sawdust to be generated after each day. This effects environment widely. The need to convert this waste product into a useful by product is the focus of the study.

In this study we have casted M25 grade concrete replacing partially cement with saw dust & coarse aggregate with plastic at various percentages 5%-5%,5%-10%,5%-15%;10%-5%,10%-10%,10%-15%;15%-5%,15%-10%,15%-15%. The fresh concrete properties and mechanical properties were observed. It was concluded that the slump and the compacting factor decreased as the SDA content increased indicating that concrete becomes less workable as the SDA content increased and 10% of saw dust ash and 5% of plastic waste substitution is adequate to enjoy the maximum benefits of strength gain.

Keywords: Sawdust Ash, Plastic Waste, Fresh Properties & Mechanical Properties of Concrete i,e, Compressive Strength and Tensile Strength.

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1. INTRODUCTION

Port land cement and coarse aggregate as an ingredient in concrete is one of the main construction material widely used especially in developing countries. In the present study the recycled plastics were used to prepare the coarse aggregates there by providing a sustainable option to deal with the plastic waste. There are many recycling plants across the world but as plastics are recycled they lose their strength with the number of recycling. So these plastic will end up as earth fill. If it is utilized to prepare aggregates for concrete, it will be a boon to the construction industries. Most of the failures in concrete structures occur due to the failure of concrete by crushing of aggregates. Plastic waste which has low crushing value will not be crushed as easily as stone aggregate. These aggregates are also lighter in waste compared to stone aggregates. Since a complete substitution for NCA was not found feasible, a partial substitution with various percentage of PCA was done. We are consequently using plastic waste instead of land fill. By the reutilization of plastic waste we can protect the environment from the land fill of plastic garbage.

Materials such as sawdust ash can replaced and reduce the utilization of port land cement. It is a natural waste & it is a wood waste and cheap product. In wood industries such as timber and furniture and saw mills the large amount of sawdust is always found as waste some amount of sawdust is re-utilized in industries which generates sawdust ash. And delivered to landfills for disposal. Using the sawdust ash in concrete is an interesting possibility for economy on waste disposal sites and conservation of natural resources. The study examines the possibility of using sawdust ash as replacement in cement for a new concrete.

2. MATERIAL USED & ITS CHARACTERISTICS

2.1 Cement

Cement is the one of the binding materials in this project. 53 grade Ordinary Portland Cement conforming to **IS: 8112-1989.**

Description of test	Values	Requirement of IS 8112-1989
Initial setting time (min)	65	Min. 30
Final setting time(min)	270	Max. 600
Fineness (m^2/kg)	412.92	Min. 225
Specific gravity	3.13	3.10-3.15

Table 1: Properties of Cement

2.1.1 The physical properties of cement

- ► Setting Time.
- ► Soundness.
- ► Fineness.
- ► Strength.

2.2 Sawdust ash:

Figure 1: Saw Dust Ash

The sawdust were procured from sawmills and sun dried for 3 days. Dried sawdust was burned in open air, kept for cooling down, & grinded for fineness.

2.2.1 Chemical properties of Saw Dust Ash

Oxides	Percentage by mass
Sio2	65.3
Al2o3	4.0
Fe2o3	2.23
Cao	9.6
Mgo	5.8
Mno	0.01
Na2o	0.07
K2o	0.11
P2o5	0.43
So2	0.45

Table 2: Chemical Properties of SDA

2.2.2 Physical properties of sawdust ash

Parameter	SDA
Specific gravity	2.5
Water absorption%	0.56
Moisture content%	0
Bulk Density(dry loose state)	1250
%Voids	64
%Porosity	41
Bulk density(dry compact state)	1300

Table 3: Physical Properties of SDA

2.3 Fine aggregate

Natural river sand was used as fine aggregate. The properties of sand were determined by conducting tests as per **IS: 383-1970(Part-3).**

2.3.1 Properties of fine aggregate

Description of test	Values
Specific gravity	2.6
Water absorption%	0.82
Finenesss modulus	2.52

Table 4: Properties of Fine Aggregate

2.4 Coarse aggregate

20mm down size aggregate was used. Test results listed below. Conforming **IS: 383-1970 (Part-3).**

Description of test	Values
Specific gravity	2.68
Bulk density	1642.45
Surface moisture%	0.08
Water absorption%	0.19
Fineness modulus%	6.98

Table 5: Properties of Coarse Aggregate

2.5 Plastic waste

Plastic waste is collected from the disposal area were sorted to get the superior one. These were crushed into small fraction and washed to remove the foreign particles. Then they are sieved to get 20mm size plastic aggregate.

Figure 2: Plastic Waste Coarse Aggregate

2.5.1 Properties of plastic

Description of test	NCA	PCA
Specific gravity	2.64	0.9
Crushing value	28	2
Density	3.14	0.81
Melting point	-	75-100

Table 6: Properties of PCA

2.6 Water

Portable water free from impurities and salt used for casting and curing the concrete blocks as per **IS: 456-2000.**

3. EXPERIMENTAL PROCEDURE

This chapter describes the experimental work. First, the material, mix proportions, manufacturing and curing of the specimen are explained. This is then followed by description of type of specimen used, test parameters, and test procedures. Development of the making plastic waste as coarse aggregate, sawdust ash as cement in concrete.

3.1 mixing, casting & curing

In this mix design we are used only crushed plastic. To achieve the objectives of the investigation the experimental program was planned to cast around 30 cubes with different percentages of plastic waste & sawdust ash.

3.1.1 Mix design

The concrete mix design was proposed by using standard for control concrete. The grade was **M25**. The mix proportion of materials is **1:1:2.** The mix proportions with different materials are listed below

3.2 Casting

The plastic waste and sawdust ash concrete is manufactured by as similar to the classic concrete. Initially the dry materials cement, aggregate, & sand are mixed. The liquid component of the mixture was then added to the dry materials and mixing continued for further about 3-6 minutes to manufacture the fresh concrete. The fresh concrete was cast into the moulds immediately after mixing, in three layers for cube specimens. For compaction of the specimens each layer was given 60-70 manual strokes using a tapping rod, and then vibrated for 12-15 seconds on a vibrating table. Before the fresh concrete was cast into the moulds, the slump and compaction factor was observed. The observed values are listed below.

3.3 Curing

After completing of casting process wait for 24 hours and open the moulds, take the blocks and dry it for 1-2 hours. Then after take Portable water free from impurities and salt used for curing the concrete blocks for 28 days.

S.No	%Replacement		Fresh properties	
	SDA%	PCA %	Slump in mm	Compaction factor
1	0	0	75	0.952
2	5	5	70	0.9496
3	5	10	60	0.948
4	5	15	20	0.894
5	10	5	36	0.855
6	10	10	32	0.875
7	10	15	30	0.913
8	15	5	28	0.860
9	15	10	26	0.869
10	15	15	20	0.880

Table 7: Slump and Compaction Values

4. TESTING PROCEDURE

An intensive experimental program is performed to study the effect of internal curing on different types of concrete properties

1. Fresh properties (slump, compaction factor)
2. Mechanical properties like compressive strength and tensile strength

The cubes were tested under 200 tons compression testing machine to study the compressive strength of the cubes.

4.1 compressive strength tests

At the time of testing, each specimen must keep in compressive testing machine. The maximum load at breakage of concrete block has been observed. From the observed values the compressive strength has been calculated by using formula

Compressive strength = load / area

Size of the test specimen is 150mm*150mm*150mm

Tensile Strength

Tensile strength is an important property of concrete because concrete structures are highly vulnerable to tensile cracking due to the various kinds of effect and applied loading itself, however tensile strength of concrete is very low in compared with compressive strength of concrete.

5. TEST RESULTS

Ratio for special concrete compressive strength and tensile strength of concrete listed below.

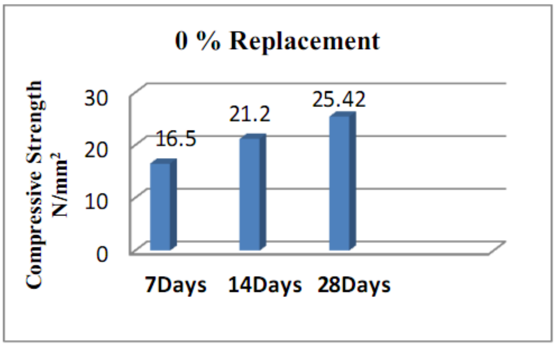
S.no	% Replacement		Compressive strength N/mm²		
	SDA	PCA	7 Days	14Days	28 Days
1	0	0	16.5	21.2	25.42
2	5	5	15.6	20.3	21.44
3	5	10	13.2	15.8	18.4
4	5	15	11.55	13.68	16.3
5	10	5	16.75	21.24	23.377
6	10	10	11.02	15.55	19.84
7	10	15	10.6	14.9	17.62
8	15	5	11.93	16.84	19.11
9	15	10	10.4	14.088	17.89
10	15	15	10.51	13.53	16.99

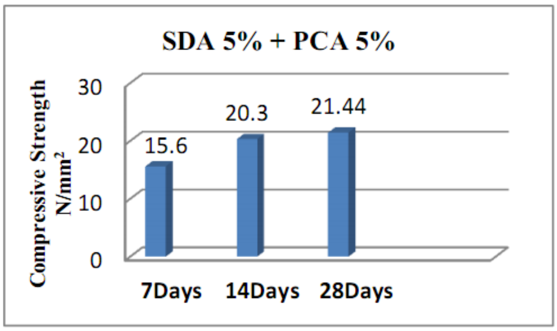
Table 8: Compressive Strength Test

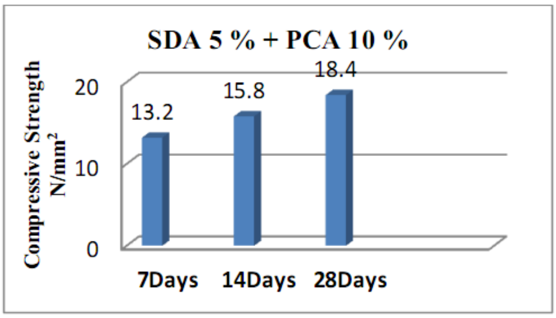
Tensile strength

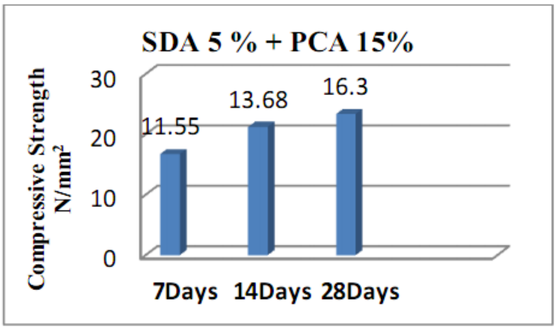
Tensile strength (N/mm2)				
SDA	PCA	7 Days	14Days	28 Days
0	0	2.843	3.223	3.529
5	5	2.765	3.154	3.241
5	10	2.543	2.782	3.003
5	15	2.379	2.589	2.826
10	5	2.865	3.226	3.384
10	10	2.324	2.760	3.118
10	15	2.279	2.702	2.938
15	5	2.418	2.873	3.060
15	10	2.257	2.627	2.961
15	15	2.269	2.575	2.885

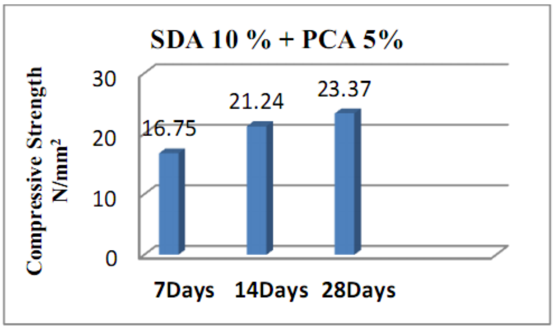
Compressive strength graphs

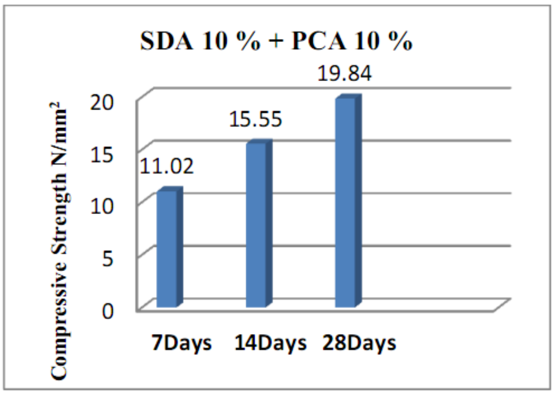


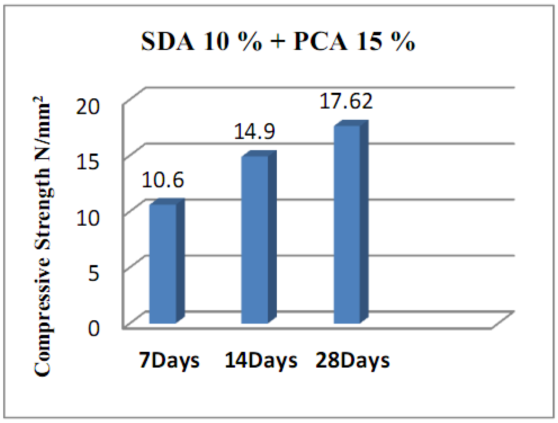


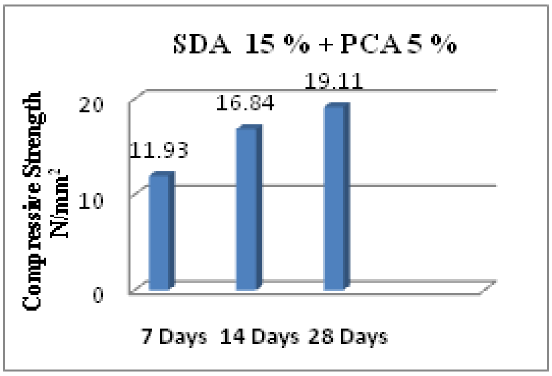


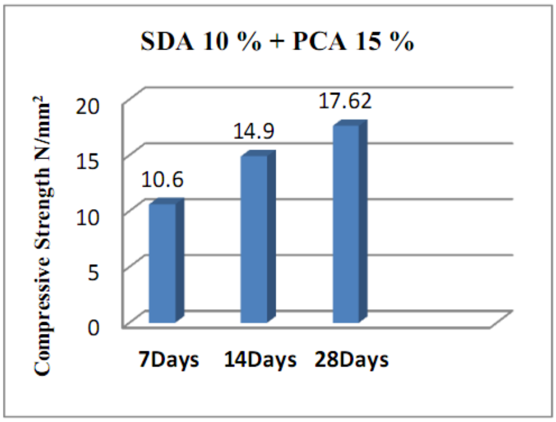


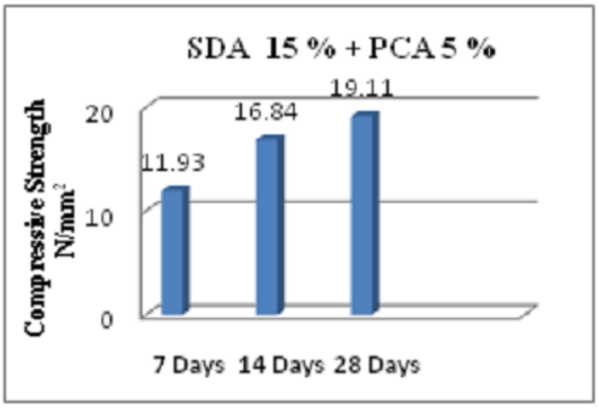


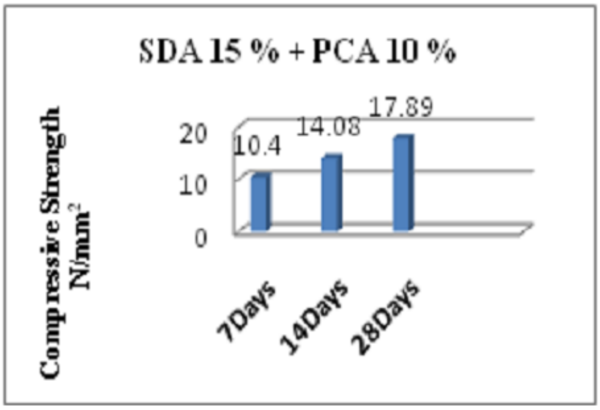


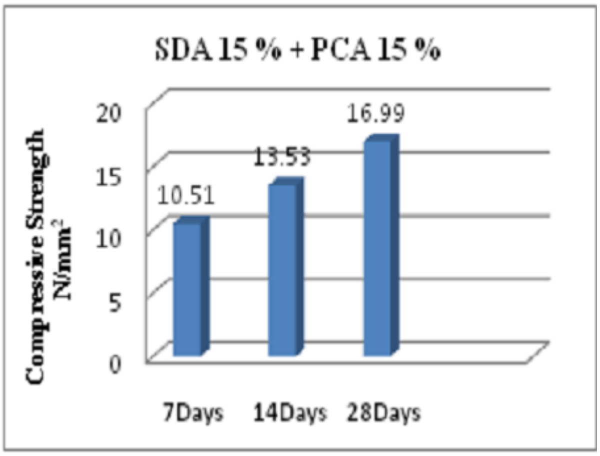




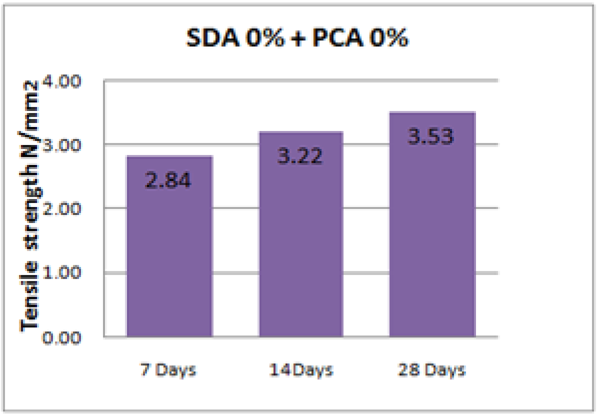


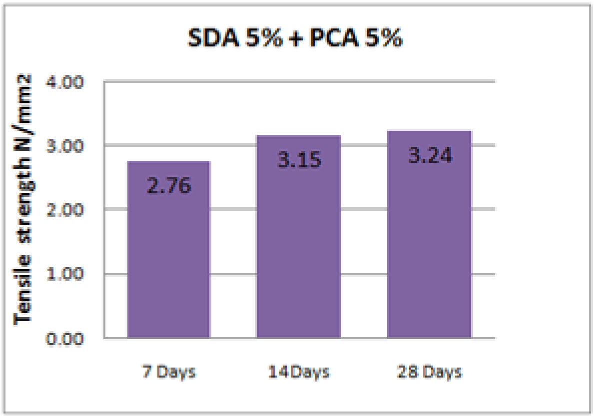


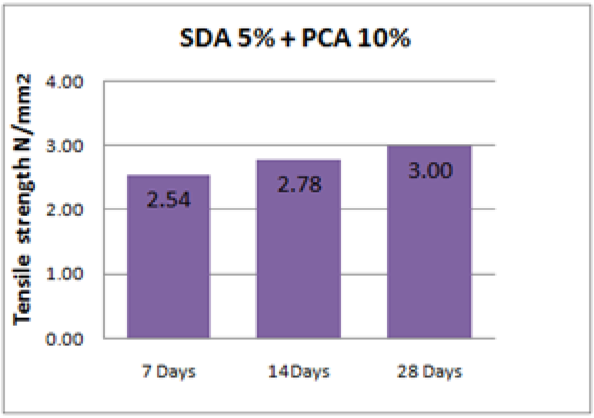


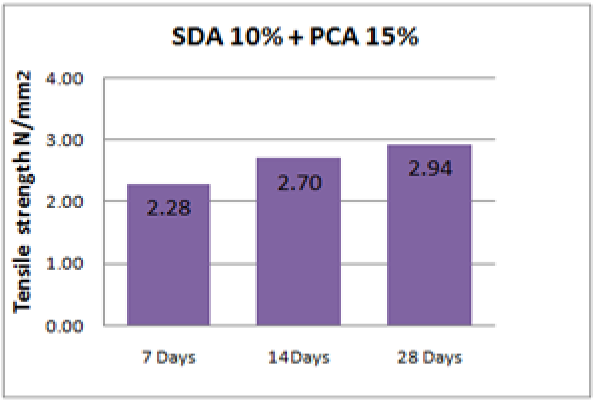


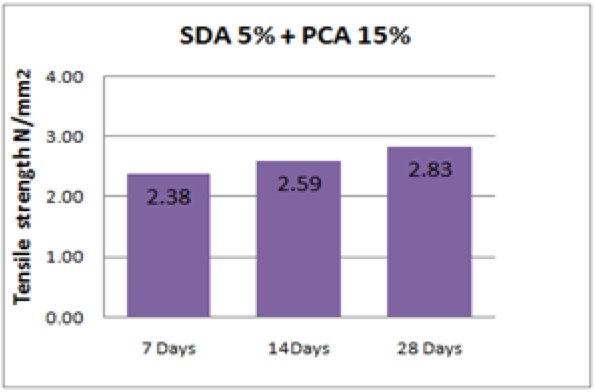
Tensile strength

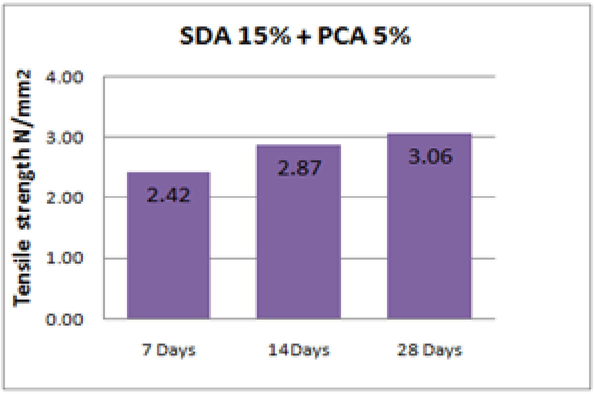


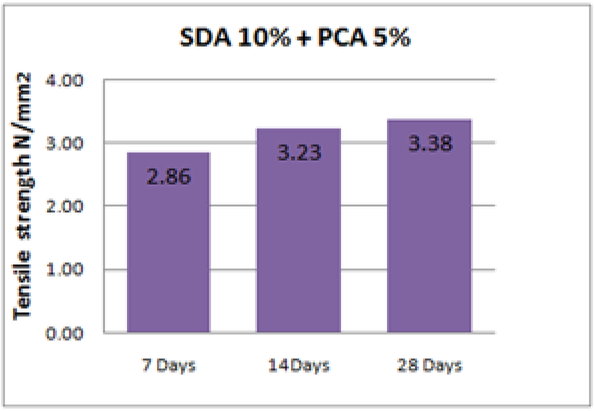


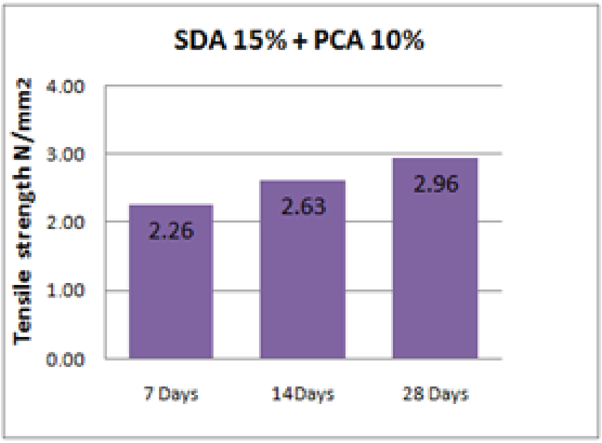

SDA 5% + PCA 10%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.54
2.78
3.00
7 Days
14Days
28 Days

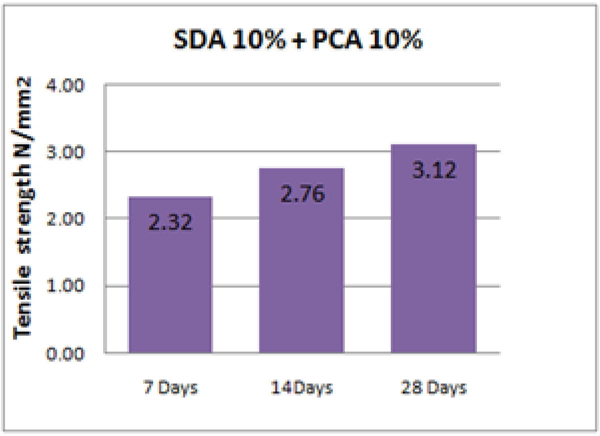

SDA 10% + PCA 15%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.28
2.70
2.94
7 Days
14Days
28 Days

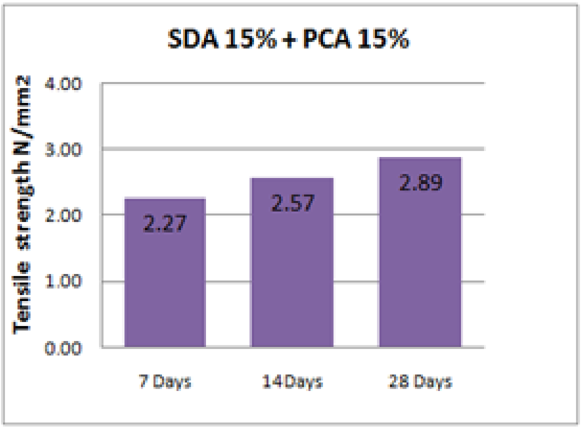

SDA 5% + PCA 15%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.38
2.59
2.83
7 Days
14Days
28 Days


SDA 15% + PCA 5%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.42
2.87
3.06
7 Days
14Days
28 Days


SDA 10% + PCA 5%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.86
3.23
3.38
7 Days
14Days
28 Days


SDA 15% + PCA 10%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.26
2.63
2.96
7 Days
14Days
28 Days


SDA 10% + PCA 10%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.32
2.76
3.12
7 Days
14Days
28 Days


SDA 15% + PCA 15%
Tensile strength N/mm2
4.00
3.00
2.00
1.00
0.00
2.27
2.57
2.89
7 Days
14Days
28 Days

CONCLUSION

- This study intended to find the effective waste to re-utilize the hard plastic as coarse aggregate and saw dust ash as cement in concrete.
- Concrete become less workable as the SDA percentage increases i.e., more water is required to make the mix more workable. It means that SDA concrete has higher water demand.
- By adding of plastic to the concrete the density of concrete will decreases.
- From the above investigation we have concluded that 10% of SDA and 5% of PCA we can replace in concrete and utilize the benefits. The compressive strength at 7,14,28 days are 16.75 N/mm2, 21.24 N/mm2, 23.377 N/mm2 and tensile strength 2.865 N/mm2, 3.226 N/mm2, 3.384 N/mm2.

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