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Experimental Investigation on Partial Replacement of Arecanut Ash with Cement by Concrete

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ABSTRACT: This study investigates the feasibility of concrete using arecanut ash (ANA) as a partial replacement for cement in concrete. ANA is a waste material obtained from the processing of arecanut, a widely cultivated crop in tropical regions. The study aimed to evaluate the effect of ANA on the compressive strength, split tensile strength, and flexural strength of concrete. The results showed that partial replacement of cement with arecanut ash up to 5%,10%,15%, can improve the mechanical properties of concrete. The study concludes that ANA can be used as a sustainable and eco-friendly alternative to cement, reducing the environmental impact of concrete production.

KEYWORDS: ARICULTURE WASTE ,ARECANUT ASH,

I. INTRODUCTION

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens (cures) over time. When aggregate is mixed with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and moulded into shape. Standard ready-mix concrete is the most common form of concrete. It is prepared for delivery at a concrete plant instead of mixed on the construction site, which guarantees the quality of the concrete

II. LITERATURE SURVEY

[1]**Sushmitha Devi : (May 2016)** Foundry sand is the waste sand which is obtained when the sand can no longer be used in the metal foundries. Foundries successfully recycle and reuse the sand many times in casting process. Generation of waste foundry sand, by-product of metal casting industries causes environmental problems because of its improper disposal. Thus, its usage in building material, construction and in other fields is essential for reduction of environmental problems. In our project work an attempt is made to increase the split tensile strength of the concrete by the partial replacement of the cement with the Areca nut husk ash and replacement of fine aggregate with the foundry sand. The assumption is considered that the Areca nut ash consists of fibrous properties and as it is unutilized it is available in a very large quantity leading to the formation of large bio waste, hence the Areca nut husk can be used for good results. This work is conducted to investigate the performance of concrete discarded foundry sand as a replacement of fine aggregate and cement with partial replacement of Areca nut husk ash. The cement is partially replaced with the percentages of 0, 5, 10, 15, 20. Compressive strength was increased from 16.8N/mm² to 19.22N/mm² for 7 days of curing and compressive strength is increased 21.33N/mm² to 21.55N/mm² that is upto 10% replacement of AHA for 28 days of curing and it was seen that the tensile property is decreased from 1.98N/mm² to 1.83 N/mm² for 7days of curing and relatively the tensile strength is increased from 2.05 N/mm² to 2.26 N/mm² for 28 days Compressive and tensile strength at 10% replacement of Arecanut husk ash to cement gives optimum strength.

[2]**Vinaya Shyam: (June 2018)** large construction, concrete is preferred as it has longer life, low maintenance cost and better performance. Ordinary Portland cement is the most common type of cement in general use around world because of its high compressive strength .The arecanut is the seed of the areca palm and extensively cultivated in India. According to an estimate India produces about 3000 million tons of husk waste annually. In this project the recycling recycled of arecanut husk ash as supplementary cementitious material in respect of the excess aggregate concrete. The mixes are prepared with 5 percent intervals (0, 5, 10, 15 and 20) of arecanut husk ash as a partial replacement of Portland cement. Concrete cubes are tested for compressive strength up to the age of 28 days. Test results have shown that arecanut husk ash is an effective pazzolanic material which gives the better result at the optimal replacement ratio of 10%. Compressive strength of recycled aggregate concrete without replacing Arecanut husk ash at the age of 28 days

is 37.37 N/mm² which is more than target mean strength (32.6 N/mm²). Compressive strength of recycled aggregate concrete with 10% replacement Arecanut husk ash at the age of 28 days is 33.6N/mm² which is more than target mean strength. 3. By observing the cost comparison of ARC with conventional concrete, found economical.

[3]Shashikant Singh :(September 2015) This paper reports the recycling of arecanut husk ash as supplementary cementitious material in respect of cement mortars. The mixes are prepared with five percentages (0, 10, 15, 20, and 25) of arecanut husk ash as partial replacement of port land cement. The properties investigated are; chemical composition, particle size, presence of crystalline matter, compressive strength, water absorption and sorption. Mortar cubes are tested for compressive strength up to the age of 56 days, whereas water absorption and sorption tests are carried out at the age of 28 days. Test results have shown that arecanut husk ash is an Effective pozzolan up to the optimal replacement ratio of 20% cement with better water absorption characteristics. 7-, 14-, 28- and 56-day compressive strength obtained for control mortar cubes were 23.2-, 33.6-, 43.2- and 47.2-MPa respectively. A significant increase in compressive strength of 3.44%, 7.14%, 1.85% and 3.38% at 7-, 14-, 28- and 56-day respectively was observed for 10% replacement of cement (ANA 10) than the control samples. However replacement with 15% and 20% ANA resulted in close comparable compressive strength. This increase in compressive strength is due to amount of silica in ANA. Setting times of the blended pastes were extended by incorporation of ANA and this will be helpful for concrete that has to be transported to long distance and to offset the effect of high temperatures.

III. MATERIALS

Cement: Ordinary Portland Cement (OPC) is the most preferred binder in the manufacturing of concrete which are locally acquired as maha OPC of 43 grade cement conforming to IS 12269 is used as shown in fig 4.1 .The cost of production is not expensive making it the sought after cement in the building industry. They are widely used for the construction of high-rise buildings, roads, dams, bridges, flyovers. Also, Ordinary Portland cement is used for making grouts and mortars. OPC is ideal for the construction of residential and industrial complexes. The physical and chemical test properties were conducted as per IS 4031 - 1988 and IS 4032 — 1985.



Fig.1 CEMENT

Sl.No.	Oxides	Percent Content
1	CaO	60.84
2	SiO ₂	16.34
3	Al ₂ O ₃	6.95
4	Fe ₂ O ₃	5.38
5	MgO	2.32
6	S ₂ O ₃	1.99

7	K ₂ O	2.73
8	Na ₂ O	1.50

Table:1 43-Grade Portland Cement Chemical Composition (IS: 12269-1987)

ARECANUT ASH (ANA):

Here are some detailed characteristics and properties of arecanut ash (ANA):

Physical Properties

- Color: ANA is typically grayish-white or light brown in color.
- Texture: ANA is a fine, powdery material with a smooth texture.
- Particle Size: The particle size of ANA ranges from 0.01 to 0.1 mm.
- Specific Gravity: The specific gravity of ANA is around 2.2-2.5.
- Bulk Density: The bulk density of ANA is around 0.5-0.7 g/c

Pozzolanic Properties

Pozzolanic Activity Index: 70-90% ANA exhibits pozzolanic activity due to the presence of silica and alumina, which react with calcium hydroxide to form calcium silicate hydrate (C-S-H) gel.

Applications

- Supplementary Cementitious Material (SCM): ANA can be used as a SCM in concrete to improve its strength, durability, and sustainability.
- Soil Stabilization: ANA can be used to stabilize soils and improve their engineering properties.
- Waste Management: ANA can be used to manage waste materials, such as industrial waste and agricultural waste.

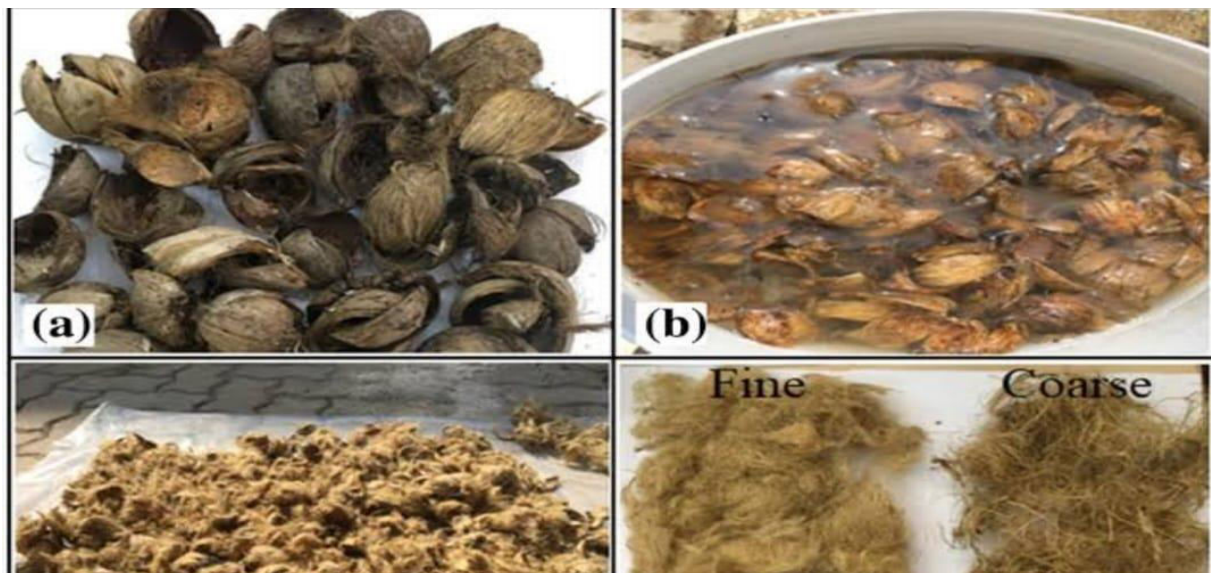


Fig:2 ARECANUT ASH WASTE

Fine Aggregate: Fine aggregate is one of the crucial components of the concrete. For the present study, the fine aggregate proportion of the concrete constituted by the natural sand. Crushed stone sand conforming to IS 383 - 2016 from SS crusher, Cheyyur are used as fine aggregates as shown in fig 1.1. Manufactured sand is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand is less than 4.75mm. They are used in construction industry mainly for concrete production and mortar mix. This is mainly crushed fine aggregate produced from a sources

material with suitable strength, durability, and shape characteristics.



FIG: 3 SAND

Coarse Aggregate In the present study the natural coarse aggregates produced by crushing stones was procured from the local quarry. The coarse aggregates were 10mm down size also called chips. The specifications of IS:2386-1963 were followed while using the coarse aggregates for the study.



FIG: 4 COARSE AGGREGATE

IV. PRELIMINARY TESTS & RESULTS

Table 2 specific gravity test on cement

Description of item	Trial 1	Trial2	Trial 3
Weight of empty bottle W1 g	51	51	51
Weight of bottle + Cement W2 g	77	68	71
Weight of bottle + Cement + DIESEL W3 g	149	143	146
Weight of bottle + Full Kerosene W4 g	130	130	130
Weight of bottle + Full Water W5 g	150	151	150
Specific gravity of cement	3.605		

Table 3 normal consistency test on cement

TRIAL	Mass of Cement (grams)	Percentage of Water Added	Vicat's Needle Penetration
1	400	30%	4.5 mm
2	400	28%	6.0 mm
3	400	26%	8.0 mm
4	400	24%	9.5 mm

Table 4 specific gravity of fine aggregate

Observations	Trial 1	Trial 2	Trial 3
Weight of the pycnometer (W1), g	620	620	620
Weight of pycnometer + 1/3 rd filled with sand(W2), g	1189	1182	1179
Weight of pycnometer + 1/3 rd filled with sand + water(W3), g	1837	1839	1842

Weight of pycnometer + water (W4), g	1515	1515	1515
Specific gravity= $(W2-W1)/((W4-W1)-(W3-W2))$	2.52	2.51	2.50
Average Specific gravity	2.51		

Table 5 fine aggregate sieve analysis details.

Sieve size (mm)	Mass of sand retained(gm)	% Retained	Cumulative %retained	%Passing
4.75	31.5	3.15	3.15	96.85
2.36	108	10.8	13.95	86.05
1.18	103	10.3	24.25	75.75
0.6	262	26.2	50.45	49.55
0.3	442	44.2	94.65	5.35
0.15	44	4.4	99.05	0.95
Pan	9.5	0.95	100	0

Table 6 specific gravity test on coarse aggregate

W1- Weight of empty pycnometer with lid	0.627kg
W2- Weight of pycnometer + C.A	1.107kg
W3 -Weight of pycnometer + C.A +water	1.771kg
W4-Weight of pycnometer +water	1.482kg
Specific gravity	2.606

Table 7 coarse aggregate sieve analysis details

Sieve Size (mm)	Empty Weight (M1)kg	Weight The Sieve +Weight of coarse aggregate (M2) (Kg)	Weight of coarse aggregate (M2- M1) (Kg)	%Retained In Each $M2-M1 * 100 M$ (%)	Cumulative (%)	% FINES S
40	0.880	0.880	0	0	0	100
25	0.820	1.140	0.320	6.4	6.4	93.6
20	0.850	2.080	1.24	24.8	31.2	68.8
16	0.920	3.060	2.140	42.8	74	26
12.5	0.760	1.74	0.980	19.6	93.6	6.4
10	0.780	0.988	0.200	4	97.6	2.4
4.75	0.820	0.92	0.100	2	99.6	0.4
PAN	0.720	0.74	0.020	0.4	100	0

Table 8 coarse aggregate impact test details

OBSERVATION	Trial 1(gms)	Trial 2(gms)	Trial 3(gms)
Total weight of the aggregate filling the cylinder metal measure (W1)	320	325	318
Weight of aggregate passing through 2.36 mm sieve (W2)	55	57	50
Aggregate impact = $W2/W1 \times 100$	17.18	17.5	15.7

Table 9 Coarse Aggregate Crushing Value Test Details

OBSERVATION	Trial 1(gms)	Trial 2(gms)	Trial 3(gms)
Total weight of the dry sample (W1)	3156	3115	3165

Weight of aggregate passing through 2.36 mm sieve (W2)	387	350	390
Aggregate crushing = $W2/W1 \times 100$	12.26	11.23	12.23

Table 10 Coarse Aggregate Crushing Value Test Details

OBSERVATION	Trial 1(gms)	Trial 2(gms)	Trial 3(gms)
Total weight of the dry sample (W1)	31156	3115	3165
Weight of aggregate passing through 2.36 mm sieve (W2)	397	360	400
Aggregate crushing = $W2/W1 \times 100$	12.57	11.55	12.63

Result: - The average aggregate crushing value is = 12.25 %.

Table 11 Coarse Aggregate Impact Test Details:

OBSERVATION	Trial 1(gms)	Trial 2(gms)	Trial 3(gms)
Total weight of the aggregate filling the cylinder metal measure (W1)	320	325	318
Weight of aggregate passing through 2.36 mm sieve (W2)	60	62	64
Aggregate impact = $W2/W1 \times 100$	18.75	19.07	20.125

Result: - The average aggregate impact value is = 19.315%

V. METHODOLOGY

- Basically work is experimental oriented. Initially the guidance of IS10262-2019 a trial mix
- of concrete grade M20 has been designed. The mix proportions obtained for control.
- concrete has been used for design of concrete by replacing by cement by arecanut ash . The unique mix design
- blocks and mixes was based on several trials using standardized code available.
- The methodology involved in manufacturing of concrete blocks is as follows
- The various literatures were reviewed as per the existing.
- The project utilizes agricultural waste and that are collection area.
- The steps involved are testing the raw materials on physical properties.

- In the next step the blended materials such as cement, coarse aggregate and fine aggregate, agricultural waste, fine aggregate and coarse aggregate in various proportions and to develop concrete blocks as per Indian Standard code of specifications.
- Then blocks are tested for “Standard quality control tests” such as compression, split tensile and flexural test.



Flow Chart

VI. EXPERIMENTAL TESTS AND RESULT

TABLE 12 COMPRESSIVE STRENGTH TEST DETAILS:

Mix id	Water cement ratio	Cement replacement With arcanut Husk ash	Compressive test N/mm ²	
			7days	28days
Mix 5%	0.40	34 g	24.44	35.55
Mix 5%		34 g	26.66	33.33
Mix 5%		34 g	26.66	34.10
Mix 10%	0.40	69 g	22.22	26.66
Mix 10%		69 g	28.88	31.11
Mix 10%		69 g	29.20	34.66
Mix 15%	0.40	104 g	17.77	24.44
Mix 15%		104 g	17.77	31.11
Mix 15%		104 g	17.99	28.88

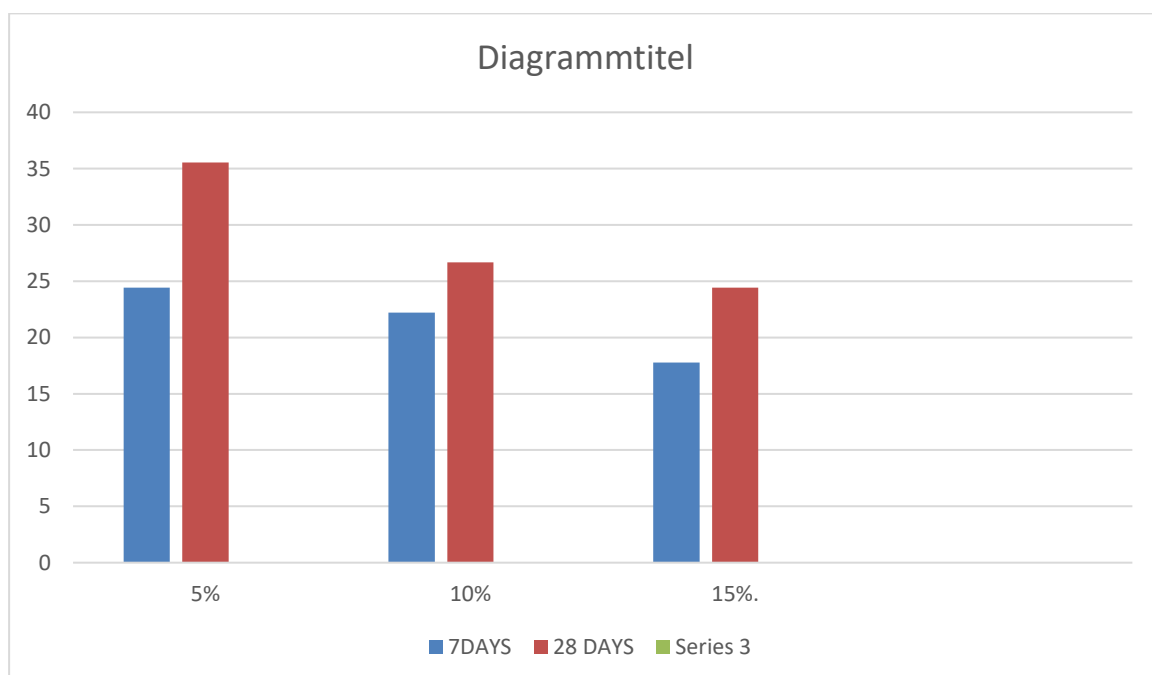


TABLE 13 TENSILE STRENGTH TEST

Mix id	Water cement ratio	Cement replacement With aracanut Husk ash in grams	Split tensile strength N/mm ²	
			7days	28days
M5%	0.40	0.0049	0.3183	0.7957
M5%		0.0049	0.3183	0.7957
M5%		0.0049	0.3183	0.8000
		0.0049		
M10%	0.40	0.0049	0.4456	0.9549
M10%		0.0049	0.4617	0.9549
M10%		0.0049	0.4777	0.9549
		0.0049		
M15%	0.40	0.0049	0.5092	1.1132
M15%		0.0049	0.5092	1.1459
M15%		0.0049	0.5092	1.1506

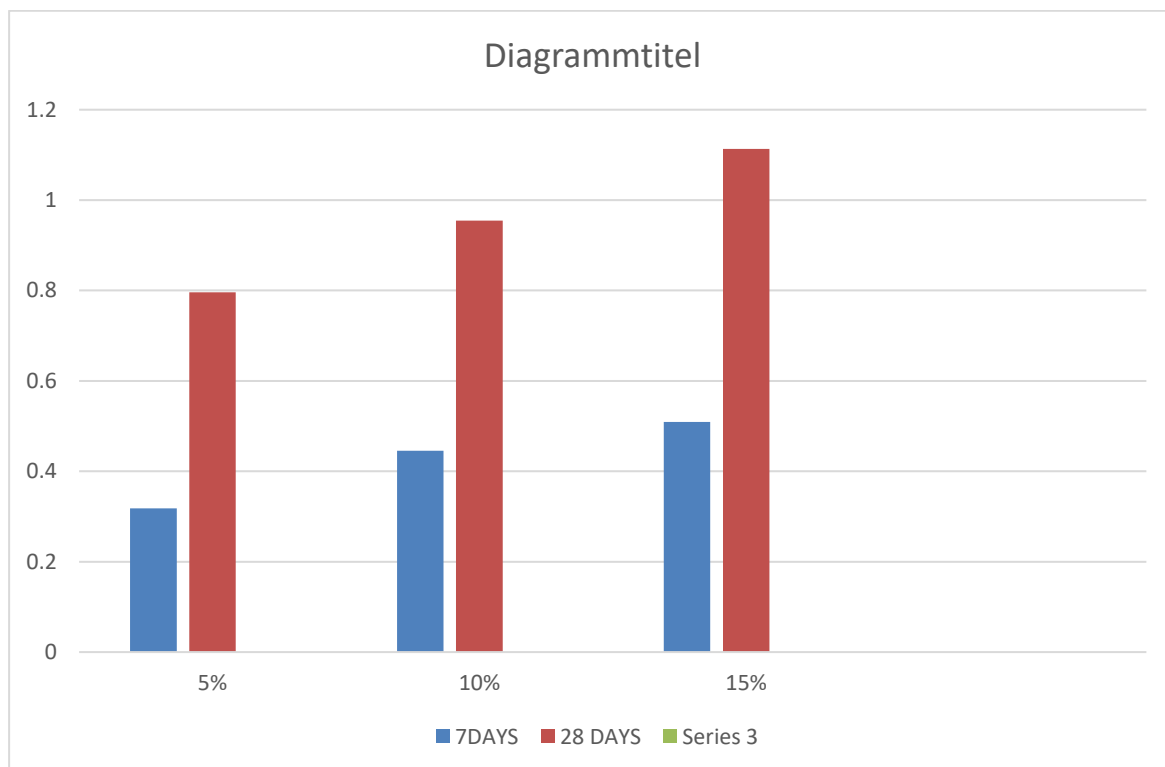


TABLE 14 FLEXURAL STRENGTH TEST

Mix id	Water cement ratio	Cement replacement With aracanut Husk ash	Flexural strength N/mm ²	
			7days	28days
Mix 5%	0.40	100	1.38	2.4
Mix 5%		100	1.44	3.3
Mix 5%		100	1.50	3.5
Mix 10%	0.40	200	1.22	2.04
Mix 10%		200	1.32	2.70
Mix 10%		200	1.28	2.55
Mix 15%	0.40	300	0.96	2.7
Mix 15%		300	1.08	2.16
Mix 15%		300	1.5	1.944

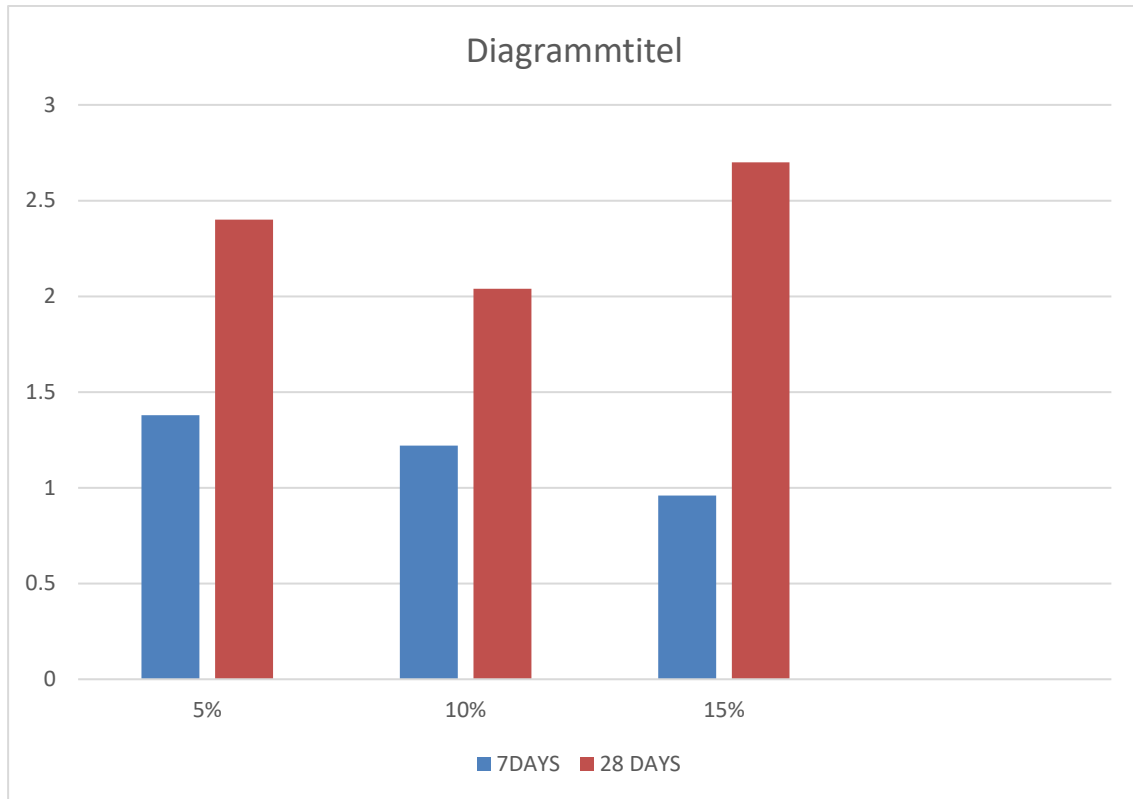
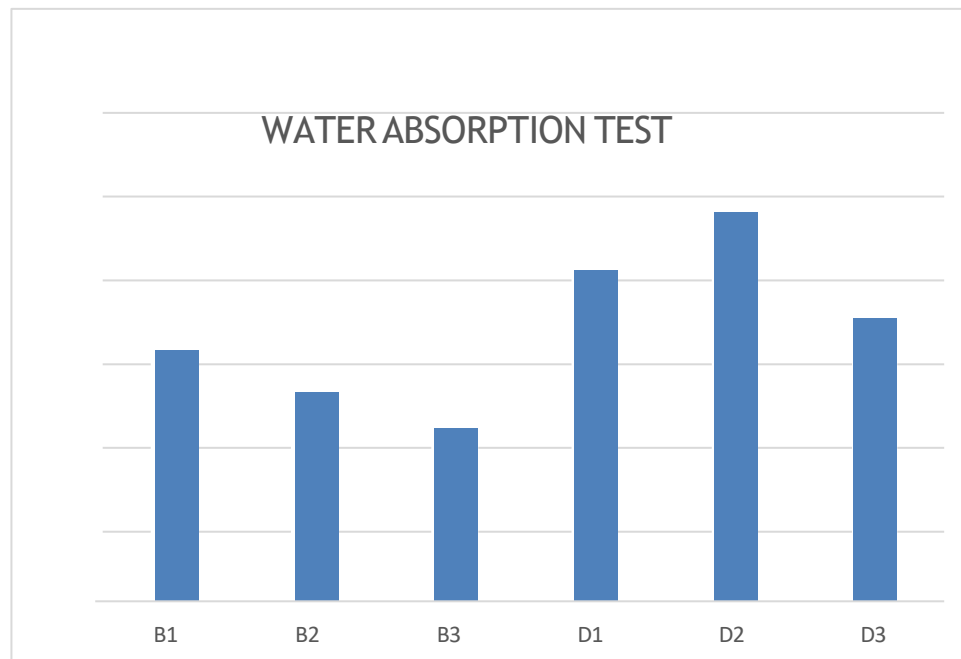


TABLE 15 sWater Absorption Test Details

TYPE	WATER ABSORPTION (%)
	28-days
B-1	0.159
B-2	0.133
B-3	0.110
D-1	0.210
D-2	0.247
D-3	0.180

Water Absorption Graph



VII. CONCLUSION

As this method encourages the utilization of arecanut ash waste, it reduces the improper disposal of the same into landfills and it is more sustainable. From the test results, it can be inferred that the replacement of cement by arecanut ash waste can be recommended. It can be used in construction

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