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Agriculture Waste Used as Partial Replacement in Green Concrete Manufacturing

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Abstract: Nowadays the total requirement of concrete increased in the whole world. This paper is about green concrete based on agricultural waste, research is using agricultural waste as a substitute for cement. Concrete mix proportion used is 1:1:2 (concrete of grade M25), from that quantities of different materials find out for Rice Husk Ash and Coconut Shell as a partial replacement of cement and coarse aggregates respectively. Like this three mix design done, one mix for Rice husk, one for coconut shell and one for combination of both.

Agricultural waste contains chemical compounds which have pozzolanic properties. The rice husk ash is finely ground material which can give the pozzolanic reaction. The silica contents in the agricultural waste material reacted with calcium oxide to produce calcium silicate gel helps in binding the concrete. Some researches has been done for the use of agricultural waste in concrete.

Collection of materials, mix design and quantities required to produce concrete blocks is find out then actual preparation of concrete blocks and different test on concrete done in this experiment. From the experimentation result is that 9% utilization of these materials in the replacement of cement gives rise to 15% increase in strength of concrete. Rice husk ash powder has a large amount of silica with which gives pozzolanic action and increases the strength. Use of coconut shell pieces of proper size (i.e. 20 mm nominal size) as a partial substitute of coarse aggregates in different percentage ranging from 0% to 50%. From the experiment results, if coconut shells used greater than 12.5% by weight of coarse fraction gives lightweight concrete without much reduction in strength. Use of both Rice husk ash and coconut shell improves test results than concrete with only coconut shell replacement. Its use reduces the environmental burden of decomposition of organic waste and also reduces pollution generated by it.

Keywords: Pozzolanic, Rice Husk Ash, Coconut Shell, Partial replacement, Agro-waste.

I. INTRODUCTION

Concrete is the second largest used material on the earth while water came first. We were harming the nature with the use of conventional concrete. It enormous areas that results in some environmental impact like it kills the Habitat and it requires natural resources in production. Also produces ground water pollution, air pollution due to emission of CO_2, soil pollution, etc.

Civil engineers especially structural engineer play a vital role in the betterment and environmental conservation that we live in. That is why, as future structural engineer, aims to produce eco-friendly green Concrete by using agricultural waste, specifically coconut shells, as a partial alternative to fine aggregates and be able to utilize plenty of available agro-waste materials that can be used in the design mix of the Green concrete. Two of the materials find out which can be used in concrete these are coconut shell and rice husk ash, wherein coconut shells would be used to partial substitute coarse aggregate and rice husk ash for partial substitution to cement. Coconuts are abundantly available in tropical countries like the India, but it also means excessive waste, such as coconut shells. Hence, the aim is to connect the environmental problems caused by the use of conventional concrete and agro-waste problem. It also aims to achieve several Sustainable Development Goals such as creating resilient infrastructure, building sustainable cities and communities, and climate change mitigation. Furthermore, its purpose is to elevate the economy and bring green development in the construction industry, whether locally or globally, resulting in productive employment and further boosting the economy.

This project studies that use of agriculture waste in concrete and its effectiveness. Impact of using agriculture waste in concrete by partial substitution give some difference in properties than the normal concrete. From that some effects are beneficial some are not. Use of ash and coconut shell in concrete gives lightweight concrete. Use of agriculture waste reduces emission of carbon dioxide during production of cement and transportation of natural aggregate. Conservation of natural aggregates can be done by the use of coconut shell as a partial replacement of coarse aggregate.

On the other hand the strength of concrete may affect with large amount of replacement. Small amount of replacement lead to same strength as that of normal concrete. Both coconut shell as partial replacement of coarse aggregate and rice husk as partial replacement of cement used at a time leads to greater strength than used separately. This is the first time that coconut shell and rice husk ash used in concrete. This concrete can be used in small scale construction like one story to two story house, footpaths, compound walls, small cow shades, etc. Less harm to the nature also conservation of nature can be done with the use of this agriculture waste based type green concrete. With the use of agriculture waste in concrete we will take small steps towards conservation of natural resources, less energy use and sustainable development.

This paper summarizes feasibility of use of agro-waste products in concrete, to improve the environmental friendliness of concrete, to make it "Sustainable Green Building Material". It is the most economical and environment friendly partial replacement for ordinary Portland cement (OPC) and coarse aggregates with Rice Husk Ash and Coconut Shell respectively.

A. *Objective of this project work is as follows*

1) To find the agricultural waste things that can be used to replace concrete component to make green concrete.
2) To find percentage by which it can replace concrete components.
3) To determine the concrete mix design for green concrete.
4) To find workability of concrete,
5) By comparing with normal mix, find out optimum percentage by which concrete component can be replace to get require strength.

II. LITERATURE REVIEW

TABLE I
LITERATURE REVIEW

Sr. no.	Title of paper	Journal name and Issue	Author detail	Finding	Remark
1.	Experimental Investigation on Partial Replacement of Rice Husk Ash as Cement and Coconut Shell as Coarse Aggregate for the Production of Light Weight Concrete.	*International Research Journal of Engineering and Technology (IRJET)* Volume: 05 Issue: 08, Aug 2018	Dileep Kumar B M, S Suresh	This paper is about rises cash and coconut shell used as partial replacement in concrete with 10% RHA and 5%, 10%, 15%, 20% and 25% CS. Study was done for mechanical and durability property of RHA and CS concrete. 25% replacement gives 10 to 13% less dense than concrete. Compressive strength and split tensile strength increases by 13 and 23% for 10 % RHA and decreases with addition of CS. Chloride permeability also increase by 24% for 25% replacement then normal concrete.	Total 25% replacement of coarse aggregate by coconut shell and ordinary portland cement by rice husk ash gives light weight and nearly same strength concrete as normal mix.
2.	Rice husk ash as a potential supplementary cementitious material in concrete solution towards sustainable construction.	*Innovative Infrastructure Solutions* (2021)	Ganta Mounika, Ramesh Baskar, Jyosyula Sri Kalyana Rama	The study based on the extensive review highlights the possibility for utilizing the RHA as a conventional binder in concrete. RHA increases for smaller replacement up to 30% in concrete shows better bond strength when compared to conventional mix and it also reduces chloride diffusion, efflorescence and increases resistance to sulphate and chemical attacks.	RHA can be used up to 30% in concrete with good strength

3.	Coconut Shell as Partial Replacement of Coarse Aggregate in Concrete.	05 (02) 2018 *International Research Journal of Engineering and Technology*	Anand Ramesh, Anandhu K J	Results showed a rise in compressive strength at 7 days curing time for 5%, 10% replacement of coarse aggregate with coconut shell. There was a rise in compressive strength at 28 days curing time for 5% but strength lowered for 15% replacement of coarse aggregate with coconut shell. Splitting tensile strength decreased for 5% replacement of coarse aggregate with coconut shell.	Coconut shell has more power to resist crushing, and impact compared to traditional aggregate.
4.	Use of Coconut Shell as Partly Substitution of Coarse Aggregate - An Experimental Analysis.	AIP Conference Proceedings 2158, 020021 (2019)	Sanjay Kumar Vermaand SagarShrivastava	On 10% partial replacement of natural coarse aggregate with waste Coconut shell, compressive strength of coconut shell concrete has obtained 20.10 N/mm2 at 28 days. Coconut shell can be grouped under lightweight aggregate because 28 day air dry densities of coconut shell aggregate concrete are less than 2000 kg/m3.	This research on coconut shell confirm that the coconut shell has potential as lightweight aggregate in concrete.
5.	Experimental study on partial replacement of coarse aggregate by coconut shell and ordinary portland cement by rice husk ash.	*International Journal of Scientific & Engineering Research* Volume 9, Issue 4, April-2018	R Gopinath, T Ajithkumar, M Nithin, V Sanjay Srikanth and P Sivakumar,	The percentage of replacement are 0%, 18%, 20%, 22%, 24% with coconut shell and 0%, 5%, 8%, 10%, 12% with rice husk ash. The characteristic properties of concrete such as compressive strength, split tensile strength using the mix made by partial replacement of coarse aggregate with crushed coconut shell aggregate and OPC with RHA. The results show that high strength is attained at replacement of 18% with CS and 8% with RHA.	With the replacement of 18% with CS and 8% with RHA strength of concrete increases.

III. MATERIALS AND METHODOLOGY

A. Materials Required to Produce Green Concrete

Agricultural waste as a partial replacement used in concrete-

1) Rice Husk Ash as a partial replacement of ordinary Portland cement.

2) Coconut Shell as a partial replacement of coarse aggregate

TABLE II
MATERIALS AND PLACE FROM WHERE IT GOT

Sr. no.	Materials required to produce concrete	Place from where it got
1	Rice Husk Ash	Industry named: Sainath Murmura Industry
2	Coconut Shell	From the tree which is in nearer farms
3	Ordinary Portland Cement (43 Grade)	Local shop
4	Coarse aggregate	Local crusher
5	Fine aggregate (Sand)	Local crusher
6	Water	Tap water

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B. Concert Mix Design

As per IS 10262: 2019

Mix Design for-

- Control Mix
- Mix type 1. Partial replacement of cement by Rice husk ash,
- Mix type 2. Partial replacement of coarse aggregates by Coconut shell and
- Mix type 3. For both partial replacement of cement by Rice husk ash and partial replacement of coarse aggregates by Coconut shell.

1) *Requirement For Proportioning*

a) Mix proportion: 1:1:2 (M 25)
b) Type of cement: OPC 43 grade
c) Type of partial replacement: Rice husk ash and Coconut shell
d) Maximum nominal size of aggregate: 20mm
e) Minimum cement content: 300 kg/m^3 as per Table 5 of IS 456-200.
f) Maximum water-cement ratio: 0.50
g) Workability: 100 mm (slump)
h) Exposure condition: Moderate (for reinforced concrete)
j) Type of aggregate: Crushed angular aggregate

2) Test Data For Materials

a) Cement used: OPC 43 grade
b) Specific gravity of cement: 3.15
c) Specific gravity of Rice husk ash: 2.14
e) Specific gravity of
1) Coarse aggregate: 2.74 2) Fine aggregate: 2.74 3) Coconut shell: 1.33
f) Water absorption:
1) Coarse aggregate: 0.5 percent. 2) Fine aggregate: 1.0 percent
g) Free (surface) moisture:
1) Coarse aggregate: Nil (absorbed moisture also nil) 2) Fine aggregate: Nil
h) Sieve analysis:
1) Coarse aggregate

TABLE III
SIEVE ANALYSIS

IS sieve size (mm)	coarse aggregate fraction		other percentage of fractions			Remark
	I	II	I 60 %	II 40 %	Combined 100 %	
20	100	100	60	40	100	Conforming to Table 7 of IS 383
10	0	72.50	0	27.5	27.5	
4.75		8.10		3.8	3.8	

C. Fine Aggregate

CONFIRMING TO ZONE I OF TABLE 9 OF IS 383.

1) Target Strength For Mix Proportioning

$$f_{ck}' = f_{ck} + 1.65\ s \text{ or } f_{ck}' = f_{ck} + X$$

Where,
f_{ck}' = target average compressive strength at 28 days,
f_{ck} = characteristics compressive strength at 28 days, and
s = standard deviation as per Table 2 of IS 10262 – 2019.
X =factor based on grade of concrete as per Table 1 of IS 10262-2019.
From Table I, Standard Deviation, s = 4 N/mm^2.
Therefore, target strength f_{ck}' = 25 + 1.65 × 4 = 31.6 N/mm^2 or f_{ck}' = 25 + 5.5 = 30.5 N/mm^2
Whichever is greater, so target strength is 31.6 N/mm^2

2) Selection Of Water-Cement Ratio
From Fig 1 of IS 10262-2019, maximum water-cement ratio from curve 2 (for 43 grade of cement) is 0.484 for target strength of 31.6 N/mm^2. So, adopt w/c ratio = 0.45

3) Selection Of Water Content
From IS 10262: 2019 Table 4, maximum
Water content for 20 mm aggregate = 186 liter (for 50 mm slump)
Estimated water content for 100 mm slump= 186+ (6/100) × 186 = 197 liter

4) Calculation Of Cement And Agricultural Waste Content
Water-cement ratio = 0.45
Cementations material (for mix type 1, 3 = cement + Rice husk ash and for mix type 2 = cement only) content = (197/0.45) = 437.77 kg/m^3
From Table 5 of IS 456, minimum cement content for 'moderate' exposure conditions
437.77 kg/m^3> 300 kg/m^3, hence. O.K.

5) Proportion Of Volume Of Coarse Aggregate And Fine Aggregate Content
From Table 3, IS 10262 : 2019, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone I) for water-cement ratio of 0.50 =0.60.
For pump able concrete these values should be reduced by 10 percent.
Therefore, volume of coarse aggregate =0.60 x 0.9 =0.54.
Volume of fine aggregate content = 1 – 0.54 = 0.46.

6) Mix Calculations
The mix calculations per unit volume of concrete shall be as follows:
a) Volume of concrete = 1 m^3
b) Volume of cement = (Mass of cement/Specific gravity of cement) x (1/1000)
c) Volume of Rice husk ash
= (Mass of rice husk ash/Specific gravity of rice husk ash) x (1/1000)
d) Volume of water = (Mass of water/Specific gravity of water) x (1/1000)
= (197/1) x (1/1000) =0.197 m^3
e) Volume of all aggregates = [a - (b + c + d)]
f) Mass of fine aggregate = Volume of all aggregates x volume of fine aggregate x Specific gravity of fine aggregate x 1000
g) Mass of coarse aggregate = Volume of all aggregates x volume of coarse aggregate x Specific gravity of coarse aggregate x 1000
h) Volume of Coconut shell = (Mass of coarse aggregates/ Specific gravity of Coconut shell) x (Percentage of coconut shell to be used/100)
I) Entrapped air volume
Entrapped Air, as Percentage of Volume of Concrete is 1% for 20 mm coarse aggregate. So for 1m^3 of concrete = 0.01 m^3 entrap air

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- For Control Mix i.e. for no replacements-

TABLE IV
WEIGHT OF QUANTITIES PER M^3 FOR CONTROL MIX FOR M25

Weight of cement (kg)	Weight of fine aggregate (kg)	Weight of coarse aggregate (kg)	Weight of water (lit.)
437.77 (0.139 m^3)	824.74	967.22	197

- For Mix type 1 –

TABLE V
WEIGHT OF RICE HUSK ASH, CEMENT, COARSE AND FINE AGGREGATES PER M^3 FOR MIX TYPE 1

RHA percentage	RHA as % by weight of cement (kg)	Cement (OPC) (Kg/m^3) = 437.77 – RHA weight (kg)	Weight of fine aggregate (kg)	Weight of coarse aggregate (kg)	Water content (lit.)
3%	13.13	424.64	824.74	967.22	197
6%	26.26	411.51	824.74	967.22	197
9%	39.40	398.37	824.74	967.22	197
12%	52.53	385.24	824.74	967.22	197
15%	65.66	372.11	824.74	967.22	197

- For Mix type 2 -

Value of mass and Weight of cement, water and total aggregates per m^3 is same as control mix.

TABLE VI
WEIGHT OF COCONUT SHELL, CEMENT, COARSE AND FINE AGGREGATES PER M^3 FOR MIX TYPE 2

Coconut shell percentage	Weight of cement (kg)	Weight of fine aggregate (kg)	Weight of coarse aggregate Required (kg)	Weight of coconut shell (kg)	Actual weight of coarse aggregates (kg) = 967.22– weight of CS (kg)
12.5%	437.77	824.74	967.22	120.90	846.32
25%	437.77	824.74	967.22	241.81	752.41
37.5%	437.77	824.74	967.22	362.71	604.51
50%	437.77	824.74	967.22	483.61	483.61

- For Mix type 3-

Value of mass and volume of cement, water and total aggregates is same as control mix.

Calculation for volume of cement, Rice husk ash, total aggregates, and fine aggregates is same as that of Mix type 1, and calculation of volume of coarse aggregates and coconut shell is same as Mix type 2.

TABLE VII
VOLUME OF RICE HUSK ASH, COCONUT SHELL, CEMENT, COARSE AND FINE AGGREGATES PER M^3 FOR MIX TYPE 3

Rice husk ash percentage	Coconut shell percentage	Weight of Rice husk ash (kg/m^3)	Weight of cement = 437.77 – RHA (kg)	Weight of fine aggregate (kg/m^3)	Weight of coconut shell (kg)	weight of coarse aggregate = 995.77 – CS (kg/m^3)
9%	12.5%	39.40	398.37	824.74	120.90	846.32
9%	25%	39.40	398.37	824.74	241.81	752.41
9%	37.5%	39.40	398.37	824.74	362.71	604.51

7) Volume of materials required for 1 block of each type of Mix

Size of block to be prepare is 0.15m x 0.15m x 0.15m

Volume of one block = 0.003375 m^3

All calculation done for 1 m^3 volume of concrete. Require volume can be found out by dividing it by 0.003375.Photos showing Fresh Blocks prepared in mold and hard blocks after 28 days of curing.

With the use of mix design the concrete is prepared and cubes where form. Experimentation done on fresh and hard concrete. On the fresh concrete slum cone test, Compaction factor test where perform to find out workability and self-compaction property of concrete. Then blocks where prepared, after 24 hours of setting blocks were removed from mold. Curing of blocks were done for 7days and 28 days then different test where perform to find out strength. Water absorption test and Compression test had performed. Compressive test done for 7 days and 28 days of curing. Graphs of each test were drown from that an idea of for which percentage we get better result. Along with conventional tests one advance test is also performed, called Scanning Electron Microscope (SEM) for concrete mix with the use of both RHA and CS

Fig. 1 Agro-Waste used in concrete (a) RHA and (b) CS

(a) (b)

Fig. 2 Blocks preparation (a) Dry quantities of material for 12.5% CS, 9% RHA in concrete (b) Sample Photos of blocks

D. Concrete Tests Carried Out

In stage II Concrete tests carried out are as follows-

Different test that are conducted on fresh concrete and hard concrete

1) Slump cone test
2) Water absorption and weight comparison with normal mix.
3) Compressive strength test at 7 days and 28 days of curing
4) Scanning Electronic microscopy test (SEM)

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Volume 10 Issue V May 2022- Available at www.ijraset.com

a) Slump cone test

Use- To find out workability and consistency of concrete. To find out how easily it can handle and placed.

Performance and value findings- Slump cone test done on the plane plate and frustum of cone on it. This cone is firstly greased from inside. Then concrete were poured 1/3 portion of cone and it tamp for 25 number of times. Again second 1/3 portion filed and typing done for 25 times and lastly one more time done this process. After that cone were removed and it allow to flow under gravity. Measure the height of settlement that is the slump value. Slump value variation noted in the following results. Higher the value of slump more is the workability of concrete.

Fig. 3 Slump cone test

b) Compaction factor test

Use- To find out self-compacting properties of concrete.

Performance and value findings- By using the hand scoop, place the concrete sample gently in the upper hopper to its brim and level it and then cover the cylinder. At the bottom of the upper hopper, open the trapdoor so that concrete falls into the lower hopper and with the rod, push the concrete sticking on its sides gently. To fall into the cylinder below, open the trapdoor of the lower hopper and allow the concrete to fall. By using trowels, cut off the excess of concrete above the top level of the cylinder and level it, then clean the outside of the cylinder. To the nearest 10g weight the cylinder with concrete and this weight is called the weight of partially compacted concrete as W1. Empty the cylinder and then with the same concrete mix in layers approximately 5 cm deep refill it and to obtain full compaction, each layer has to be heavily rammed. Level the top surface and then weigh the cylinder with fully compacted which is known as the weight of fully compacted concrete as W2. Then as W, find the weight of the empty cylinder

Fig. 4 Compaction factor apparatus

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Volume 10 Issue V May 2022- Available at www.ijraset.com

Weight of Empty Cylinder = W_1
Weight of Empty Cylinder + Free Fall Concrete = W_2
Weight of Empty Cylinder + Hand Compacted Concrete = W_3
Weight of Partially Compacted Concrete = $W_P = W_2 - W_1$
Weight of Fully Compacted Concrete = $W_F = W_3 - W_1$
Compaction Factor = W_P / W_F

c) Water absorption and weight comparison with normal mix.

Use- Water absorption test is required to get an idea of how much water required for curing. This test is important due to lack of water in most of the aired region of India.

This test is also give superficial idea about strength of concrete, as water absorption increase there is decrease in strength.

Performance and value findings- First, specimens of size 0.15m x 0.15m x 0.15m were taken out from curing tank after 28 days of curing. Blocks keep for surface drying for 10 min. Then they were placed in an oven and maintained at 100 °C–110 °C for 24 h. After this period, specimens were allowed to cool at room temperature for 24 h and then the weights were measured frequently until the weights became constant. This value was considered as mass of the specimen and noted as A. The specimens were then immersed in water for 24 h and surface dried properly. The weights were taken in the surface dried condition and noted as B.

Water absorption (%) = [(B – A)/ A] * 100
A=Dry weight of specimen after oven drying
B= Wet weight of specimen after 24 hr. curing after drying.

d) Compressive strength test at 7 days and 28 days of curing

Use- Competition test use to find out load carrying capacity of concrete block.

Performance and value findings- In the compression test direction of loading is towards the specimen. Compression tests results in mechanical properties that include the compressive yield strength, compressive ultimate strength, and compressive modulus of elasticity in compression, % reduction in length etc.

The compressive loading tests on concretes were conducted on a compression testing machine of capacity 2000 kN. For the compressive strength test, a loading rate of 2.5 kN/s was applied as per IS: 516–1959. The test was conducted on 150mm cube specimens at 7 and 28 days. Each sample was weighed before putting into the crushing machine to ascertain it density. The compression strength of each sample was determined as follows-

Compressive strength = Crushing Load (kN) /Effective Area (mm^2)

Fig. 5 Compression test

e) Scanning Electronic microscopy test (SEM)

Use- Composition i.e. compounds form after hardening of concrete can be find out.

Effect on chemical bonding can be find out by Scanning Electronic microscopy test (SEM) test

Fig. 6 SEM Test specimen

Performance- Permeation of collage is taken before carried out the test. Test were performed in Central instrumentation facility, Savitribai Phule Pune University, Pune. 10 to 15 Test Blocks size 5mm x 5mm x 3mm were prepared to get an exact sized and sharp block. After 7days of curing blocks were sent to lab along with permeation letter and test fees. Blocks where scan under focused electron beam. Detector detects reflected electrons, and send signals to the computer to get a clear 3D image.

IV. RESULT AND DISCUSSION

A. Workability of concrete

Workability of concrete cane find out by slump cone test

1) Slump cone test values for concrete made with RHA

TABLE VIII

SLUMP CONE TEST FOR MIX-1

RHA replacement as cement (%)	Slump value (mm)
0	75
3	68
6	63
9	56
12	49
15	39

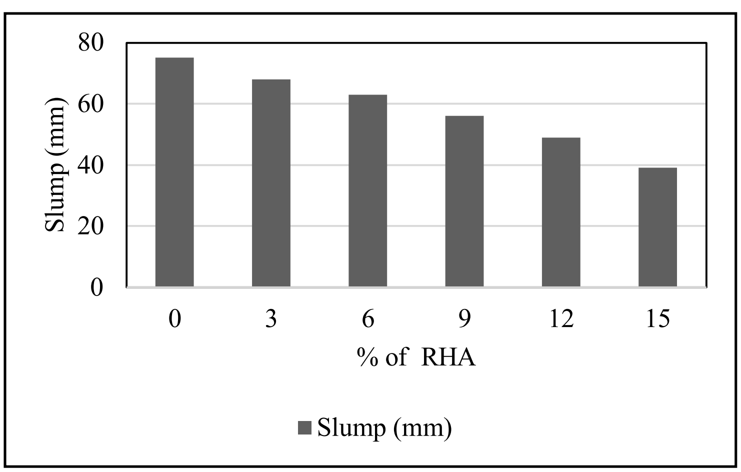

Fig. 7 Slump cone value chart for mix-1

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2) Slump cone test values for concrete made with coconut shell

TABLE IX
SLUMP CONE TEST FOR MIX-2

CS replacement as coarse aggregate (%)	Slump value (mm)
0	75
12.5	42
25	48
37.5	58
50	64

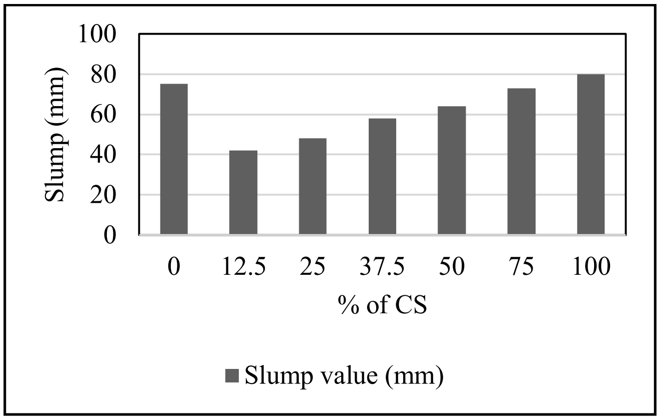

Fig. 8 Slump cone value chart for mix-2

3) Slump cone test values for concrete made with Rice husk ash and coconut shell

TABLE X
SLUMP CONE TEST FOR MIX-3

RHA replacement as cement (%)	CS replacement as coarse aggregate (%)	Slump value (mm)
0	0	75
9	12.5	68
9	25	63
9	37.5	56

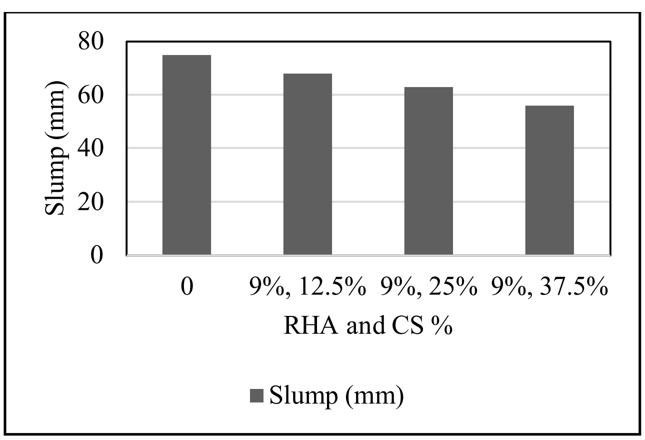

Fig. 9 Slump cone value chart for mix-3

B. Compaction factor test.

1) Compaction factor values for concrete made with RHA

TABLE XI
COMPACTION FACTOR FOR RHA USED IN CONCRETE

RHA as partial replacement of cement (%)	Compaction factor
0	0.872
3	0.868
6	0.865
9	0.862
12	0.855
15	0.851

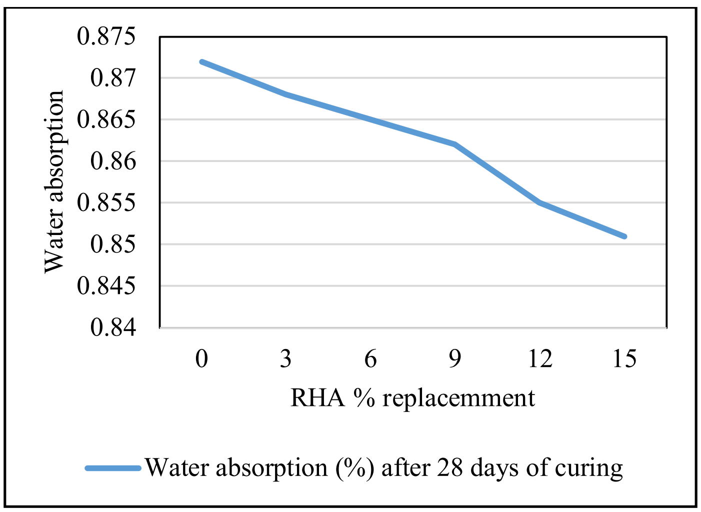

Fig. 10 Compaction factor for concrete Mix type 1

2) Compaction factor test values for concrete made with CS

TABLE XII
COMPACTION FACTOR FOR CS USED IN CONCRETE

CS as partial replacement of coarse aggregate (%)	Compaction factor
0	0.872
12.5	0.859
25	0.847
37.5	0.838
50	0.824

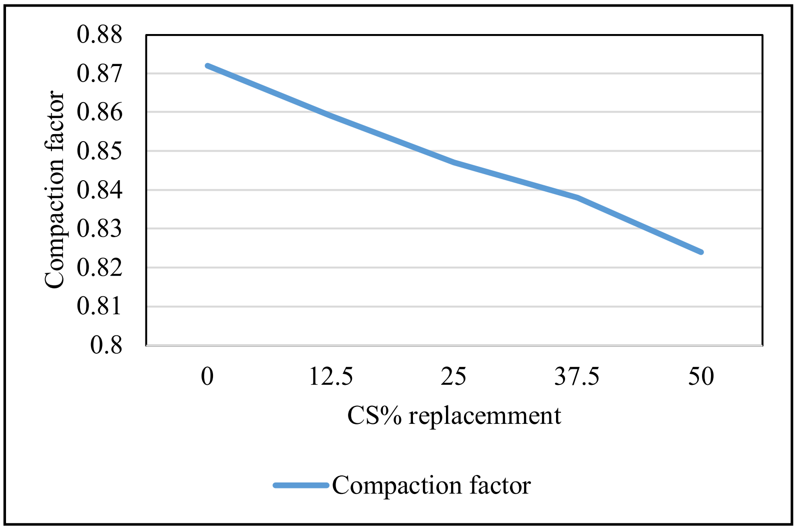

Fig. 11 Compaction factor for Mix type 2

3) Compaction factor test values for concrete made with RHA and CS.

TABLE XIII
COMPACTION FACTOR FOR BOTH RHA AND CS USED IN CONCRETE

RHA replacement as cement (%)	CS replacement as coarse aggregate (%)	Compaction factor
0	0	0.872
9	12.5	0.864
9	25	0.853
9	37.5	0.842

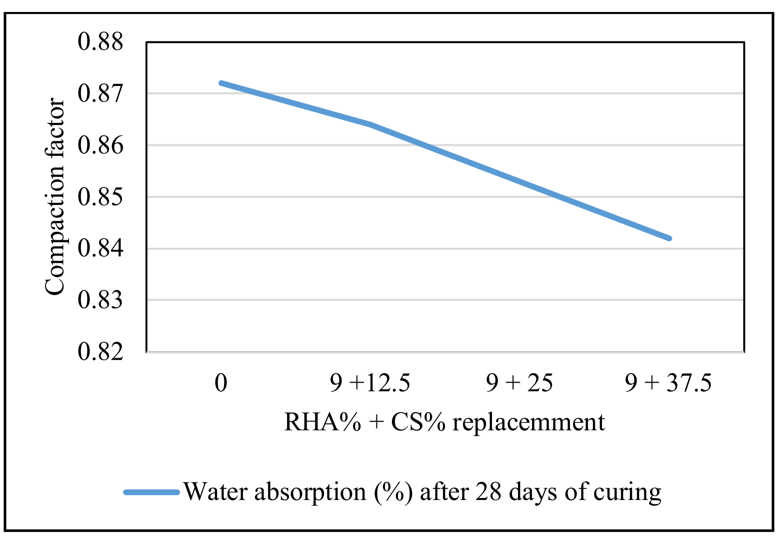

Fig. 12 Compaction factor for Mix type 3

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C. Water absorption

1) Water absorption (%) for concrete made with RHA

TABLE XIV
WATER ABSORPTION FOR RHA USED IN CONCRETE

RHA as partial replacement of cement (%)	Dry weight of block in kg	Water absorption (%) after 28 days of curing
0	8.53	1.09
3	8.48	1.18
6	8.44	1.21
9	8.39	1.38
12	8.35	1.51
15	8.31	1.60

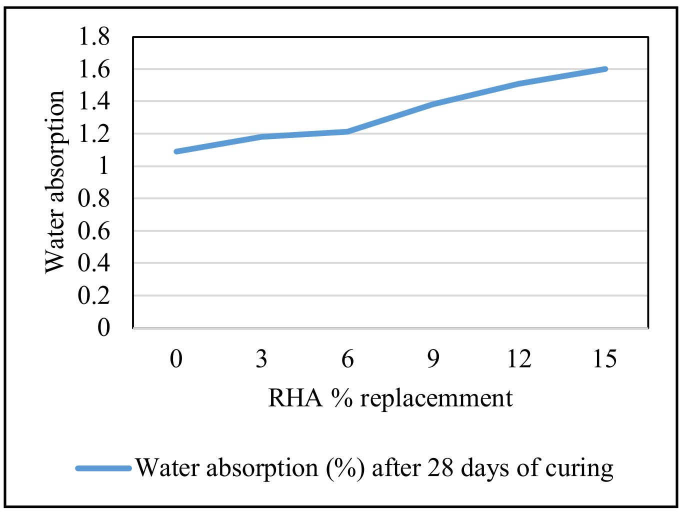

Fig. 13 Water absorption (%) for Mix type 1

2) Water absorption (%) for concrete made with CS

TABLE XV
WATER ABSORPTION FOR CS USED IN CONCRETE

CS as partial replacement of coarse aggregate (%)	Dry weight of block in kg	Water absorption (%) after 28 days of curing
0	8.53	1.09
12.5	7.58	2.62
25	7.77	4.96
37.5	7.58	6.43
50	7.42	8.10

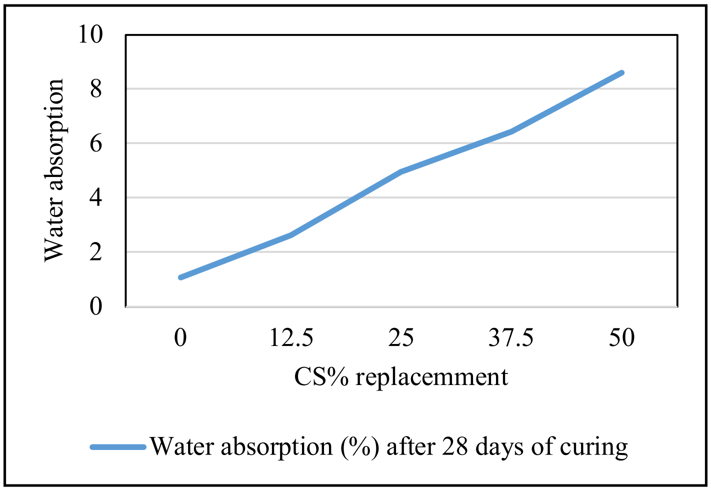

Fig. 14 Water absorption (%) for Mix type 2

3) Water absorption (%) for concrete made with RHA and CS

TABLE XVI
WATER ABSORPTION FOR BOTH RHA AND CS USED IN CONCRETE

RHA replacement of cement (%)	CS replacement of coarse aggregate (%)	Dry weight of block in kg	Water absorption (%) after 28 days of curing
0	0	8.53	1.09
9	12.5	7.96	3.07
9	25	7.57	5.08
9	37.5	7.31	7.58

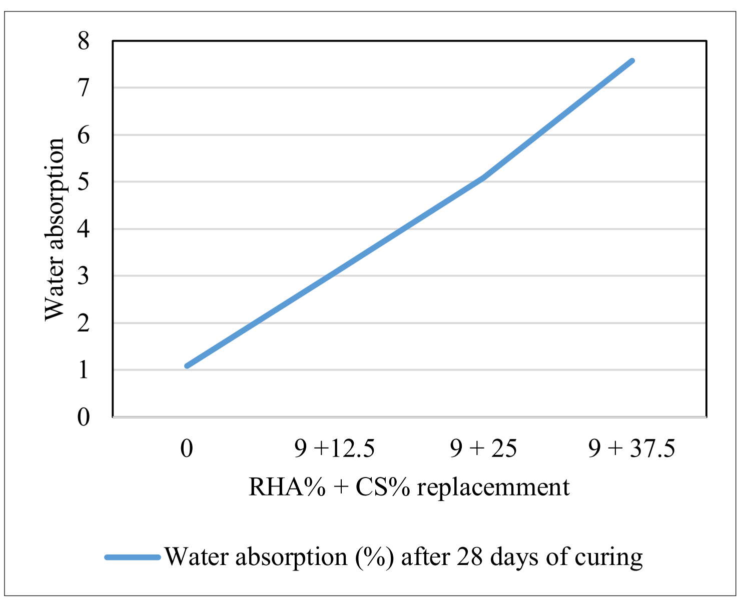

Fig. 15 Water absorption (%) for Mix type 3

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D. Compressive strength test at 7 days and 28 days of curing.

1) Compression strength for mix type 1-

TABLE XVII
COMPRESSION TEST RESULTS FOR RHA IN CONCRETE.

RHA replacement as coarse aggregate (%)	Compressive strength (N/mm^2)	
	After 7 days of curing	After 28 days of curing
0	21.60	30.54
3	22.01	31.26
6	23.21	33.93
9	25.08	35.10
12	19.09	28.44
15	17.84	26.04

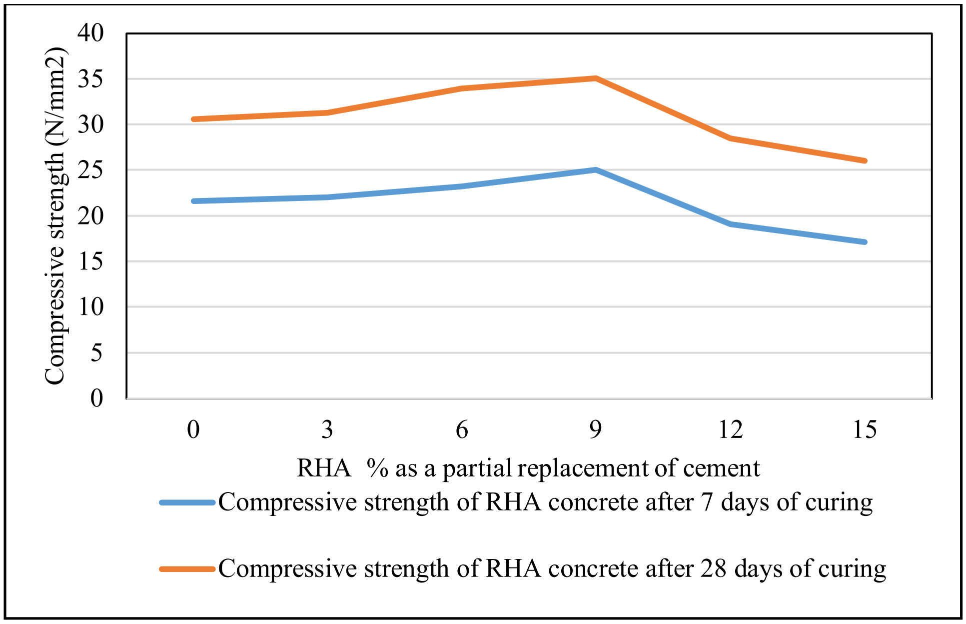


Fig. 16 Chart showing compressive strength of concrete for Mix type 1

2) Compression strength for mix type 2-

TABLE XVIII
COMPRESSION TEST RESULTS FOR COCONUT SHELL IN CONCRETE

CS replacement as coarse aggregate (%)	Compressive strength (N/mm^2)	
	After 7 days of curing	After 28 days of curing
0	21.60	30.54
12.5	18.80	28.35
25	16.68	26.97
37.5	13.50	19.02
50	12.00	17.45

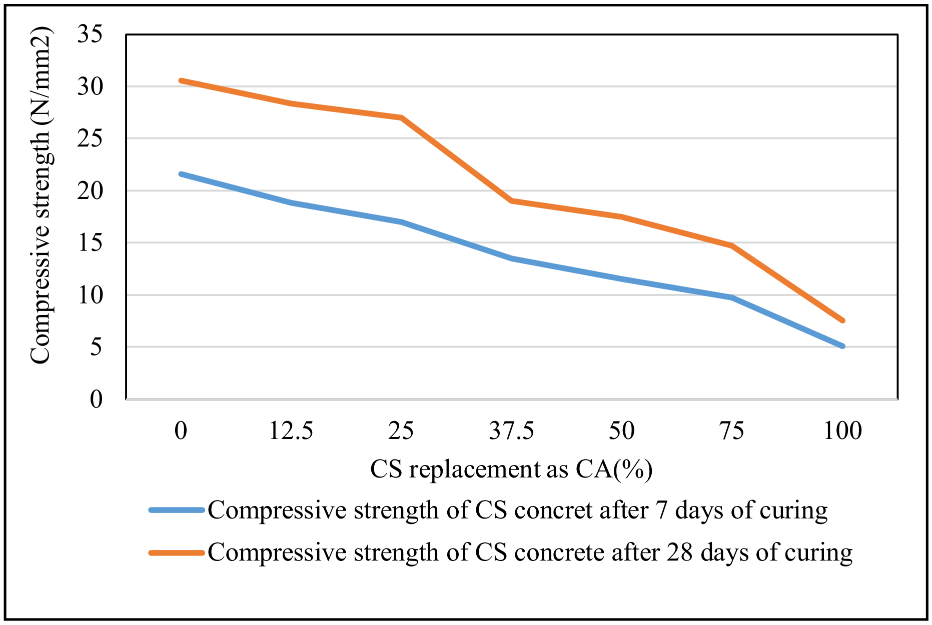


Fig. 17 Chart showing compressive strength of concrete for Mix type 2

3) Compression strength for mix type 3-

TABLE XIX

COMPRESSION TEST RESULTS FOR RICE HUSK ASH AND COCONUT SHELL IN CONCRETE

RHA as replacement of cement (%)	CS as replacement of coarse aggregate (%)	Compressive strength (N/mm^2)	
		After 7 days of curing	After 28 days of curing
0	0	21.36	29.98
9	12.5	22.07	28.58
9	25	14.12	23.02
9	37.5	7.90	11.83

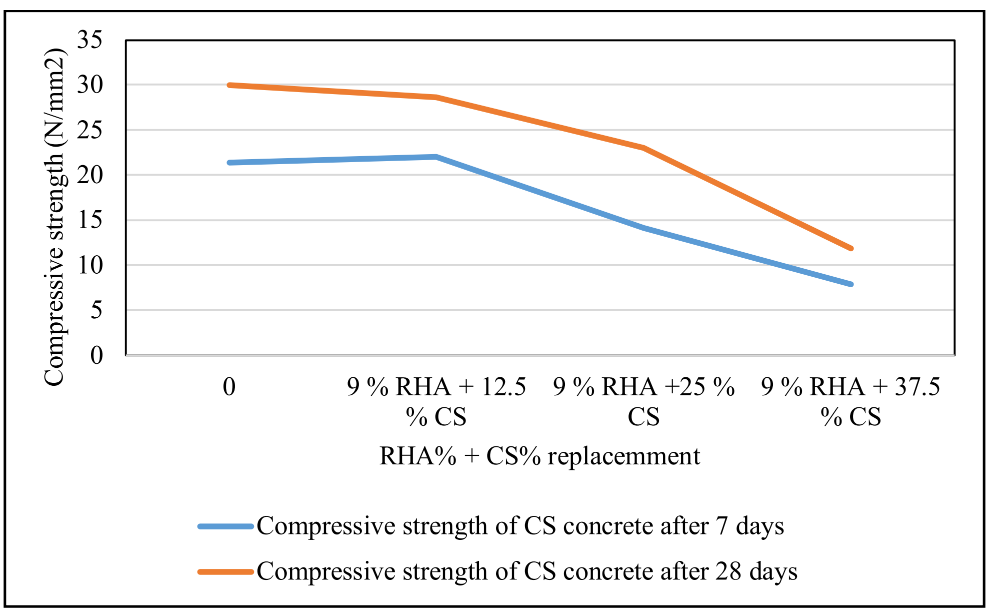
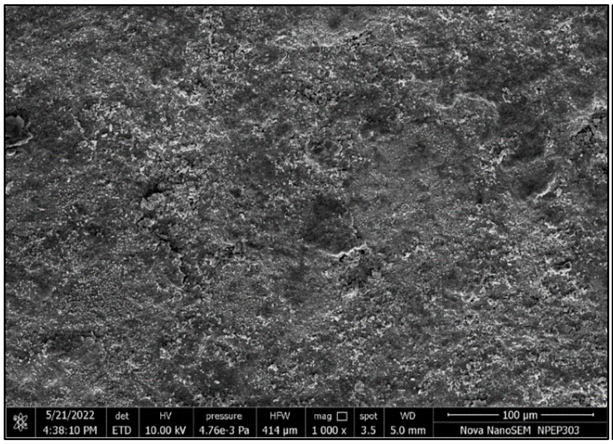


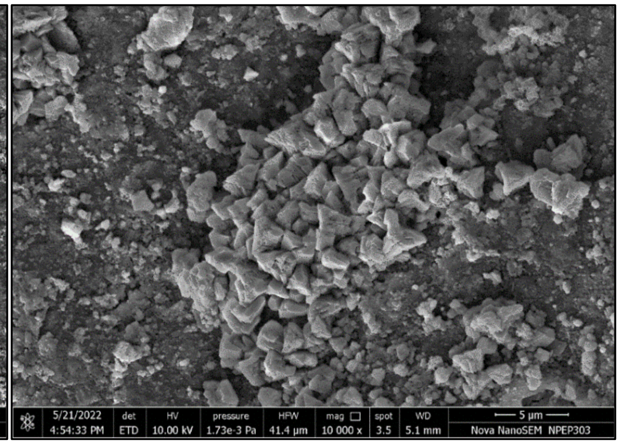
Fig. 18 Chart showing compressive strength of concrete for Mix type 3

E. Scanning Electronic microscopy SEM) Test Results

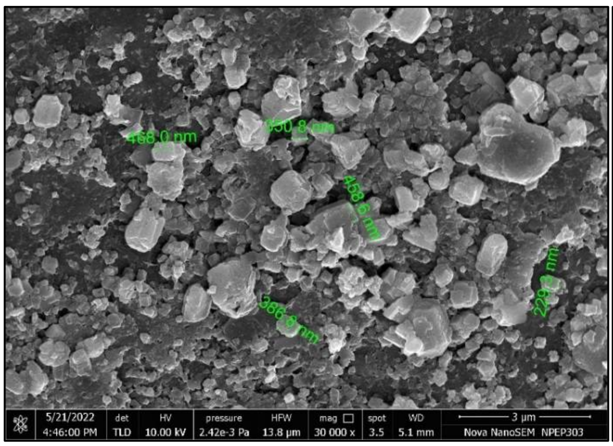
SEM test for mix type 3-



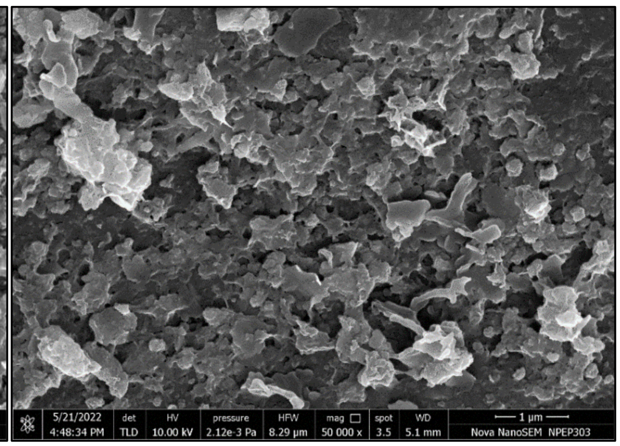
(a)



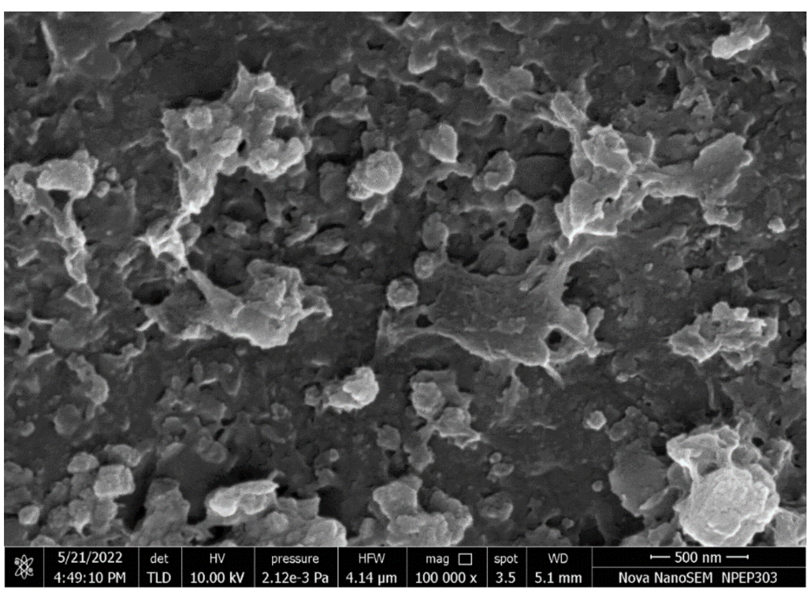
(b)



(c)



(d)



(e)

Fig. 19 (a), (b), (c), (d), and (e) Photos under Scanning electron microscope

Above pictures shows that there is good bonding between components of concrete in 3D view. Void spaces and cracking of concrete can be seen under Scanning electron microscope. Some nanosized cracks and void spaces formed which can be neglected. Lighter area of picture shows bump or convexity for that area, and dark portion shows flat surface. Therefore uniformity in 85% of portion which shows consistent hard solid concrete.

From all test results shows that M25 concrete can be used in light reinforcement structures but due to the use of 9% RHA as a partial replacement of cement compressive strength increase by 10% so RHA can be used in some high-rise construction with higher mix proportions. By using CS in concrete strength decrease, but concrete made with 12.5% CS gives 7% less strength, so that it can be used in light reinforced to no reinforced structures. Example- parapet walls, compound walls, partition walls, dividers in road, etc.

But the concrete which uses both RHA and CS gives somewhat greater strength than concrete uses only CS. Therefore it can be used for the construction of less reinforced to no reinforced structures which carries very less load.

V. CONCLUSIONS

Conclusion drown from the experimental test are as follows:-

From the experimental result shows that-

A. *RHA as partial replacement of cement*

1) 9% utilization of RHA in the replacement of cement gives near about 15% increasing the compressive strength.
2) Increase in percentage of RHA as a cementitious material gives rise to decrease in absorption of concrete i.e. up to 12% decrease for 9% RHA mix at 28th day.
3) Workability of this type of concrete decreases with increase in percentage of RHA.
4) SCM test shows RHA powder has a large amount of silica with which will give pozzolanic action and increases the strength.

B. *CS as partial replacement of coarse aggregates*

1) 25% CS as a replacement of coarse aggregate gives optimum results more than that affects the strength. Up to 25% CS in concrete gives less decrease in strength i.e. up to 13% to 15% than control mix, but more percentage decreases compressive strength vigorously.
2) Use of CS pieces of proper size (i.e. 20 mm nominal size) as a partial substitute of coarse aggregates result is that, if CS used equal to or greater than 25% by weight of coarse fraction produces lightweight concrete.
3) Water absorption of concrete increases with increase in coconut shell percentage. For 25% CS used in concrete 20% increase in water absorption.
4) Workability increases with increase in coconut shell percentage.

C. *Both RHA as partial replacement of cement and CS as partial replacement of coarse aggregates in concrete*

1) 9% utilization of RHA in the replacement of cement along with 25% CS as a replacement of coarse aggregates gives 8% to 10% decrease in compressive strength.
2) Workability increases with increase in coconut shell percentage with same RHA percentage.
3) Water absorption also increases with increase in percentage of RHA and CS. Which may reduce strength. But we can use 9% RHA and 12.5% CS with 3% of water absorption for construction in less rainy area and away from water source.
4) SCM test shows that RHA and coconut shell produces bond with each other as one is water repellent and other one is water absorbent which leads to increases compressive strength than that of only CS in concrete.

D. *General Conclusions*

1) Use of coconut shell and Rice husk ash reduces the environmental burden of decomposition of organic waste and also reduces pollution generated by it.
2) With the use of Rice husk ash and Coconut shell in concrete deducts the use of cement and aggregates respectively. Which helps in conservation of natural resources.
3) Cost of construction will get reduced without compromising with strength.
4) Weight of concrete also get reduced and it leads to light weight concrete.
5) Aim of reduction of pollution and conservation of nature get fulfilled so that this project helps in green and sustainable development

E. Future Scope

1) From the study as the percentage replacement of CS is increased water absorption increases and workability decreases to increase the workability and reduce water cement ratio, plasticizers and any other material can be used.
2) As the partial replacement of coconut shell in concrete is rising then the strength of concrete is falling. So in order to overcome this we can add 10 % of other ingredients like fly ash, rock powder, etc. to CS concrete and the trials should be done.
3) Experiments can be done on split tensile strength and flexural strength also.
4) Other than mentioned different percentage of RHA and CS can be used in concrete for further experimentation.

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