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Comparative Study on Coconut Shell Aggregate with Conventional Concrete

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Abstract: Aggregates provide volume at low cost, comprising 66 percent to 78 percent of the concrete. Conventional coarse aggregate namely gravel and fine aggregate is sand in concrete will be used as control. While natural material is coconut shell as course aggregate will be investigate to replace the aggregate in concrete. In this studies, three different concrete mixes with different the combination of natural material content namely 0%, 10%, 20%, 30%.Three sample specimen will be prepared for each concrete mixes. The aim behind this is to use low cost material like coconut shell and thus taking close to the concept of low cost housing. All precaution is taken to maintain serviceability, strength and durability of the members. Thus it will be helpful for civil engineers and society to adopt this concept to fulfill the basic need of human that is housing.

I. INTRODUCTION

Concrete is the widely used number one structural material in the world today. The demand to make this material lighter has been the subject of study that has challenged scientists and engineers alike. The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost. Introducing new aggregates into the mix design is a common way to lower a concrete's density. Normal concrete contains four components, cement, crushed stone, river sand and water. The crushed stone and sand are the components that are usually replaced with lightweight aggregates. Lightweight concrete is typically made by incorporating natural or synthetic lightweight aggregates or by entraining air into a concrete mixture. Some of the lightweight aggregates used for lightweight concrete productions are pumice, perlite, expanded clay or vermiculite, coal slag, sintered fly ash, rice husk, straw, sawdust, cork granules, wheat husk, oil palm shell, and coconut shell. The coconut shell when dried contains cellulose, lignin, pentosans and ash in varying percentage.

Materials and Preparations: Lateritic soil samples, coconut shell and husk ash and water were used for this study. The lateritic soil samples were obtained from three different borrows pits meant for road construction works. This was meant to serve as reference guide for the soil samples after pavement construction. These borrow pits were located in Osogbo, Ile-Ife and Ibadan, Nigeria. The soil samples were obtained at average depths of 4m to obtain true representative samples of the soils used for the road construction. The natural moisture contents of the samples were immediately determined on getting to the laboratory and the samples were kept safe and dry in jute bags in the Geotechnic laboratory of the Department of Civil Engineering, Obafemi Awolowo University, Ile-Ife. Marks were placed on them to indicate soil descriptions, sampling depths and dates of sampling. The samples were spread on different matting to facilitate air drying. All the clods and lumps in the samples were broken down and well pulverized before running classification test on them. The coconut shells and the husk were obtained from a market waste dump. They were subsequently spread on matting and allowed to properly dry to facilitate proper combustion during burning. The coconut shells and the husk were burnt separately in a metal drum. The ashes formed were allowed to cool down before sieving through 4.75mm BS sieve. The ashes were therefore stored in airtight containers to prevent moisture loss and any form of contamination. The portable water available in the laboratory was used for the study. Preliminary tests (natural moisture content, specific gravity, particle size analysis and Atterberg's limits) were performed on the three soil samples for classification and identification purposes. Coconut shell and husk ash (CSHA) was added to each of the soil samples in 2, 4, 6, 8 and 10% by weight of the samples. Atterberg's limits and engineering property tests (compaction, California bearing ratio (CBR), undrained triaxial) were also performed on the samples. The effects of the coconut shell and husk ash as stabilizing agent on the samples were thereafter determined. The procedures for the various tests were carried out in accordance with that stipulated in BS 1377-1990:1-8. The results from the preliminary test (natural moisture content, specific gravity, particle size analysis and Atterberg's limits) as well as the engineering property tests (compaction, California bearing ratio (CBR), undrained triaxial) are discussed below. Housing is one of the basic requirements for human survival. For a normal citizen owning a house provides significant economic security and status in society. For a shelter less person, a house brings about a profound social change in his existence, endowing him with an identity, thus integrating him with his immediate social milieu. For the first 25 years after independence, the problem of rural housing did not receive any serious attention from the Government. A housing program for the rehabilitation of refugees was taken up immediately after partition by the Ministry of Refugee Rehabilitation and lasted till around 1960 under which approximately 5 lakh families were housed in various centers mainly located in Northern India. There was, however, no uniform policy for rural housing in the states. For instance some states permitted only part of the construction cost to be borne from NREP/RLEGP funds and the balance was to be met by beneficiaries from their savings or loans obtained by them. On the other hand others permitted the entire expenditure to be borne from NREP/RLEGP funds.

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While some states allowed construction of only new dwelling others permitted renovation of existing houses of beneficiaries. As per announcement made by Government in June 1985, a part of RLEGP fund was earmarked for the construction of SCs/ STs and freed bonded laborers.

II. METHODOLOGY

The present project work requires preliminary investigations in a methodological manner.

Material and grade of mix

- Selection of type of grade of mix, mix design by an appropriate method, trial mixes, final mix proportions.
- Estimating total quantity of concrete required for the whole project work.
- Estimating quantity of cement, fine aggregate, coarse aggregate, coconut shells required for the project work.
- Testing of properties of cement, fine aggregate, coarse aggregate and coconut shells.

Production of concrete mixes

Production of mix (normal concrete of grade M-20) in the laboratory is carried out by IS method of concrete mix design (IS 10262-1982). Coconut shell concrete is produced by adding coconut shells in different percentage (i.e. 25% and 50%) replacement in concrete. Test on ingredients materials: The ingredients of concrete i.e. cement, fine aggregate, coarse aggregate, coconut shells are tested before producing concrete. The respective Indian standard codes are followed for conducting various tests on ingredients materials and the concrete. Test on Coarse Aggregate: Crushed black trap basalt rock of aggregate of size 20 mm and 10 mm is used confirming to IS 383-1970.Various test such as such as sieve analysis aggregate impact value etc; have been conducted on coarse aggregate to know their quality and grading. Fineness modulus of Coarse Aggregate

Aim: To determine fineness modulus of Coarse Aggregate

Apparatus: Set of Sieve, mechanical sieve shaker, etc.

Observation Table:

Table 1 Fineness Modulus of Coarse Aggregate

Sr. No.	Sieve Size	Weight Retained (gm)	Cumulative weight retained (gm)	% cumulative weight	% passing
1.	40 mm	-	-	-	-
2.	20 mm	58	58	1.16	98.84
3.	10 mm	4385	4443	88.86	11.14
4.	4.75 mm	557	5000	100.00	00
5.	2.36 mm	-	-	-	-
6.	1.18 mm	-	-	-	-
7.	600 mic.	-	-	-	-
8.	300 mic.	-	-	-	-
9.	150 mic.	-	-	-	-
10.	Total	-	-	-	690.02

Test on Coconut Shells:

Crushed coconut shells of size 20 mm and 10 mm are used. Various test such as such as sieve analysis aggregate impact value etc; have been conducted on coconut shells to know their quality and grading.

Fineness modulus of Coconut shells

Aim: To determine fineness modulus of Coconut shells

Apparatus: Set of Sieve, mechanical sieve shaker, etc.

Observation Table:

Table 2 Fineness Modulus of Coconut shell Aggregate

Sr. No.	Sieve Size	Weight Retained (gm)	Cumulative weight retained (gm)	% cumulative weight	% passing
1.	40 mm	-	-	-	-
2.	20 mm	76	76	1.52	98.48
3.	10 mm	4286	4362	87.24	12.76
4.	4.75 mm	483	4845	96.90	3.10
5.	2.36 mm	115	5000	100.00	00
6.	1.18 mm	-	-	-	-
7.	600 mic.	-	-	-	-
8.	300 mic.	-	-	-	-
9.	150 mic.	-	-	-	-
10.	Total	-	-	-	685.66

Table 3 Graphical Representation for Various Mix Proportion Conventional concrete mix

Load kN	Displacement 'mm'	Stress kN/m2	Strain
0	0	0	0
7.5	0.5	108	0.000178
14	1	202.89	0.000357
20	2	289.85	0.000714
24	3	347.82	0.00107
28	4	405.79	0.001428
35	5	507.24	0.001785
39	6	556.21	0.002142
42	7	608.69	0.002499
45	8	652.70	0.002856
49	9	710.59	0.003273
52	10	753.62	0.00357
55.5	11	804.34	0.003927
57	12	826.08	0.004284
61	13	884.05	0.004641
62.5	14	905.79	0.004998
65	15	942.01	0.005355
66	16	956.52	0.005712
67	17	971.01	0.006069
69	18	1000	0.006426
71	19	1028.48	0.006783

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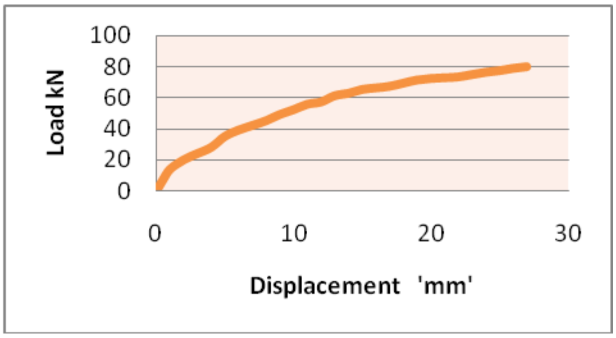
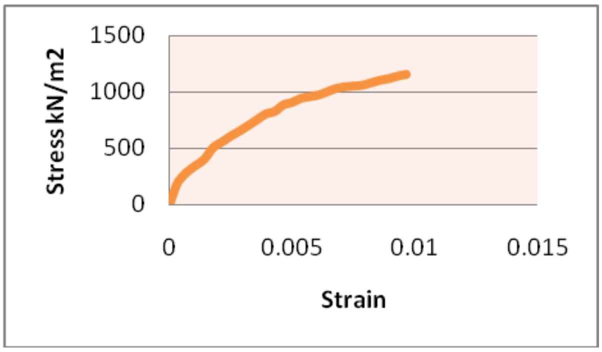
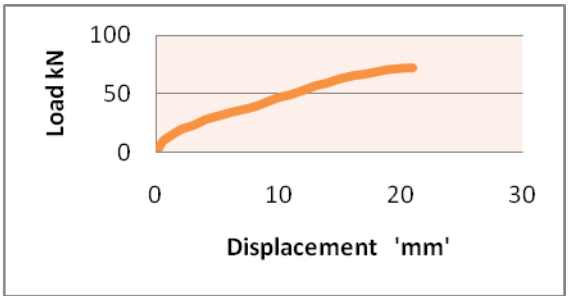
72	20	1043.47	0.00714
72.5	21	1050.72	0.007497
73	22	1057.97	0.007854
74.5	23	1079.97	0.008211
76	24	1101.44	0.008568
77	25	1115.94	0.008925
78.5	26	1137.68	0.009282
79.5	27	1152.78	0.009639

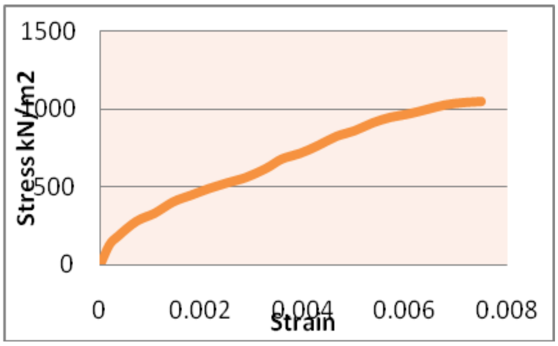




Load v/s displacement for conventional stress v/s strain for conventional 10% Replacement for specimen



Load v/s displacement for 10% replacement



Stress v/s strain for 10% replacement

Load kN	Displaceme nt‘mm’	Stress kN/m2	Strain
0	0	0	0
9	0.5	130	0.000178
13	1	188.40	0.000357
19.5	2	282.61	0.000714
23	3	333.33	0.00107
28	4	405.79	0.001428
31	5	449.27	0.001785
34	6	492.75	0.002142
36.5	7	528.98	0.002499
39	8	565.22	0.002856
43	9	623.18	0.003273
47	10	681.16	0.00357
49.5	11	717.39	0.003927
53	12	768.115	0.004284
57	13	826.08	0.004641
59.5	14	862.32	0.004998
63	15	913.04	0.005355
65.5	16	949.27	0.005712
67	17	971.01	0.006069
69	18	1000	0.006426
71	19	1028.98	0.006783
72	20	1043.47	0.00714
72.5	21	1050.72	0.007497

20% replacement for specimen

Load kN	Displaceme nt ‘mm’	Stress kN/m2	Strain
0	0	0	0
4	1	57.97	0.000357
7.5	2	108.7	0.000714
10	3	144.93	0.001071
13.5	4	195.65	0.001428
17	5	246.38	0.001785
21	6	304.35	0.002142
22.5	7	326.1	0.002499
24	8	347.82	0.002856
27.5	9	398.55	0.003213
30	10	434.78	0.00357
31.5	11	456.52	0.003927
32	12	463.78	0.004284
34	13	492.75	0.004641
39.5	15	572.46	0.005355
41	16	594.2	0.005712
42.5	17	615.94	0.006069
43	18	623.18	0.006426
44	19	637.68	0.006783
45	20	652.17	0.00714
45.5	21	659.42	0.007497
46	22	666.66	0.007854
48	23	695.95	0.008211
50	24	724.63	0.008568
52.5	25	760.86	0.008925
55	26	797.1	0.009282
56	27	811.84	0.009639
57.5	28	833.33	0.01
58.5	29	847.82	0.0103

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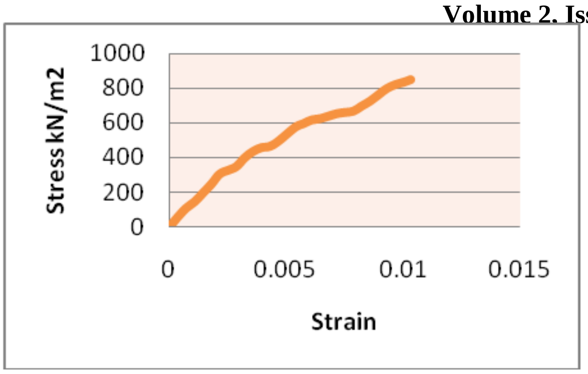

Stress v/s strain for 20%

III. CONCLUSION AND FUTURE WORK

Coconut shell exhibits more resistance against crushing, impact and abrasion, compared to crushed granite aggregate. Coconut shell can be grouped under lightweight aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption. Coconut shell is compatible with the cement. The 28-day air-dry densities of coconut shell aggregate concrete are less than 2000 kg/m3 and these are within the range of structural lightweight concrete. Coconut shell aggregate concrete satisfies the requirements of ASTM C 330. The flexural behaviors of reinforced coconut shell aggregate concrete beams are similar in comparison to other lightweight concrete. All beams exhibited typical failure in flexure with vertical flexural cracks appearing in the pure bending region. No bond failure was observed, confirming that there was adequate bonding between the coconut shell aggregate concrete and the steel bars. It was observed that for coconut shell aggregate concrete beams both IS 456 and BS 8110 can be used to obtain a conservative estimate of the ultimate moment capacity and also provide adequate load factor against failure for reinforcement ratios up to 3.14%. Although coconut shells aggregate concrete has a low modulus of elasticity. The average moisture content and water absorption of crushed coconut shell was found to be 4.20% and 24% respectively. The coconut shell aggregates have higher water absorption because of higher porosity in its shell structure. The fresh concrete density and hardened concrete density after 28 days (under SSD condition) using coconut shell was found to be in the range of 1975-2110 kg/m3 and 1880-1930 kg/m3. The 28 days compressive strength of coconut shell concrete was found to be 24.21, 22.81 and 21.80 for 10%, 20% and 30% replacement by coconut shell aggregate under full water curing and it satisfies the requirement for structural lightweight concrete.

Maximum attempt is made to maintain economy, strength and serviceability of concrete. Seismic analysis can be boosted up by using same methodology. The house model can be tested under government scheme testing its practical serviceability. Checking the strength of concrete by adding fly ash in same work.

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