IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 13, Issue 6 Ver. IV (Nov. - Dec. 2016), PP 28-32
www.iosrjournals.org

Investigation on the Suitability of Crushed Clam (Egeria Radiata) Shells (CCS) As Partial Replacement for Coarse Aggregates in Concrete Production

F.A Olutoge, B.E. Yabefa, E.N Nwabueze
Department of Civil Engineering, University of Ibadan, Ibadan, Nigeria

Abstract: *The increasing demand for infrastructural development in the country has necessitated high demand for the construction materials which are already in short supply in some places. This study investigated the suitability of agro-waste materials; Crushed Clam(Egeria radiata) shells (CCS) as partial replacement for coarse aggregates in concrete production. Concrete cubes and beams of 100mmx100mmx100mm and 100mmx100mmx500mm were casted respectively. The (CCS) were used to replace coarse aggregates from 10% to 40% in steps of 10%. The compressive and flexural strength were evaluated at 7, 14, 21 and 28 days. Increase in percentage of (CCS) in the concrete reduced the compressive and flexural strength of the concrete respectively. It was observed that, at a low replacement value of 10% CCS can produce light weight concrete of 18.7N/mm2 and 2.77N/mm^2 as compressive and flexural strength respectively, in the 28 days curing period, which met the ASTM-77 and BS 1881 part 4(1970) recommended standard minimum compressive and flexural strength for light weight concrete respectively. Using (CCS) in construction will not only reduce cost, but will also help to enhance the management of these non biodegradable wastes in the environment.*

Keywords: *Concrete, Egeria radiata shells, compressive and flexural strength, coarse aggregates*

I. Introduction

The increasing infrastructural development across the world has also increased the demand for more construction materials. Concrete is a versatile material used basically for buildings and other construction works. It's a composite material made of cement, aggregates, water and some chemical additives and reinforcements are sometimes added for some desired physical properties of the finished product. Concrete is widely used in large quantities almost everywhere mankind has need for infrastructure. The amount of this composite material used worldwide supersedes other construction materials such as steel, wood, plastics, aluminum, glass and iron combined.

Hence, due to the non availability and insufficiency of these conventional construction materials such as granites, cement etc as required, the local demand for these construction materials far exceeds the local supply resulting in a continuous increase in cost of construction project such as buildings, roads, pavements etc. in a developing country like Nigeria. Therefore, it is very necessary to make meaningful efforts to save the nation from this housing problem as the population increases every day, hence needing more shelter provision at low cost. The cost of gravels, crushed stones used as coarse aggregates are very expensive in Nigeria, and the transportation of these materials to the coastal communities in Bayelsa, Delta, Rivers, Akwa-ibom, Cross River etc is far beyond the cost of purchasing the materials, thereby, making the cost of construction projects unbearable in these areas. In a backdrop of such unbearable condition, there is a large demand for materialsfrom both agricultural and industrial wastes which are locally available. It is with this view that, an investigation of the suitability of crushed Clam (*Egeria radiata*)shells (CCS) as partial replacement in concrete production would be carried out to properly study its compressive and flexural strengths and workability, since the CCS are agro-wastes which are locally available in large quantities in almost all the coastal communities in Nigeria.

Egeria radiata is a fresh water Clam inhabiting the lower reaches of some large West African rivers. (Udoidiong and Akpan 1991). They arefound on the coastal regions, seas, riversetc around the West African countries such as Nigeria. It's locally called Ukpoku or Gbou by the Ijaws and are widely eaten for their proteinus and nutritious mineral content.(Ogogo 2004). However, after consuming the soft flesh, the empty shells are constantly discarded as wastes inspite of their ostensible economic value. (Chang 1991, Claude 2002). The *Egeria radiata* shells are strong lightweight materials and therefore ideal for partial substitution as coarse aggregate in light weight concrete production. Malu et al 2009 analysed the chemical composition of Egeria radiata shell and found that it contains the metallic oxides such as Fe_2O_3, CaO, MgO, MnO, TiO_2, NiO, CuO, ZnO, SiO, ZrO, P_2O_5,and PbO, which are also contained in granites though in different percentages
Donatelle, (2005) in a study stated that, the extraction/processing of seashells is quite environmentally friendly than that of quarrying/mining of limestone deposit which comes with pollution of the environment and soil erosion.

Elijah et al (2009) investigated the use of seashells such as Egeria radiata shells, periwinkle and oyster shells for civil construction work in coastal Bayelsa State as waste management. In his work, he visited a site in Okpoma community among others in Bayelsa state, were concrete roads, buildings and pavements are constructed with these wastes shells as partial coarse aggregate replacement.

Muthusamy et al (2012) presented the result on the workability and compressive strength of concrete containing various percentages of cockle shell content as partial coarse aggregate replacement. Concrete mixes containing 0%, 5%, 10%, 15%, 20%, 25%, and 30% cockle shell replacement level were casted before subjected to water curing for 28days. Workability test and compressive strength test were conducted in accordance to BSEN 12350 and 12390 respectively. Result show that, replacement of appropriate cockle shell content is able to produce workable concrete with satisfactory strength.

Adewuyi et al (2008) found that, the replacement of granite with 35.4-42.5% waste periwinkle shells did not compromise the compressive strength of the resulting concrete and was found adequate saving 14.8-17.5% of materials cost.

Dahunsi (2002) investigated the compressive strength of concrete made from seashells (periwinkle shells) in combination with chippings, and reported that, concrete containing periwinkle shells alone as coarse aggregates were lighter and of lower compressive strength compared to those with periwinkle in combination with granite and concluded that, periwinkle shells could be used as partial replacement for granite in normal construction works.

This study aims to investigate the influences of crushed Clam(*Egeria radiata*) shells (CCS) as partial replacement for the conventional coarse aggregates on the workability, compressive and flexural strength in concrete as well as to assess the suitability of CCS concrete as structural material, which will in turn help to reduce construction cost and management problems of these shell waste materials in our environment.

II. Research Methodology

Materials

Egeria radiata shells

The Clam (*Egeria radiata*) shells were sourced from a dumpsite at Korokorosei community in Southern Ijaw Local Government Area of Bayelsa State, Nigeria. The shells were washed and separated from soils and other forms of impurities and sundried before crushing to the coarse aggregates size of 15mm manually.

Plate 1 Clam shells

Coarse aggregates

The coarse aggregates used in this study were crushed granites sourced from the Bodija market in Ibadan, Oyo State, Nigeria.

Fine aggregates

The fine aggregates used were river sands that were also source from the market at Bodija in Ibadan, Oyo State, Nigeria.

Cement

Ordinary Portland Cement (OPC) locally available in Nigeria (i.e. the Elephant cement brand) packaged in 50kg bags was used for the experiment.

Water

The water used was obtained from a borehole in the department of civil engineering, University of Ibadan, Oyo State, Nigeria. The water was clean and free from any visible impurities.

Batching and Mixing of materials

The batching of materials was done by weight with a weighing scale. Concrete cubes and beams were prepared in percentage by mass of crushed Clam(*Egeria radiata*) shells (CCS) to granites as coarse aggregates in the other of 0:100, 10:90, 20:80, 30:70, and 40:60, where 0:100 served as the control. The mix ratio used was 1:2:4 and a water to cement ratio of 0.5 was used. The mixture was manually done with a shovel until a uniform distribution and color was attained, then the required quantity of of water was gradually added and mixed properly to obtain a workable mix.

Casting of Samples

The casting was done using wooden moulds. The sizes of formworks used were cubes of 100x100x100mm, and beams of 100mmx100mmx500mm.The concrete was properly mixed, placed and compacted in the lubricated wooden formworks. The samples were removed from the moulds after twenty four (24) hours. They were then immersed in to a curing tank to increase the strength of the concrete, eliminate shrinkage, and promote hydration and take-in heat of hydration until the test date. The concrete specimens were cured for 7, 14, 21and 28 days.

Samples Testing

All the tests were carried out in the material testing laboratory of Civil Engineering Department in the University of Ibadan, Ibadan, Oyo State, Nigeria. The concrete cubes were removed from the curing tank and left in open air for two (2) hours before crushing. The specimens were weighed before testing and the density of the concrete cubes were measured at the different times of testing.

The compressive strength of the concrete was done by crushing the 100x100x100mm concrete cubes in accordance with BS 1881 (1983) using a digital compression machine which automatically evaluates the compression load and displays the result in a digital LCD screen in all the sixty (60) concrete cubes that were cast and tested. The flexural strength test on the concrete beams was also carried out with the automatic techno test flexural machine which automatically displays the load and the results in the digital screen. The load was gradually applied until failure occurs and then displays the load and the flexural strength.

III. Results And Discussions

The results and discussions of the laboratory tests carried out on the Clam shells (CCS) as well as the concrete produced with the partial replacement of CCS are presented as follows: The specific gravity and bulk density of the Clam shells were found to be 2.61 and 1169Kg/m^3 respectively.

Workability

Table 1 shows workability of the concrete in the different percentage replacement of CCS for granites using slump test. The slump test result shows that, the workability of the concrete increased with increase in the percentage replacement of CCS for granites. The slump values were 51mm, 62mm, 73mm, 87mm and 103mm for the %CERS replacement level of 10- 40% in step of 10% respectively. The increase in the slump values on increasing the percentage of CCS is due to the reduction of granite which absorbs more water than CCS. Also, the irregular and non round shape of the CCS is also a factor.

Density of the Concrete

Table 2 below gives the density of the concrete cubes produced with the partial replacement of granites with CCS at 0%-40 in a step of 10%. And Figure 1 gives the variation of the density with the curing age. It shows that the density of the concrete produced has decreased with the increase in the percentage of CCS substitution with granites. At the 28 days curing period, the density of the concrete were 2570, 2540, 2480, 2440, 2420Kg/m^3 at 0%-40% replacement level respectively, which met the requirements of a normal weight concrete.

Compressive Strength

The compressive strength test results of concrete cubes produced with the different percentages of CCS as partial replacement for granites is shown in Table 3 below. The effects of the replacement of the Clam shells in the concrete are presented in the fig 2 below. The results showed that, the compressive strength decreases as the content of CCS increases. Also, the compressive strength increases as the curing age increases. The maximum compressive strength at CCS replacement was obtained at 5% CCS replacement and minimum at 40% CCS replacement in 28days curing. This is simply attributed to the insufficient cement paste to bond the increased specific surface area in the concrete containing the CCS, because strength is dependent on the effectiveness of the bonding between the cement paste and aggregates. The compressive strength ranged from 23.75-10.63N/mm^2 at 28 days curing period. However, the 28 days recommended standard minimum compressive strength of 17N/mm^{2}in accordance with ASTM-77 was ascertained with 10%CCS replacement giving strength of 18.71N/mm^2.

Flexural Strength

Table 4 below shows the results of the flexural strength test of the concrete beams. And the variation of flexural strength with curing age is shown in figure 3 below. The flexural strength test result %CCS replacement for granites shows2.79N/mm2 for 10%, 2.26N/mm2 for 20%, and 1.82N/mm2 for 30% and 1.59N/mm2 for 40% replacement level at 28 days curing age. It also shows a decrease in the flexural strength with increasing CCS replacement. While the flexural strength increases with increasing curing age of the concrete.

IV. Tables and Figures

Table 1: Slump test results.

%CCS	0	10	20	30	40
Slump(mm)	50	62	73	87	103

Table 2: Density test resultsof the concrete cubes (kg/m3)

%CCS	**7 days**	**14days**	**21days**	**28days**
0%	2470	2520	2540	2570
10%	2440	2480	2500	2540
20%	2410	2450	2440	2480
30%	2400	2410	2420	2440
40%	2390	2400	2410	2420

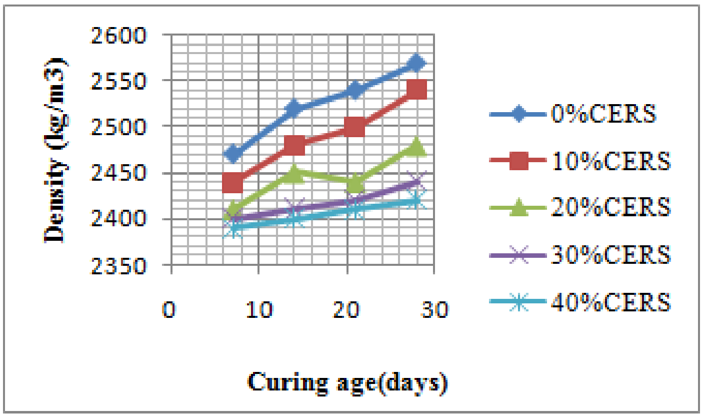

Figure 1: Density variation with curing age

Table 3: Compressive strength test results (N/mm^2)

%CCS	**7 days**	**14days**	**21days**	**28days**
0%	19.07	20.03	20.64	23.75
10%	17.44	17.96	19.29	18.17
20%	13.81	14.19	15.14	15.05
30%	10.60	10.02	10.48	13.15
40%	8.49	8.92	8.42	10.63

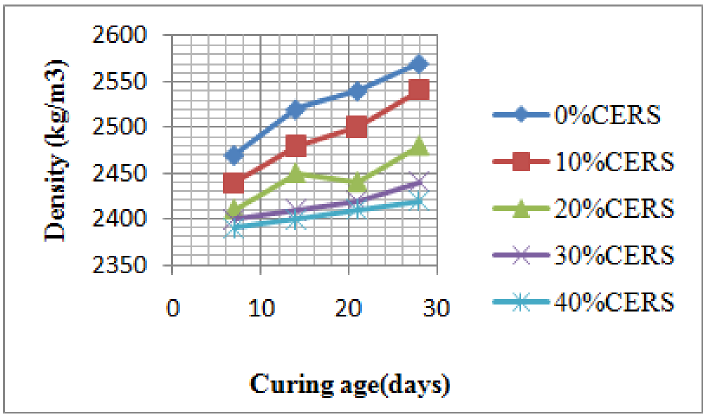

Figure 2: Compressive strength variation with curing age

Table 4: Flexural strength test results (N/mm^2)

%CCS	7 days	14 days	21 days	28days
0%	2.09	2.89	3.06	3.41
10%	1.28	1.84	2.36	2.79
20%	0.85	1.33	1.64	2.26
30%	0.91	1.50	1.00	1.82
40%	0.70	1.12	0.99	1.59

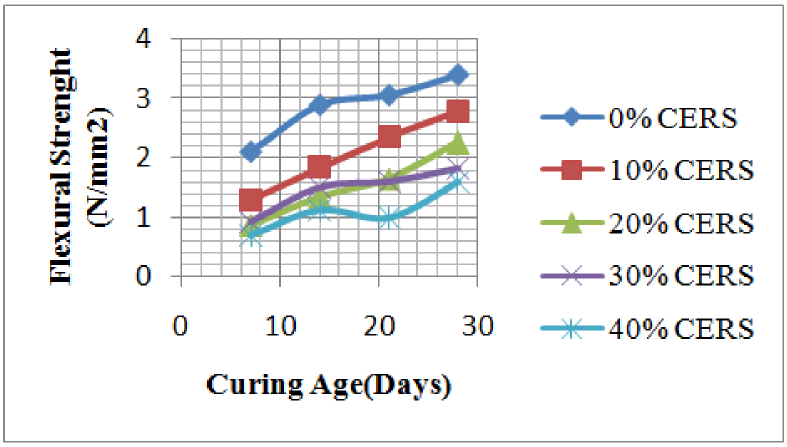

Figure 3: Flexural strength variation with curing age

IV. Conclusions

The following conclusions were reached from the results of the study.

1. CCS can be used as partial replacement of granites to produce normal weight concrete in places where the Clam (*Egeria radiata*) shells are available. This will help to reduce the cost of construction and the management of these wastes as pollutants in the environment.
2. The workability of the concrete decreases as the content of the Clam(*Egeria radiata*) shells increases.
3. The strength development of the CCS concrete is similar to those of granite. Replacement of the granite up to 10% CCS gives 18.71N/mm2, and 2.79N/mm2 as compressive and flexural strength respectively. And this met the lightweight concrete requirements of ASTM-77 and BS 1881 part 4 (1970) respectively.

V. Recommendations

The following recommendations are hereby made from the findings of this study.

1. The Clam (*Egeria radiata*) shells which are of different sizes should be crushed to small coarse aggregate sizes before use in construction. Since the shells are not uniformly shaped.
2. The CCS concrete curing should be extended beyond 28 days to ascertain the long term strength development of the concrete.
3. Further research should be carried out to authenticate the use of Egeria radiata shells as structural materials.

References

[1]. Adewoye A.P and Adegoke .T (2008); Exploratory study of periwinkle shell as coarse aggregates in concrete works .J. Engr. Applied Sci.3(6):1-5 http//arpn journals.com/jeas/research-paper/rp_ 2008/jea_ 12-8_ 136 pdf
[2]. BS 1881: Part 116 Method for Determination of Compressive Strength of Concrete, British Standards Institute, London, 1983
[3]. BSS 812 part 2, 1995. Method of Department of Bulk Density of aggregate. British Standards Institute, London. United Kingdom.
[4]. Chang. R., 1991. Chemistry. 4th Edition. Mc Graw-Hill, London, /SBN-13:9780070105188, pp:252.
[5]. Claude, E.B 2002: Properties of limiting Materials. J. Fish Aquac, 3:70-74.
[6]. Dahunsi, B.I.O, 2002, Properties of Periwinkle Granite concrete. J. civil Engr. 8:27-36. http:// ajol:info/ index php/ jce/ article/view/18993.
[7]. Donatelle, R.J. 2005. Healthy the Basics. 6th Edition, Pearson Education, New York, pp:56.
[8]. Elijah. I, Ohimain, Sunday Bassey and Dorcas D.S Bawo (2009). Used of sea shell for civil construction works in coastal Bayelsa State, Nigeria: A waste management perspective. Reseach Journal of Biological Science 4(9): 1025-1031, 2009.
[9]. Muthusamy. K, and Sabri. N.A (2012): Cockle shell, a potential partial aggregate replacement in concrete. International Journal of Science, environment and Technology, Vol 1, No.4, 2012, pp260-267.
[10]. Ogogo, A.U; 2004 Wild life management in Nigeria-Objective, principles and Procedure,Mdian Press, Calabar
[11]. Udoidionge O.M, Akpan P,M (1991): Toxity of Cadmium, Lead Laindaere for Egeria radiata Lamark. Revised Hydrobiology Tropical. 24(2): 111-117.