CLAM SHELLS AGGREGATES FOR HOUSING CONSTRUCTION

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ABSTRACT

This paper presents the use of clam shells as aggregates for concrete works in housing construction. Various cement aggregate ratios were designed for the study. The physical and mechanical properties of clam shells concrete mixtures, both fresh and hardened, were examined. The compressive strength values obtained ranged from 9.50 to 18.16 N/mm^2. The highest strength was obtained with a design mix of 1:2:3. All the concretes failed the slump test showing poor workability. Concretes containing higher percentage of clam shells (more than 60% of the total aggregates) produced samples with honeycombs. The study shows that clam shells can be used as coarse aggregates for plain and simple reinforced concrete works with the characteristic compressive strength of 15N/mm^2 for housing construction.

Keywords: Clam shells, cement aggregates, concrete works, compressive strength

1. INTRODUCTION

Conventionally, crushed rocks and all-in-aggregates are mostly used for concrete works in housing construction. These aggregates are used due to the fact that their physical and engineering properties have been investigated and found to be suitable for both mass and reinforced concretes (BS 881, 1992; Lea, 1970). Also, where these materials are scarce, or cost of haulage is quite high, other known hard materials such as limestone, blast-furnance slag, broken bricks etc, are used instead (Poitevin, 1999; Alduaij *et al,* 1999).

However, there are other solid materials that are used as coarse aggregates by local artisans, especially in developing countries, for concrete works. These materials are essential ingredients for construction in areas they occur, though their mechanical properties, which are essential for design purposes, are either not known or been determined. One of such materials is the clam (oyster) shell. It occurs abundantly along the southern banks of the Volta River in Ghana and is the main source of coarse aggregates for housing construction in the towns and villages where it occurs.

This paper presents a study of the use of clam shells as coarse aggregates for concrete works in housing. The suitability of the material with respect to compressive strength and water absorption of concretes produced are analysed. This study is aimed at encouraging the use of durable local materials in housing construction in developing countries in order to reduce the cost of housing construction.

2. EXPERIMENTAL METHOD

2.1 Materials

The materials used for the tests were ordinary Portland cement (OPC), pit sand and clam shells (as coarse aggregates). Table 1 presents the grading analysis of the aggregates whilst the particle size distribution of the sand is shown in Figure 1.

Table 1 Sieve analysis of aggregates

Sieve size, mm	% passing by weight	
	Sand	Clam shells
37.50	-	95.0
20.00	-	37.0
10.00	-	17.2
5.00	100	0.2
2.36	98	-
1.18	86.2	-
0.60	56.5	-
0.30	16.6	-
0.15	3.4	-
<0.02	1.2	-

The analysis shows that the shell sizes do not meet the standard requirements of BS 882. The sand is medium-sized which could produce concrete of adequate strength and consistency with a 20mm maximum-sized aggregate, from low to high strength concretes.

2.2 Methods

Various concrete mix designs which were used in order to obtain an optimum mix for simple and reinforced concrete works are given in Table 2.

The sampling, mixing, moulding and testing of the samples were done according to BS EN 196 methods. For each mix, the workability was measured by the slump

Table 2 Mix designs for concrete mix

Mix No.	Mix proportion by mass			Coarse Aggregate as % total aggregate	W/C Ratio
	Cement	Sand	Clam shells		
C1	1	3	2	40.0	0.55
C2	1	2	2	50.0	0.55
C3	1	2	3	60.0	0.55
C4	1	2	3.5	63.6	0.55
C5	1	2	4	66.7	0.55
C6	1	3	6	66.7	0.55

method, prior to the moulding of the test cubes. Twenty (20) 150mm concrete cubes were cast for each designed mix. The concrete specimens were demoulded after 24 hours and cured in water, at 22 ± 1,° and Relative Humidity of 75% before testing at 7 and 28 days. The water absorption of the hardened concretes was determined before the strength test.

3. RESULTS AND DISCUSSION

3.1 Concrete properties

The properties of both fresh and hardened concrete are shown in Table 3. The values are averages of six samples each. All the concretes failed the slump test showing poor workability. Also, concretes containing more than 60% clam shells aggregates produced samples with honeycombs.

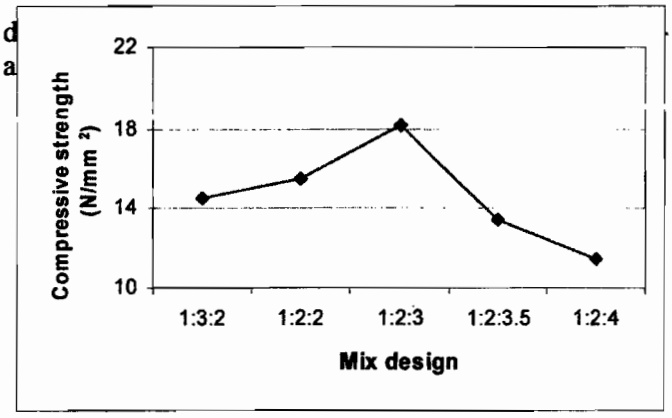
Table 3 Properties of fresh and hardened concretes

Mix No.	Slump	Density at 28 days	Water Absorption (%)	Compressive strength, (N/mm²)	
				7days	28days
C1	Fail	2425	2.49	9.50	14.55
C2	Fail	2420	2.56	14.70	15.54
C3	Fail	2510	2.65	12.55	18.16
C4	Fail	2510	2.68	12.87	13.43
C5	Fail	2500	2.67	9.91	11.45
C6	Fail	-	-	-	-

The densities of the concretes varied from 2420 to 2510 kg/mm² and so can be classified as structural dense types (Lea, 1970). Figure 2 presents the strength development of the concrete mixes at 28 days.

It shows that mix C3 (1:2:3) produced the highest strength of 18N/mm² with C5 (1:2:4) giving the lowest value of 11.4N/mm². This indicates that clam shells can be used for plain and simple reinforced concrete works of up to Grade 15 with characteristic strength of 15N/mm² (BS, 1972). However, mixing and moulding are quite

Figure 2: Compressive strength development of concrete samples at 28 days



the smoothness of the shells. One, therefore, needs to be extra careful to avoid producing very porous concrete structures. Sample C6 could not be moulded for testing

4. CONCLUSION

From the various tests undertaken, the following conclusions are made:

⇒ clam shells concretes are suitable for plain/mass concrete
⇒ clam shells are also suitable for simple reinforced concretes for simple residential buildings and structures that require compressive strengths of below 20 N/mm².
⇒ all the mixes failed the slump test showing poor workability
⇒ mix 1:2:3 gave the highest strength of 18.16N/mm²
⇒ mix 1:2:4 gave the lowest strength of 11.45 n/mm²
⇒ mix 1:3:6 is not suitable for any concrete works

Further investigation on the performance of reinforced concrete and flexural properties using clam shells are recommended. This is because the extensive adoption of its use will greatly reduce the cost of housing delivery in areas where clam shells occur abundantly.

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Figure 1 : Particle Size Distribution of Aputuogya Sand