ISSN (e): 2250 – 3005 || Volume, 06 || Issue, 06|| June – 2016 ||
International Journal of Computational Engineering Research (IJCER)

Experimental Characterization of Mortar Made From Local Fine Aggregate Used For Masonry

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ABSTRACT

Mortar as a building component has been in use in Nigeria and many nations for a very long time. However, the high and increasing cost of the constituent materials has contributed to the non-realization of adequate housing for both urban and rural dwellers in many African countries. But, mortar like any typical building component, has properties that are used for their classification, quality determination and hence, their application. In this research, tests were performed on mortar blocks containing cement and sand in varying mix proportions, i.e. mix ratios of 1:4, 1:3, 1:2 and 1:1 and water/cement ratios of 0.75, 0.66, 0.44 and 0.38, respectively (CEMEX mortars testing) were used to determine the effect of sand from Coscone in Awka, Niger Bridge River Sand in Onitsha, Obichuluekwe river sand in Nimo and NAU(Unizik) soil, all in Anambra State on compressive strength of mortar cubes. A total of 144 mortar cubs (48 mortar cubs from each soil sample) were tested to determine the effect of sand on compressive strength. The tests include sieve analysis, compressive strength and specific gravity. The main variables in this investigation were the sand and mix proportions. All tests were carried out in accordance with the British Standards. For the mortar samples, the tests results showed that, depending on the mix proportions, the mortars have different compressive strengths. The test results also indicated that the improvement in these engineering properties (i.e. compressive strength) of the mortars increased as the ratio of sand to cement decreased. This shows that, the more of sand added to the same quantity of cement, the lower the compressive strength of mortar.

Keywords: *Aggregate, Characterization, Compressive; Mortar and Strength.*

I. INTRODUCTION

Mortar has been an integral part of masonry wall systems for centuries. Its primary function is simple i.e. to successfully bond unit masonry together. Mortar's presence and performance are as crucial to a masonry wall system as the units it bonds together, yet its relevance is often over looked by the designer and mason contractor. A thorough understanding of mortar and its application is necessary to achieve successful performance. Mortar has developed through an evolutionary process. The Egyptians discovered that workable mortar could be produced by burning lime stone at high temperature and then soaking the byproduct [quicklime] in water after it cooled. The quicklime was then mixed with volcanic ash or river sand to produce the first lime mortar. Lime-sand mortars remained unchanged until development of hydraulic lime yields a harder and more durable mortar because the clay provides additional cement properties. EzeUzoamaka, (1977), Ezeagu et al (2012)Mortar and its usage significantly changed in the late 19th century with the advent of Portland cement. The introduction of cement into mortar initially leads to the development of cement-lime mortars. Eventually cements contain three basic ingredients.

1. Portland cements for higher strength and increase setting time.
2. Plasticizers, such as finely ground limestone or lime hydrate for increased workability.
3. Air –entraining additives for greater durability and workability.

Masonry cement mortars are pre-blended and prepackaged in bags. Each bag is mixed with a specified volume of fine aggregate (sand) to meet certain minimum physical requirements. Consequently, masonry cement mortars provide consistency of mixture during construction. Furthermore, masonry cement mortars provide excellent workability along with adequate bond and good compressive strength.

Aim of the Study: The aim of the work is to experimentally characterize mortar made from local fine aggregate used in masonry works.

Objectives of Study: The objectives of the study are:

i. To highlight the mechanical properties of mortar.

ii. To determine Specific Gravity of sand and compressive strength of mortar using Coscone sand,Niger Bridge River Sand, Obichuluek we river sand and NAU (Unizik) sand.
iii. To predict and being able to estimate the possible contaminant which may affect (unpaired) construction or mortar works.
iv. To determine whether Coscone sand, Onitsha Niger Bridge River Sharp Sand, Obichuluek we river sand and NAU (Unizik) sandis the best for mortar.

Significant Of Study: This work will assist the construction industry in Anambra State to avoiding design and construction problems with masonry construction as noted in Nwokoye. And Ezeagu (2016),. It is intended for mason contractors, field personnel, and architects, engineers, building officials, general contractors, construction managers, students, suppliers, manufacturers and other industry representatives.

Limitation Of Project: This study is limited to tests on compressive strength, specific gravity and sieve analysis of sand {i.e Coscone sand, Onitsha Niger Bridge River Sharp Sand, Obichuluek we river sand and NAU (Unizik) sand}.

II. LITERATURE REVIEW

The functional requirements of mortar are numerous. A mortar joint acts as a sealant, a bearing pad, sticks the units together yet keeps them apart and in this sense performs as a 'gap filling adhesive'. EzeUzoamaka, (1977), Ezeagu et al (2012), An ideal mortar has the followings;

- Adheres completely and durably to the brick, block or other masonry unit to provide stability.
- Remains workable long enough to enable the operative to set the masonry unit right to line and level; this implies good water retentivity.
- Stiffens sufficiently quickly to permit the laying of the units to proceed smoothly, and provides rapid development of strength and adequate strength when hardened.
- Is resistant to the action of environmental factors such as frost and/or abrasion and the destructive effects of chemical salts such as sulfate attack.
- Resists the penetration of rain.
- Accommodates movement of the structure.
- Accommodates irregularities in size of masonry units.
- Contributes to the overall aesthetic appearance.
- Is cost effective

The ability of a mortar to fulfill these various roles depends not just on the mortar producer but also on the specifier who must select an appropriate mortar for the particular application(The craftsman on site also plays a key role). The factors to be taken into account include the environmental conditions, the composition of the masonry units involved and the workmanship and site practice of those engaged in the construction process (CEMEX mortars). Historically, mortar was specified by prescription that is using nominal mix proportions as given in the BS 5628 Part 1:2005 and other British Standards. The two British Standards relevant for the specification and testing of mortar are: BS 4721:1981, Specification for ready-mixed building mortars and BS 4551:2005, Methods of testing mortars, screeds and plasters. These standards describe mortar and require that it be specified under two categories: the plastic properties of fresh mortar and the hardened properties. This approach is also adopted in the European Standard for Masonry Mortar BS EN 998-2:2003 (anticipated implementation April 2005).The plastic properties are those properties that are relevant in the un-set or wet condition that is before the mortar has begun to harden. The hardened properties of the mortar are normally measured at 28 days of age. The specification of mortar is a compromise between all the requirements the mortar has to fulfill. The role of plastic mortar during construction is a very important and complex one: The mortar must spread easily and remain workable long enough to enable the accurate laying to line and level of the masonry units.It must retain water so that it does not dry out and stiffen too quickly, especially when using absorbent masonry units.It must then harden in a reasonable time to prevent it deforming or squeezing out under the weight of the units lay above.

III. METHOTOLOGY

Grading: for the fine aggregates; the grading are divided into four zones, ranging from the coarser limit of zone 1 to the finer limit of zone 4. The division into zones is largely based on the percentage retained in the number 25 sieve. For example BS sieve number 25 with percentage by weight passing of 53.59% tells us that the quantity of fine aggregate that passed through the sieve number 25 belongs to zones 2, and so on. This is because 53.59% falls within the ranges of 35-59 of percentage by weight passing (BS 882, 1973) for sieve number 25.

Sieve Analysis of Sand: For the purpose of this research study, sieve analysis of sand was conducted and 500g of each sample was collected for analysis. The results are shown below.

Method Used For the Sieve
The stacks of sieves were arranged according to their ascending order of magnitude of their individual mesh aperture sizes. The sand was poured one after the other until the 500g of sand finished from the container which it were measured from. The mesh was shake with sieve shaker and the weight of each mesh were taking and recorded as shown.

Specific Gravity Test for Sand: Procedure to Determine the Specific Gravity of Fine-Grained Soil:
1. The density bottle along with the stopper, should be dried at a temperature of 105 to 110°C, cooled in the desiccator and weighed to the nearest 0.001g (M_1).
2. The sub-sample, which had been oven-dried should be transferred to the density bottle directly from the desiccator in which it was cooled. The bottles and contents together with the stopper should be weighed to the nearest 0.001g (M_2).
3. Cover the soil with air-free distilled water from the glass wash bottle and leave for a period of 2 to 3hrs. for soaking. Add water to fill the bottle to about half.
4. Entrapped air can be removed by heating the density bottle on a water bath or a sand bath.
5. Keep the bottle without the stopper in a vacuum desiccator for about 1 to 2hrs. until there is no further loss of air.
6. Gently stir the soil in the density bottle with a clean glass rod, carefully wash off the adhering particles from the rod with some drops of distilled water and see that no more soil particles are lost.
7. Repeat the process till no more air bubbles are observed in the soil-water mixture.
8. Observe the constant temperature in the bottle and record.
9. Insert the stopper in the density bottle, wipe and weigh (M_3).
10. Now empty the bottle, clean thoroughly and fill the density bottle with distilled water at the same temperature. Insert the stopper in the bottle, wipe dry from the outside and weigh (M_4).
11. Take at least two such observations for the same soil.

Mortar Moulding: The three major constituent materials to be used for this production of mortar blocks are; cement, sand and water. The dimension of the blocks to be produced is 50 by 50 by 50mm blocks. Cement/sand ratio of mix (i.e. 1:4, 1:3, 1:2 and 1:1) and water/cement ratio of 0.75, 0.66, 0.44 and 0.38 respectively should be used. In the production of these blocks, hand mixing was employed as shown in figure 3.1 and the materials were turned over a number of times until an even color and consistency were attained as shown in figure 3.2. This mixing was done on the concrete floor in the concrete laboratory. Water was added with the measurement obtained through mix design which is needed in just sufficient quantity and further turned with a trowel to secure adhesion. It was then rammed into the steel mould, this was done uniformly over-cross section of the mould with a tamping bar, compacted and levelled off with a steel face tool. After removal from the mould, the blocks were left in concrete laboratory floor under cover in separate rows.

Figure 3.1: Photos of freshly mixing masonry mortar

Figure 3.2: Photos of freshly mixed masonry mortar

Curing Of Mortar Blocks: Curing is the term to describe the method of maintaining moisture in the newly cast block to allow proper hydration and hardening to take place for a certain period, say 7days within which, the mortar blocks is said to have attained its 65 percent characteristic strength. The fresh mortar blocks molded were cured in the laboratory curing units. Method used was allowing mortar blocks inside a shade and protected against the effect of drying winds and then sprinkling of water on the blocks and covering it with a tarpaulin or damp sacks for 7, 14 and 28 days, from a day after the day of production.

Compaction: After mixing and placing the fresh mortar on the mould, it is compacted manually, using a compaction bar made of steel, weighing 1.8kg, 30mm square. The compaction was done in three layers; each layer was given a good number of strokes of the compaction bar. After the compaction of the top layer, the top surface of the mortar was leveled off with a steel face tool.

IV. TEST RESULTS

The following results were obtained

Table 4.1: Sieve Analysis Results for Obichuluek we river Sand

New sieve no	Sieve size	Mass retained (g)	Percentage retained	Cumulative % Passing	Cumulative % retained
10	2.00 mm	6.75	2.25	97.75	2.25
16	1.18 mm	30.22	10.07333333	87.67666667	12.32333333
30	600µm	91.22	30.40666667	57.27	42.73
40	425µm	57.41	19.13666667	38.13333333	61.86666667
50	300 µm	51.28	17.09333333	21.04	78.96
100	150µm	52.68	17.56	3.48	96.52
200	75µm	8.65	2.883333333	0.596666667	99.40333333
Pan		1.79	0.596666667	0	100

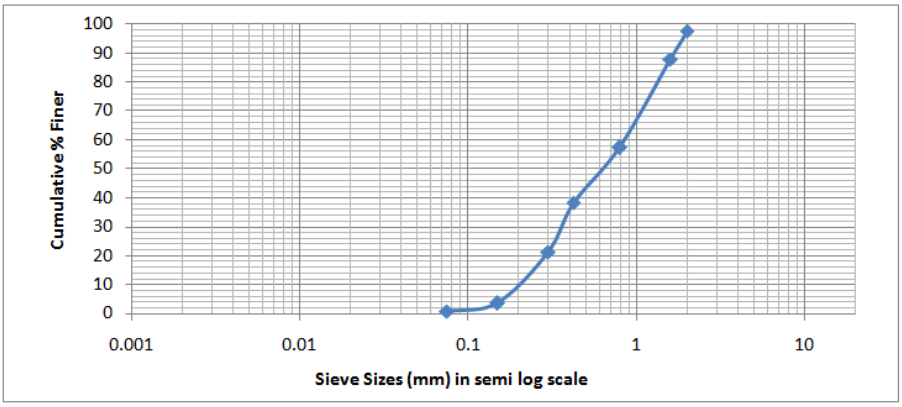

Figure: 4.1: Graph of Sieve Analysis Results for Obichuluek we river Sand

The curve in the graph shows that the soil is only sand with different grain sizes and no indication of gravel or silt. Hence, the Obichuluek we river sand is good for mortar.

Table 4.2: Sieve Analysis Results for Coscone sand

New sieve no	Sieve size	Mass retained (g)	Percentage retained	Cumulative % Passing	Cumulative % retained
10	2.00 mm	1.48	0.493333333	99.50666667	0.493333333
16	1.18 mm	2.84	0.946666667	98.56	1.44
30	600µm	37.32	12.44	86.12	13.88
40	425µm	105.99	35.33	50.79	49.21
50	300 µm	101.01	33.67	17.12	82.88
100	150µm	46.74	15.58	1.54	98.46
200	75µm	2.85	0.95	0.59	99.41
Pan		1.77	0.59	0	100

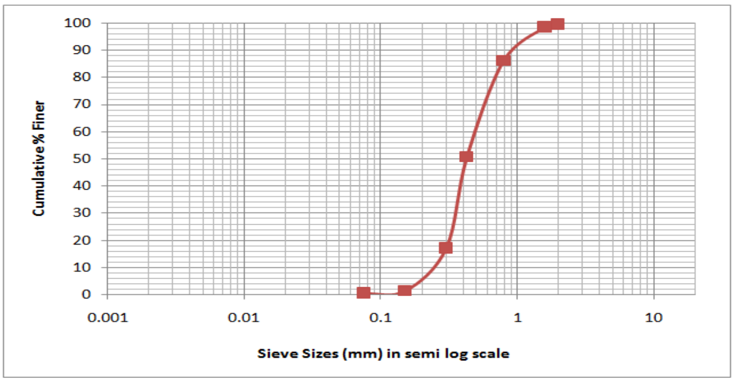

Figure 4.2: Graph of Sieve Analysis Results for Coscone sand

The curve in the graph shows that the soil is only sand with different sizes and no gravel or silt. Hence, the Coscone sand is good for mortar.

Table 4.3: Sieve Analysis Results for NAU (UniZik) sand

New sieve no	Sieve size	Mass retained (g)	Percentage retained	Cumulative % Passing	Cumulative % retained
10	2.00 mm	2.68	0.893333333	99.10666667	0.893333333
16	1.18 mm	6.7	2.233333333	96.87333333	3.126666667
30	600µm	12.74	4.246666667	92.62666667	7.373333333
40	425µm	36.81	12.27	80.35666667	19.64333333
50	300 µm	94.17	31.39	48.96666667	51.03333333
100	150µm	89.17	29.72333333	19.24333333	80.75666667
200	75µm	30.33	10.11	9.133333333	90.86666667
Pan		27.4	9.133333333	0	100

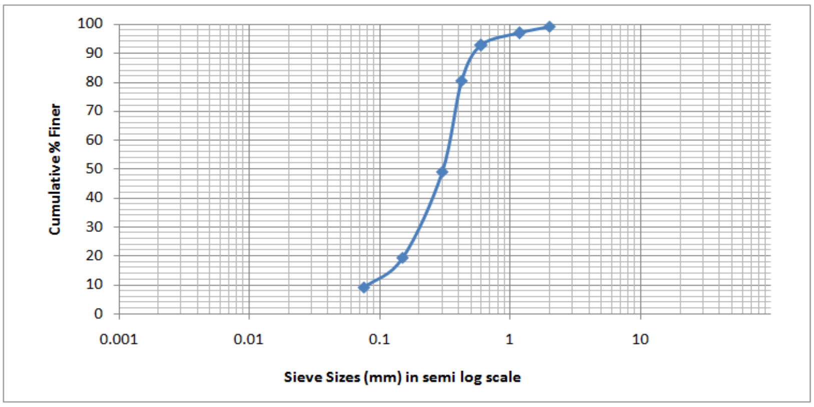

Figure 4.3: Graph of Sieve Analysis Results for NAU (UniZik) sand

The curve in the graph shows that the soil is combination of sand silt with different sizes and no gravel or silt. Hence, the NAU (Unizik) sand is good for (Plastering) mortar.

Table 4.4: Sieve Analysis Results for Onitsha Niger Bridge River Sharp Sand

New sieve no	Sieve size	Mass retained (g)	Percentage retained	Cumulative % Passing	Cumulative % retained
10	2.00 mm	11.07	3.69	96.31	3.69
16	1.18 mm	38.68	12.89333333	83.41666667	16.58333333
30	600µm	83.31	27.77	55.64666667	44.35333333
40	425µm	56.82	18.94	36.70666667	63.29333333
50	300 µm	61.72	20.57333333	16.13333333	83.86666667
100	150µm	32.12	10.70666667	5.426666667	94.57333333
200	75µm	14.15	4.716666667	0.71	99.29
Pan		2.13	0.71	0	100

Figure 4.4: Graph of Sieve Analysis Results for Onitsha Niger Bridge River Sharp Sand

The curve in the graph shows that the soil is only sand with different sizes and no gravel or silt. Hence, the Onitsha Niger Bridge River Sharp Sand is good for mortar. From sieve analysis result table (table 4.1 to 4.4), it can be seen that weight of aggregate retained in 2.00mm and 1.18mm, mesh sizes of sieve corresponding to sieve numbers 10 and 16 respectively are very small compared with sieve number 30,40, 50 and 100 which have aperture sizes of 0.6mm, 0.425mm, 0.3mm and 0.15mm respectively. From the sieve analysis result for Obichuluekwe River sand, Coscone, Onitsher River sand and NAU (Unizik) sand, it was possible to select the particle sizes which should be mixed with the water and cement in a given ratio. Such particle sizes are; 2 mm, 1.18mm, 0.6mm, 0.425mm 0.3mm and 0.15mm corresponding to sieve numbers 10,16,30,40, 50 and 100 respectively.

Table 4.5: Specific Gravity Test Results for Obichuluekwe River sand

Test sample	**A**	**B**	**C**
Weight of density bottle, m_1(g)	25.4	23.74	24.4
Weight of sample + bottle, m_2(g)	56.26	48.98	47.76
Weight of sample + bottle + water,m_3(g)	95.96	91.69	90.05
Weight of bottle + water, m_4(g)	77.63	76.39	76.03
Weight of water, (m_3-m_2) (g)	39.7	42.71	42.29
Weight of sample, (m_2-m_1) (g)	30.86	25.24	23.36
Volume of sample, (m_4-m_1)-(m_3-m_2) (ml)	12.53	9.94	9.34
Specific gravity,(m_2- m_1)/{(m_4-m_1)-(m_3-m_2)}pL (Mg/m^3)	2.46	2.54	2.50

Average specific gravity's= (2.46 + 2.54 + 2.50)/3 =2.50Mg/m^3

Table 4.6: Specific Gravity Test Results for Coscone Sand

Test sample	A	B	C
Weight of density bottle, m_1(g)	25.67	25.06	24.97
Weight of sample + bottle, m_2(g)	57.91	61.34	55.55
Weight of sample + bottle + water,m_3(g)	97.36	98.38	95.81
Weight of bottle + water, m_4(g)	77.76	76.32	77.02
Weight of water, (m_3-m_2) (g)	39.45	37.04	40.26
Weight of sample, (m_2-m_1) (g)	32.24	36.28	30.58
Volume of sample, (m_4-m_1)-(m_3-m_2) (ml)	12.64	14.22	11.79
Specific gravity,(m_2- m_1)/{(m_4-m_1)-(m_3-m_2)}pL (Mg/m^3)	2.55	2.55	2.59

Average specific gravityps = (2.55 + 2.55 + 2.59)/3 =2.57Mg/m^3

Table 4.7: Specific Gravity Test Results for Onitsha Niger Bridge River Sharp Sand

Test sample	**A**	**B**	**C**
Weight of density bottle, m_1(g)	26.91	25.78	25.97
Weight of sample + bottle, m_2(g)	51.82	51.3	50.46
Weight of sample + bottle + water,m_3(g)	95.36	93.15	93.79
Weight of bottle + water, m_4(g)	81.05	77.78	79.04
Weight of water, (m_3-m_2) (g)	43.54	41.85	43.33
Weight of sample, (m_2-m_1) (g)	24.91	25.52	24.49
Volume of sample, (m_4-m_1)-(m_3-m_2) (ml)	10.6	10.15	9.74
Specific gravity,(m_2- m_1)/{(m_4-m_1)-(m_3-m_2)}pL (Mg/m^3)	2.35	2.51	2.51

Average specific gravity gs = (2.35 + 2.51 + 2.51)/3 = 2.45Mg/m^3

Table 4.8: Specific Gravity Test Results for NAU (UniZik) Sand

Test sample	**A**	**B**	**C**
Weight of density bottle, m_1(g)	25.26	26.67	26.26
Weight of sample + bottle, m_2(g)	52.61	51.3	51.35
Weight of sample + bottle + water,m_3(g)	94.67	89.75	92.96
Weight of bottle + water, m_4(g)	79.25	74.9	79.09
Weight of water, (m_3-m_2) (g)	42.06	38.45	41.61
Weight of sample, (m_2-m_1) (g)	27.35	24.63	25.09
Volume of sample, (m_4-m_1)-(m_3-m_2) (ml)	11.93	9.78	11.22
Specific gravity,(m_2- m_1)/{(m_4-m_1)-(m_3-m_2)}pL (Mg/m^3)	2.29	2.52	2.24

Average specific gravity gs = (2.29 + 2.52 + 2.24)/3 = 2.35Mg/m^3

Compressive test results: In this research, preferred ages of 7, 14 and 28 days compressive strength test were used for mortar blocks produced with sand at different mix ratio (i.e. 1:4, 1:3, 1:2 and 1:1) and water/cement ratio of 0.75, 0.66, 0.44and 0.38 respectively. The tests for compressive strength of blocks the compression testing machine was used for testing the compressive strength of the blocks. The load was applied until the block crushed and the crushing load was recorded. The results obtained from this test are shown below in tables 4.9 to 4.20.

TABLE 4.9: 7- Day Compressive Strength cube test results Mix Ratio=1:4 and W/C=0.75

	Obichuluekwe River sand			**Coscone Sand**			**Onitsha River sand**			**NAU (Unizik) Sand**		
Sample	Force (kN)	Compressive strength(N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength(N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	17.25	1.725	2.45	15.3	1.53	2.45	17.3	1.73	2.5	15.1	1.51	2.45
2	17.27	1.723	2.45	15.35	1.535	2.45	17.3	1.73	2.5	15.0	1.50	2.45
Avg.		1.725	2.45		1.535	2.45		1.73	2.5		1.505	2.45

TABLE 4.10: 14-day Compressive Strength cube test results Mix Ratio=1:4 and W/C=0.75

	Obichuluekwe River sand			**Coscone Sand**			**Onitsha River sand**			**NAU (Unizik) Sand**		
Sample	Force(kN)	Compressive strength(N/mm	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength(N/mm	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	19.38	1.938	2.55	18.70	1.870	2.60	19.42	1.942	2.50	18.10	1.810	2.65
2	19.05	1.965	2.55	18.66	1.866	2.60	19.34	1.934	2.50	17.96	1.796	2.65
Avg.		1.952	2.55		1.868	2.60		1.938	2.50		1.803	2.65

TABLE 4.11: 28-day Compressive Strength cube test results Mix Ratio=1:4 and W/C=0.75

	Obichuluekwe River sand			**Coscone Sand**			**Onitsha River sand**			**NAU (Unizik) Sand**		
Sample	Force(KN)	Compressive strength (N/mm	Mass of sample (kg)	Force (KN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(KN)	Compressive strength (N/mm	Mass of sample (kg)	Force (KN)	Compressive strength (N/mm)	Mass of sample (kg)
1	22.64	2.264	2.45	22.00	2.200	2.45	23.14	2.314	2.45	21.60	2.160	2.50
2	22.76	2.276	2.45	22.00	2.200	2.45	23.14	2.314	2.45	21.80	2.180	2.50
Avg.		2.270	2.45		2.200	2.45		2.314	2.45		2.170	2.50

TABLE 4.12: 7-day Compressive Strength cube test results (W/c) = 0.66 Mix ratio =1:3

	Obichuluekwe River sand			**Coscone Sand**			**Onitsha River sand**			**NAU (Unizik) Sand**		
Sample	F(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	18.65	1.865	2.46	14.64	1.464	2.50	18.65	1.865	2.45	14.31	1.431	2.55
2	18.67	1.867	2.46	14.94	1.494	2.50	18.67	1.867	2.45	14.32	1.432	2.55
Avg.		1.866	2.46		1.479	2.50		1.866	2.45		1.4315	2.55

TABLE 4.13: 14-day Compressive Strength cube test results Water / cement (W/c) = 0.66 Mix ratio=1:3

	Obichuluekwe River sand			**Coscone Sand**			**Onitsha River sand**			**NAU (Unizik) Sand**		
Sample	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	18.95	1.895	2.50	18.49	1.849	2.60	19.27	1.927	2.50	18.15	1.815	2.70
2	18.97	1.897	2.50	18.45	1.845	2.60	19.35	1.935	2.50	18.15	1.815	2.70
Avg.		1.896	2.50		1.847	2.60		1.931	2.50		1.815	2.70

TABLE 4.14: 28-day Compressive Strength cube test results Water / cement (W/c) = 0.66 Mix ratio =1:3

	Obichuluekwe River sand			**Coscone Sand**			**Onitsha River sand**			**NAU (Unizik) Sand**		
Sample	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength(N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	24.45	2.445	2.50	23.70	2.370	2.55	25.50	2.550	2.50	22.05	2.205	2.55
2	24.47	2.447	2.50	23.80	2.380	2.55	25.70	2.570	2.50	21.94	2.194	2.55
Avg.		2.446	2.50		2.375	2.55		2.560	2.50		2.1995	2.55

TABLE 4.15: 7-day Compressive Strength cube test results: (w/c) = 0.44 Mix ratio =1:2

	Obichuluekwe River sand			Coscone Sand			Onitsha River sand			NAU (Unizik) Sand		
Sample	Force(kN)	Compressive strength (N/mm	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	18.95	1.895	2.50	18.49	1.849	2.60	19.27	1.927	2.50	18.15	1.815	2.70
2	18.97	1.897	2.50	18.45	1.845	2.60	19.35	1.935	2.50	18.15	1.815	2.70
Avg.		1.896	2.50		1.847	2.60		1.931	2.50		1.815	2.70

TABLE 4.16: 14-day Compressive Strength cube test results (W/c) = 0.44 Mix ratio =1:2

	Obichuluekwe River sand			Coscone Sand			Onitsha River sand			NAU (Unizik) Sand		
Sample	Force(kN)	Compressive strength (N/mm	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	27.60	2.760	2.50	23.00	2.300	2.50	28.90	2.890	2.45	21.99	2.119	2.55
2	27.70	2.770	2.50	22.00	2.200	2.50	28.90	2.890	2.45	22.00	2.200	2.55
Avg.		2.765	2.50		2.250	2.50		2.890	2.45		21.595	2.55

TABLE 4.17: 28-day Compressive Strength cube test results (W/c) = 0.44 Mix ratio =1:2

	Obichuluekwe River sand			Coscone Sand			Onitsha River sand			NAU (Unizik) Sand		
Sample	Force(kN)	Compressive strength (N/mm	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	36.86	3.686	2.50	29.84	2.984	2.55	39.95	3.995	2.50	27.89	2.789	2.60
2	36.86	3.686	2.50	29.84	2.984	2.55	38.75	3.875	2.50	27.89	2.789	2.60
Avg.		3.686	2.50		2.984	2.55		3.935	2.50		2.789	2.60

TABLE 4.18: 7-day Compressive Strength cube test results (W/c) = 0.38 Mix ratio=1:1

	Obichuluekwe River sand			Coscone Sand			Onitsha River sand			NAU (Unizik) Sand		
Sample	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	34.12	3.412	2.50	29.84	2.984	2.55	34.95	3.495	2.50	27.89	2.789	2.60
2	33.00	3.30	2.50	29.84	2.984	2.55	35.05	3.505	2.50	27.89	2.789	2.60
Avg.		3.356	2.50		2.984	2.55		3.5	2.50		2.789	2.60

TABLE 4.19: 14-day Compressive Strength cube test results (W/c) = 0.38 Mix ratio=1:1

	Obichuluekwe River sand			Coscone Sand			Onitsha River sand			NAU (Unizik) Sand		
Sample	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	36.86	3.686	2.45	30.60	3.060	2.55	39.95	3.995	2.45	30.10	3.010	2.65
2	36.86	3.686	2.45	30.80	3.080	2.55	38.75	3.875	2.45	29.80	2.980	2.65
Avg.		3.686	2.45		3.070	2.55		3.935	2.45		2.995	2.65

TABLE 4.20: 28-days Compressive Strength cube test results (W/c) = 0.38 Mix ratio=1:1

	Obichuluekwe River sand			Coscone Sand			Onitsha River sand			NAU (Unizik) Sand		
Sample	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force(kN)	Compressive strength (N/mm)	Mass of sample (kg)	Force (kN)	Compressive strength (N/mm)	Mass of sample (kg)
1	37.82	3.782	2.45	31.80	3.180	2.50	39.8	3.98	2.45	30.60	3.060	2.50
2	37.82	3.782	2.45	31.80	3.180	2.50	39.6	3.96	2.45	30.60	3.060	2.50
Avg.		3.782	2.45		3.180	2.50		3.97	2.45		3.060	2.50

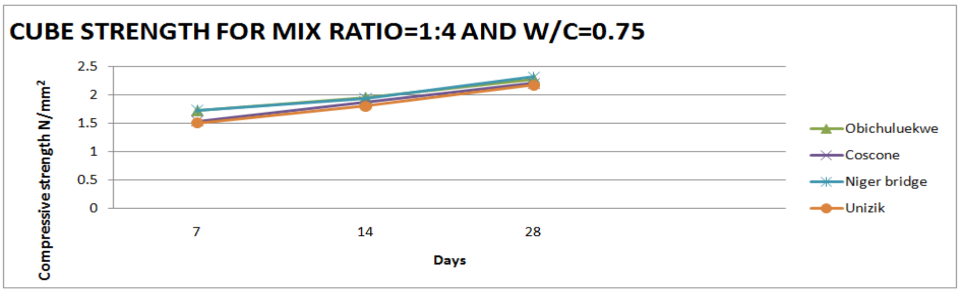

Figure 4.5 Cube Strength for Mix Ratio=1:4 and W/C=0.75

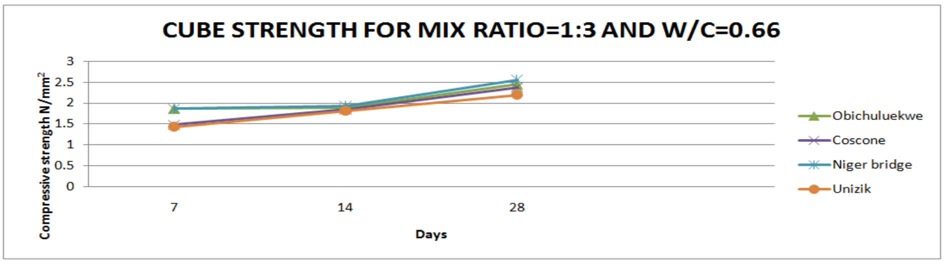

Figure 4.6 Cube Strength for Mix Ratio=1:3 and W/C=0.66

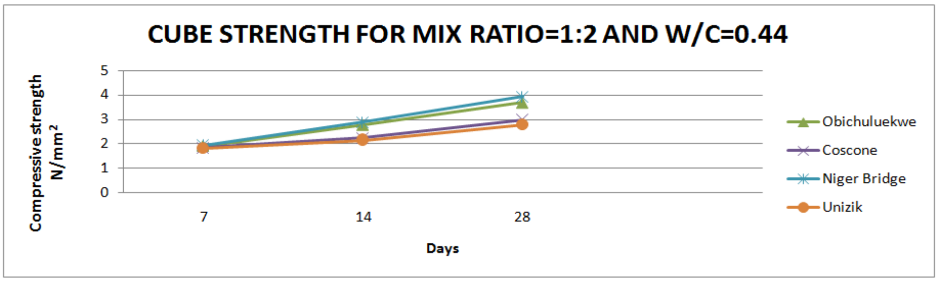

Figure 4.7 Cube Strength for Mix Ratio=1:2 and W/C=0.

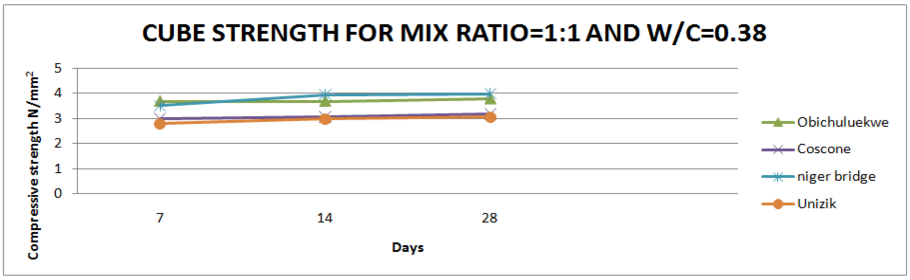

Figure 4.8 Cube Strength for Mix Ratio = 1: 1 and W/C=0.38

V. DISCUSSION

From the specific gravity tests results for Obichuluekwe river sand, Onitsha Niger Bridge River Sharp Sand, Coscone Sand and NAU (Unizik) sand shown in tables above, it is clear that the specific gravity of NAU (Unizik) sand is lower than that of Obichuluekwe river sand, Onitsha Niger Bridge River Sharp Sandand Coscone Sand. This implies that mass of Obichuluekwe river sand, Onitsha river sand, Coscone Sand and NAU (Unizik) sandis greater than that of NAU (Unizik) sand and so, a mortar block produced withUnizik sand, is expected to be lighter than a mortar block produced with Obichuluekwe river sand, Onitsha Niger Bridge River Sharp Sand, Coscone Sand and NAU (Unizik) sand**.** This project investigates the behaviour of the compressive strength of mortar mixes containing sand and cement in cement/sand mix ratio of (i.e. 1:4, 1:3, 1:2, and 1:1) and water/cement ratio: 0.75, 0.66, 0.44 and 0.38 respectively. Also cement/sand mix ratio was used to show the effect of varying quantity of cement on the compressive strength of mortar blocks. The sieve analysis of sand produced very closely related gradingcurves for the two river sands (Onitsha Niger Bridge and Obichuluekwe)which revealed that it will be advisable to use Obichuluekwe river sand for partial replacement for Onitsha Niger Bridge River Sharp Sandwithout separating it into zones of different particle sizes but we cannot replace Obichuluekwe river sand or Onitsha Niger Bridge River Sharp Sandwith NAU(Unizik) or

Coscone sand without separating it into zones of different particle sizes. This is to say that without this zoning, the expected result may not be achieved. This project research made it clear to us that for river sand to be partially replaced by NAUor Coscone sand, it is important to extract the zones of NAU or Coscone sand which have higher degree of fineness at which we will have higher values for compressive strength **.** B. S standard specified that the lowest compressive strength of individual load bearing mortar blocks shall not be less than 1.5 N/mm^2, but it is shown in the table of compressive strength results that the individual compressive strength of the mortar blocks produced in the laboratory are above minimum specification. However the results indicate good quality control in the sense that the strength results did not wide range within the same lot**..** The sieve analysis results for sand indicate that the soil particles are suitable for construction purposes since the results were able to produce a smooth sieve analysis grading curve. Also, the sand will also satisfy the properties of soil that will influence its rate and ease of mixing since it has high degree of fineness at sieve number 100 with 89.17g retained (see sieve analysis table 4.1, 4.2, 4.3 and 4.4 for sand). This is in accordance with BS 3921; 1965 which pointed out that the properties of a soil that will influence its rate and ease of mixing include its degree of fineness, density and sharpness. It can be seen that Onitsha Niger Bridge River Sharp Sand has high compressive strength followed by Obichuluekwe River sand and then Coscone sand while NAU (Unizik) sand has the lowest compressive strength.It is obvious that cement is the major component material in mortar production. It serves the major purpose of binding other constituents such as sand and sand Crete block into a compact entity. Cement is an example of binders. Four tests samples of mortar blocks were produced in the laboratory using sand and cement in a cement/sand ratio of 1:4, 1:3, 1:2 and 1:1. On all the four soil samples, the sample that were retained in sieve number 10 which is one of the particle sizes that produced the lowest value of compressive strength. It was discovered after curing and crushing that the compressive strengths of these four test sample were different from each other. Therefore, cement is the main constituent of mortar block which determines the amount of its compressive strength depending on the quantity added. That is, as quantity of cement increases and quantity of sand decrease the compressive strength increases.

VI. RECOMMENDATION

It is necessary to acknowledge the fact that economic satisfaction is desired from this aspect with limiting value of cement content which could be improved through good quality control and curing conditions. Mortar has been found to be suitable for making materials such as bricks and tiles. It is also used in building. But results so far from another research (AU J. T. 9(2):126-132(Oct.2005)) show that sand and cement mix only has increased workability, making it more flexible and easy to use, but there are doubts about its durability, and compressive strength. Mortar serves as a better material when it is used for concrete manufacturing. This study have shown that the strength of the two river sands (Niger Bridge and Obichuluekwe) mortar is comparatively 10-12 percent more than that of similar mix of Coscone and NAU(Unizik) sand, and the final result of this study provided a strong support for the use of Niger Bridge and Obichuluekwe river sand as fine aggregate in mortar for masonry work production.

VII. CONCLUSION

The aggregate grading of the soil used for the production of the mortar blocks is within the limit specified by BS 882: 1973 and are therefore suitable for mortar making. The compressive strength of the mortar blocks was found to be within standard. The compressive strength of individual block tested was between standard while the average compressive strength in each category of sieve in terms of their number was okay and satisfactory.

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