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Determination of Mechanical Properties of Sandcrete Block Made With Sand, Polystyrene, Laterite and Cement

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ABSTRACT
The recent wave of structural building collapses around Nigeria and the world in general needs research into construction materials with the aim of improving its properties. Concrete and sandcrete hollow blocks are major construction materials used in the building industry. "The objective of this study was to determine the mechanical properties of sandcrete hollow blocks". The materials used in this work were sand, polystyrene, laterite and cement to produce sandcrete hollow blocks, which were cured under laboratory conditions and subjected to compressive strength test and water absorption test at 7,14,21 and 28days of age. The average compressive strength was determined from a set of three blocks at every 7,14,21 and 28days age of curing. For different material combinations, sandcrete hollow blocks has an average compressive strength of 3.41N/mm2 at 28days of curing which falls within the range of specification of Nigerian Building and Road Research Institution(2006) which proposes a minimum compressive strength of sandcrete hollow blocks within the range of 2.7N/mm2 to 3.45N/mm2 .Laterite cement hollow block is observed to have the highest compressive strength when being compared with the other blocks as it strength ranges from 1.77N/mm2 to 5.62N/mm2 between 7 and 28days age of curing respectively, which meets the minimum requirements proposed by the Nigerian Industrial Standard(NIS 87,2000),while polystyrene blocks proved to be the weakest in compressive strength with strength value ranging from 0.57N/mm2 to 2.33N/mm2 between day 7 and day 28 age of curing respectively, while compressive strength of the cement +laterite+sand+polystyrene hollow blocks had strength values ranging from 1.13N/mm2 to 3.67N/mm which also meets the Nigerian Building Code,(2006) which specifies a minimum strength of 1.7N/mm2 and the International British Standard which specifies a minimum of 2.0N/mm2.

Key words: Sandcrete, laterite, sand, block, cement and polystyrene

I. INTRODUCTION

The advancement in Urban and rural infrastructural development is gradually resulting to the scarcity and availability of building materials in domestic market. This has led to compromise on strength and other properties of blocks by suppliers. They tend to take advantage of this high demand and deliver low quality blocks to prospective building developers (Olusola 2005 and Saradhi et al. 2005). This research attempt to incorporate expanded polysterene (EPS), a rigid, tough, closed cell foam, known to cause threat to waste disposal and thereby affecting waste management practices (Abdullahi 2005 and Taylor 2002). However, due to the harmful properties found in the materials, it has become a major waste management issue. In addition, inadequate curing practices, poor compaction, and low cement content have also contributed to the low strength of sandcrete blocks available in Nigeria (Wee 2006). In other to maximize profits, commercially available sandcrete blocks in Nigeria are below minimum standard strength (AASHO 1986 and Anosike 2011). The compressive strength of sandcrete blocks, commercially produced in some parts of Nigeria have been proven by scientist to be of low compliance with the required standards. Adequate curing improved the strength of commercial sandcrete blocks by over 98%. In different areas of Nigeria, buildings are mostly made up of sandcrete blocks. Yet, its high cost has contributed partly to the non-realization of adequate housing for both urban and rural area (Babu and Tuuli 2004., BSI 1983 and Chen and Liu 2004).

One of the fundamental and structural components of a building are the walls, poorly erected walls could lead to collapse of the building. The walls are load bearing, most especially in the low-rise buildings (1-2 upper floors). Wall construction in Nigeria and most parts of the world, especially Africa are made of sandcrete blocks. and indeed, the entire West Africa (Jones and McCarthy 2005 and NIS 2000 (2004)). The construction of some modern residential buildings with laterite, bricks and other forms of walling units has not made significant progress as compared to the use of sandcrete blocks (Cook 1973 and Duggal 2003). The production and laying of sandcretes blocks are without much stress.The structural composition of blocks consists of compressive strength, flexural and water absorption capacity. While, others include the density, fire resistance, durability and thermal conductivity. The components of theses blocks are solely dependent on the relative proportions of the materials used and methods of production of the blocks (Duna and Matawal 2007 and Ewa and Ukpata 2013).Sandcrete blocks are made up of sea sand, cement and water. They are mixed thoroughly and placed in a mould, compacted and removed immediately after leveling at the top. The newly produced blocks are allowed to dry for two to three days before usage (FHWA 2003 and BS12 1996). Individual blocks are layed together, after curing to form walls using mixed cement-sand in an appropriate quantity to form mortar (Ganesh and Saradhi 2003). Sand may be partially mixed with other materials like laterite, coarse aggregate or polysterene.Polysterene is beginning to gain advantage especially in the developing countries in the production of concrete and masonry products. However, the use of polysterene in the production of concrete is as a result of high increase in prices of fine aggregates (rive sand) (Ilangovan et al, 2008, Devi and Kannan, 2011) and environmental degradation (Khamput, 2006, Jayawardena and Dissanayake, 2008). The problem of scarcity of good fine aggregate in some areas has been exacerbated by the ever-increasing demand for concrete and masonry products. Attempts have been made to either partially or completely replace sand with other materials in the production of concrete and masonry products. Such materials have included laterite and polystyrene. Hence, the aim of this paper is to determine the high-quality mix with maximum strength of each mix of blocks made with sand, laterite, polystyrene and all in one mix.

II. MATERIALS AND METHODS

Five materials were used in developing sandcrete blocks for non-load and loadbearing walls. The following materialswere used: polystyrene beads (used normally for packing and manufacturing of thermal insulation boards), natural river sand, water, laterite collected in bags, they were taken to the laboratory and dried for over 48hrs to reduce the moisture content andordinary Portland cement manufactured by UNICEM-LARFAGE were used for the study. All materials used were locally available in Calabar.

Materials Utilize

(i) Cement: **'**The cement used in this research was an ordinary Portland cement OPC, Type I cement, purchased from the major Lafarge Cement WAPCO Nigeria Plc: they are the manufacturer of, Elephant brand of cement in Nigeria, which would be used for all the test'. This cement is the most widely used one in the construction industry (Table 1).

Table 1: Cement quality test

Test type	Ordinary Portland cement
Fineness cm^2/g	3,357
Specific gravity	3.05
Initial setting min	110

(ii) Water: Potable water conforming to the specification of EN 1008: (2002) was used for specimen preparations and curing.

(iii) Sand: Sharp sand was collected fromCalabar River.

(iv) Polystyrene beads: Polystyrene is made up of carbon and hydrogen atoms, is a lightweight cellular plastic that is produced from petroleum and natural gas by-products (Cook 1973; Hagoet al. 2002). Over the past decades, the physical properties of polystyrene as effective material have been proven. This material tends to possess a good, vapor diffusion and fire resistance, frost proof, lack of toxic components and outgassing, and vermin and insect proof. The lightweight aggregates were used in this research and consistof polystyrene beads that have a density ranging from 12 to 25 kg/m^3 and a diameter ranging from 1 to 6 mm.

(v) Laterite: 'Laterite is both a soil and rock type rich in iron and aluminum and is commonly considered to have formed a hot and wet tropical area, nearly all laterite are of rusty-red coloration, because of high iron oxide content, they develop by intensive and prolonged weathering of the underlying parent rock'.

Method Employed in Production

Method of mixing

Mixing was done manually, the cement and sand, cement and laterite, cement and polystyrene, cement,polystyrene,sand and laterite were mixed separately in a dry form and water was sprayedin moderate proportion to allow the mixture to be moist and prevent excess water.

Compaction

The sandcrete block was compacted manually, the compaction wasaffected with the aid of wooden rod/tamping rod. Manual compaction is a method always used by small scale producers. The processing of the blocks is often singlyby a locally manufactured mould. Great care is always applied during the de-mouldingof the blocks in order to avoid cracks, the blocks are of the size 50mmx100mmx450mm.

Curing method and duration

After the compaction of the blocks, water was sprayed twice daily (morning and evening) for 28 days to cured the blocks to a specific strength, in an open space.

Determination of Compressive Strength of Block Sample

Compressive strength test was carried out every 7^{th} day for 28days using ELE2000KN compressive strength machine.Twelve (12) blockssamples were investigated for their strength."Smooth surface wood (serving as base plate) was placed at the base and top of each specimen block, to ensure uniform distribution of load for accurate crushing". "To obtain the compressive strength in N/mm2, the load recorded was divided by the effective surface area of the block. The effective surface area of the block = Total surface area – Area of hollow. All samples were tested using HFI compressive strength machine 1500KN capacity. The compressive strength values obtained from all tests specimens were derived from the crushing values obtained using compression test machine".

Sandcrete Block (Sand and Cement)

Step I

Manually mix sandcrete block in the laboratory

1, The cement and sand are mix on a tight non-absorbent platform, until the mixture is thoroughly blended and of uniform color

2. Water is sprayed on the mixture to thoroughly blend.

Step II

Sampling of blocks for test

1. The mould is clean and oil (condemn grease) is applied on the mould.
2. The sandcreteis filled in the mouldto a layer approximately 5cm thick.
3. The layer is compacted properly
4. The top surface is leveled and smoothen with trowel

Step III

Curing of blocks

"The test specimens were removed from the moulds and kept submerged in clear fresh water until taken out prior to the test".

Note: The water for curing should be changed every 7days and the temperature of the water must be at 27 ± 20^0C.

Step IV

Removal and testing of the sandcrete blocks

1. After specified curing time, it was ensured that the specimens were dried before placing it on the UTM.
2. The samples were measured and the weight was not less than 81kg.
3. The bearing surface of the machine was clean
4. The specimen was placed in the machine, in such a manner that the load shall be applied to the opposite sides of the cube cast.
5. The specimenwas centrally placed on the base plate of the machine

The movable portion was rotated gently by hand, so that it touches the top surface of the specimen.

6. "Apply the load gradually without shock and continuously at the rate of 140kg/sqcm/min till the specimen fails /collapse".
7. Due to the constant application of load the specimen starts cracking at a point and final breakdown of the specimen must be noted.

Formula for calculating compressive strength:

Compressive strength of concrete=max load carried by specimen/Top surface area of specimen.

The same calculation is done for the specimen at different ages,7,14,21 and 28.

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Please Note: As per IS:516-1959minimum of three specimens is to be tested at each selected age (that means three specimens at 7days, 14days, 21days and 28days). If strength of any specimen varies by more than 15% of average strength such specimen should be rejected.

Laboratory test on materials

The various test below was carried out on the soil samples,both sand and lateritic soil.

- Particle size distribution test on sand and laterite
- Specific gravity test on sand and laterite
- Moisture density relationship
- Atterberg limits test

Determination Of Particle Size Distribution

An oven dried sample of soil is weighed and passed through a back of sieves by using mechanical analysis (mechanical sieve shaker). The weight on each sieve is recorded and the percentage of the total sample passing each of the sieves is calculated.This percentage passing is plotted on the sand and gravel fraction of a semi logarithmic chart.

Procedure for sieve analysis

The sample is been carry out for sieve analysis as follows:

1. Weigh of sample 100kg is been taken for washing
2. Oven dry for 24hr before sieving
3. Sieves sizing is taken from 4.75mm, 3.35mm,2.36mm,1.18mm, 600mm, 425mm, 300mm, 212m/c, 150m/c, 75/63m/c, and passing pan for sieving
4. After sieving, the reading start for each sieve sizing for recording.
5. To determine the strength of the soil.
6. the analysis graph has to been curve to know the strength

Determination of Specific Gravity

Specific gravity is measured using standard density bottle. A known weight of oven dried particles Ws is put into a density bottle and is topped up with distilled water and ensured that all air from the sample is removed. The bottle is brought to a constant temperature, carefully wiped,dried and weighed.

Determination of Atterberg Limits

Procedure for liquid limit

The value of tan (can) was taken for all soils, good results can generally be obtained from this equation if the single test to obtain is taken for an N count of between 10 and 50. This is so because in this small range of the flow curve, the change in vertical movement (or water content) is small even for steeply sloping curves.

The plastic limits

Plastic limits could be defined as water content of the soil at which a thread crumbles when it is rolled down to a diameter of 3mm. To increase the precision by eliminating weighing errors, the test was done as follows:

1. The 20 – 30g peanut of soil was broken into smaller samples.
2. Weight of two can masswas taken.
3. About 500g of the sample was weighed.
4. The soil sample was sieve with 425mm sieves size.
5. The soil was rolled between the fingers.
6. If the thread crumbles at a diameter > 3mm, this is satisfactory to define wp.
7. This test is somewhat more subjective (operator dependent) than the liquid limit test.
8. The diameter can be displayed in the laboratory using wire or welding rods for a visual comparison.
9. It appears that plastic limit values can be reproduced to within 1 to 3 percent.

Procedure: carryout for compaction test

A water content sample should be taken 24h prior to this test so that the initial water content can be reasonably estimate; otherwise, it may take 6 to 8 trials to obtain the compaction curve – especially for any soil where OMC is 17 to 22 percent.

1. Three (3) kg nominal weight of air-dry soil sample was taken, pulverize sufficiently to run through the test.
2. The mouldand cylinder of soil were measured.
3. The cylinder of soil was removed from the mould and was split, two water content samples one near the top and the other near the bottom of as much as the moisture cups had about 100g.
4. The sample reducer could be used as an alternative.
5. The compactedmouldwas measured to determine its volume, at the discretion of the instructor, assuming the volume was 944cm^3 or 1000cm^3.
6. The compactedmouldmeasured, did not include collar or base plate.
7. "If the mold is not filled above the collar joint from the last compacted layer, do not add soil to make up the deficiency redo the test".
8. We avoided this unpleasant situation because of the block test carry out. However, by carefully watching and after about 10blows on

the last layer, if the soil is below the collar joint, adding enough material to fill above the collar joint and then continuing with the remainder of the blows.

9. Do not add more than about 6mm of soil above the collar joint on the other extreme.
10. If you have more than this amount and precaution is not, the last layer of compacted soil cake might be removed when you remove the collar.

Computation of Compressive Strength of Sandcrete Blocks made with sand, polystyrene, laterite and cement

"In obtaining the compressive strength of sandcrete block in N/mm2 the loads recorded is divided by effective area of block, Equation 1 is used in calculating the compressive strength and Equation 2 gives the effective surface area of the sandcrete block",

Compressive strength =Crushing load/Effective surface area of blocks Eqn 1.

Effective surface area of block =Total surface Area of Block-Area of hollow Eqn 2.

III. RESULTS AND DISCUSSION

Results obtained from the experimental work of this project were compared to the results from the same test done by other researchers. The results should meet the minimum requirements for building according to the specifications of Nigeria Building and Road Research Institute (2006), Nigeria Building Code (2006) and Nigerian Industrial Standards (2000).**BS 1377: 1975**

Table 2: Strength of Materials Testing Laboratory

PARTICLE SIZE DISTRIBUTION						**OPERATOR:**OMEKA, MICHAEL **DATE:** JULY, 2021
COMPANY: CALABAR BY PASS						**STATION:**CALABAR
ABSOLUTE DRY WT: 960g			**DEPTH:**1.05m			
WT OF SAMPLE WET:960g			**CHAINAGE/SAMPLE NO:**A (LIGHT YELLOWISH SAND)			
HYGROSCOPIC MOISTURE CONTENT:0.01%			**WEIGHT OF DRY SAMPLE:** 960g			
SIEVES	WEIGHT RETAINED	CUMULATIVE WEIGHT RETAINED	% RETAINED	% CUMULATIVE	% PASSING	SPECIFICATION
20mm						
14mm						
10mm						
6mm						
5mm	-	-	-	-	100.0	100.00
4.75mm	18	18	1.9	1.9	98.1	90 – 100
3.35mm	5	23	0.5	2.4	97.6	-
2.36mm	44	67	4.6	7.0	93.0	75 – 100
1.18mm	221	288	23.0	30.0	70.0	55 – 90
600mIc	125	413	13.0	43.0	57.0	35 – 59
425mIc	300	713	31.3	74.3	25.7	-
300mIc	100	813	10.4	84.7	15.3	8 – 30
212mIc	90	902	9.4	94.1	5.9	-
150mIc	49	952	5.1	99.2	0.8	0 – 10
75/63mIc	8	960	0.8	100.0		
PASSING 63mic	-					
TOTAL	960					

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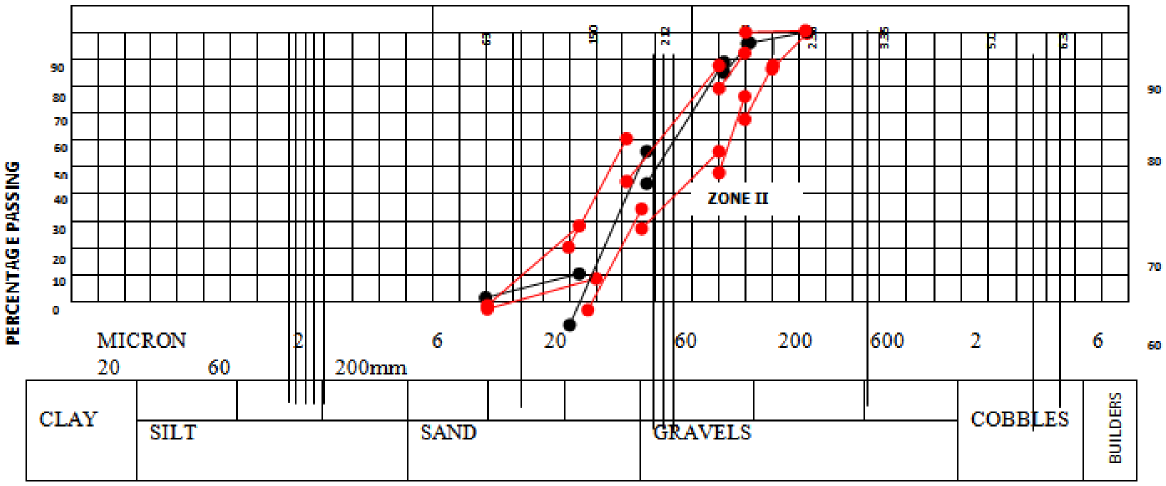

Tested By: ____________________ **Contractor's Rep:** ____________________ **Consultant's/Client Rep:** __________________

BS 1377: 1975

Table 3: Strength of Materials Testing Laboratory

PARTICLE SIZE DISTRIBUTION			**OPERATOR:** OMOH, EMMANUELLA **DATE:** JULY, 2021	
COMPANY: CALABAR BY PASS			**STATION:** CALABAR	
ABSOLUTE DRY WT: 1000g			**DEPTH:** 1.5m	
WT OF SAMPLE WET: 1000g			**CHAINAGE/SAMPLE NO:** A(BROWISH LATERITE)	
HYGROSCOPIC MOISTURE CONTENT: 0.02%			**WEIGHT OF DRY SAMPLE:** 1000g	
SIEVES	WEIGHT RETAINED	% RETAINED	% CUMULATIVE	% PASSING
20mm				
14mm				
10mm				
6mm				
5mm				
4.75mm	29	2.9	2.9	97.1
3.35mm	57	5.7	8.6	91.4
2.36mm	80	8.0	16.6	83.4
1.18mm	225	22.6	39.2	60.8
600mIc	226	22.7	61.9	38.1
425mIc	45	4.5	66.4	33.6
300mIc	192	19.3	85.7	14.3
212mIc	63	63	92.0	8
150mIc	26	2.6	94.6	5.4
75/63mIc	34	3.4	98.3	2
PASSING 63mic	19	1.9	100	
TOTAL	996			

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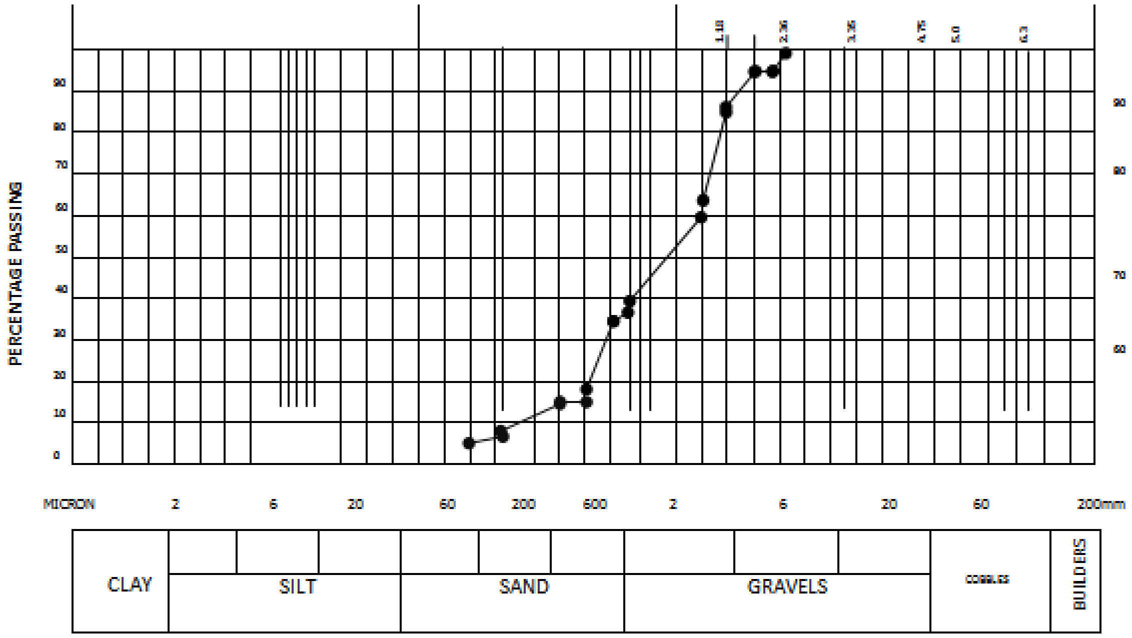
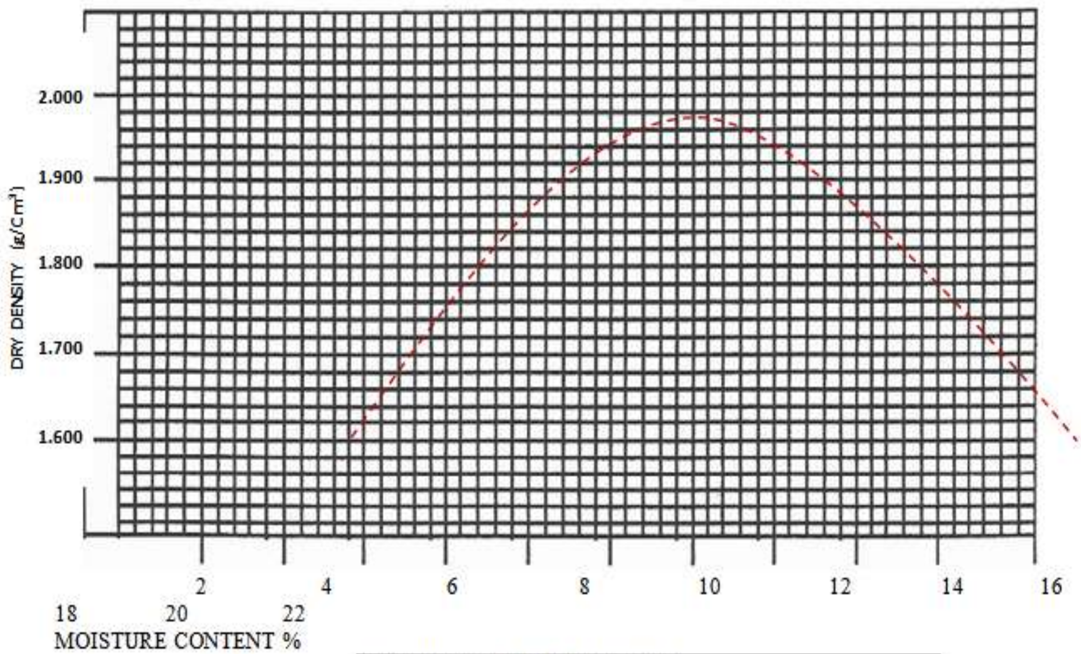


Tested By: ____________ Contractor's Rep: ______________ Consultant's/Client Rep: ____________

Table 4: Compaction Test

Project: CALABAR BY PASS										
Sample Description: YELLOWISH BROWN SANDY CLAY OF MEDIUM PLASTICITY (LATERITE)								**Operator:** OMOH, EMMANUELLA		
Location: CALABAR								**Date:** JULY, 2021		
Depth of Sample: 1.50m										
Type of mould: MODIFIED PROCTOR			**Number of layers:** 3							
Number of blows per layer: 27			**Weight of Hammer:** 4.5Kg							
A	Wt of mould + wet soil (W_1)	Kg	3674		4015		3936		3645	
B	Wt of empty mould (W_2)	Kg	1631		1631		1631		1631	
C	Wt of wet sample (W_1 - W_2)	Kg	2043		2384		2305		2014	
D	Wet Density P=(W_1 - W_2) / V	Kg/M^3	2.080		2.428		2.347		2.051	
E	Moisture Content	TIN	FG	OD	CY	SP	AG	EL	BM	TM
F	Wt of wet soil +TIN (M_1)	G	75	77	68	65	78	80	87	85
G	Wt of Dry soil +TIIN (M_2)	G	72	73	63	61	70	72	76	75
H	Wt of Water (M_1 – M_2)	G	3	4	5	4	8	8	9	9
I	Wt of TIN (M_3)	G	9	9	9	9	9	8	9	9
J	Wt of Dry soil (M_2-M_3)	G	63	64	54	53	61	64	67	66
K	Moisture Content (M)	%	4.76	6.	9.26	7.55	13.11	12.5	13.43	13.64

				2 5						
L	Mean M/C	%	**5.5**		**8.4**		**12.8**		**13.5**	
M	Dry Density	g/cm 3	**1.97**		**2.24**		**2.08**		**1.81**	



COMPACTION STANDARD:BS
MAXIMUM DRY DENSITY: 2.24g/cm³
OPTIMUM MOISTURE CONTENT: 12.8%

Table 5: Atterberg Limit Test

SOIL MECHANICS LABORATORY		**ATTER BERG LIMITS**	**Date:** JULY, 2021			
Project:CALABAR BY PASS			**Operator:**OMEKA ,MICHAEL			
Sample No: A			**Remarks:** YELLOWISH BROWN SANDY CLAY OF MEDIUM PLASTICITY			
Depth: 0.04 – 0.060m			**Linear Shrinkage**: 132.5			
At: 25 BLOWS	**LL**	**LL**	**LL**	**LL**		
NUMBER OF BLOWS	28	35	40	50	**PLASTIC LIMIT**	
MOISTURE CONTENT TIN NUMBER	UK	OD	UD	EL	BS	EF
WEIGHT OF TIN + WET SOIL g	80	69	75	90	79	70
WEIGHT OF TIN +DRY SOIL g	60	55	61	75	60	59
WEIGHT OF TIN g	10	9	9	10	10	9

WEIGHT OF WATER g	20	14	14	15	9	11
WEIGHT OF DRY SOIL	50	46	52	65	50	50
MOISTURE CONTENT %	40	30	27	23	18	22
ONE POINT METHOD FACTOR	**AVERAGE LIQUID LIMIT: 30.0%**		**AVERAGE PLASTIC LIMIT: 20.0%**			

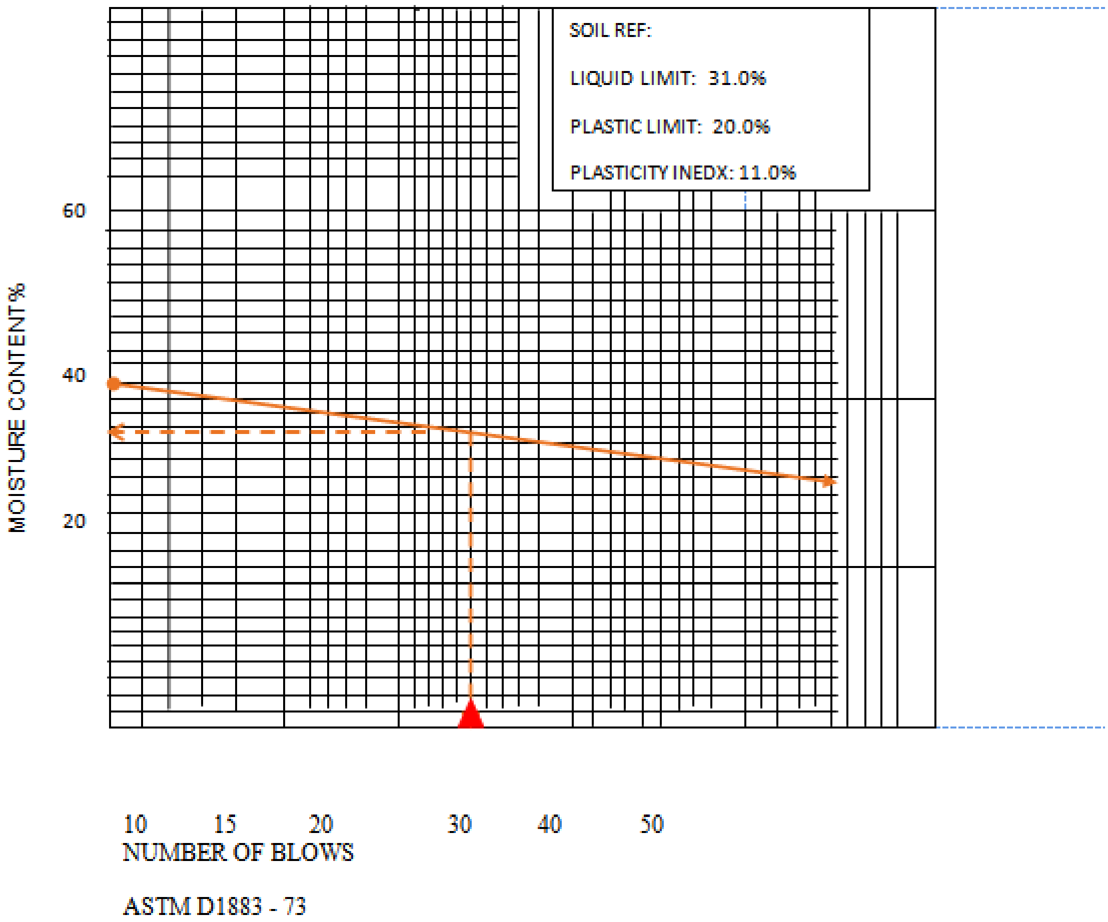


Table 6: Specific Gravity Test

S/No.:	**A**	**A**
SAMPLE No:	**SAND**	
LOCATION:	**CALABAR RIVER SAND**	
Mass of Bottle (m_1) g	460	472
Mass of Bottle + Sample (m_2) g	857	869
Mass of Bottle + Sample + Water (m_3) g	1512	1520
Mass of Bottle full of water (m_4) g	1269	1280

Mass of Water used (m_3 – m_2) g	655	651
Mass of Sample used (m_2 – m_1) g	397	397
Specific Gravity, $Gs=\frac{m_2-m_1}{(m_4-m_1)-(m_3-m_2)}$	2.6	2.5
GS AVERAGE	2.55	

ASTM D1883 - 73

Table 7: Specific Gravity Test

S/No.:	**B**	**B**
SAMPLE No:	**LATERITE**	
LOCATION:	**CALABAR RIVER SAND**	
Mass of Bottle (m_1) g	460	472
Mass of Bottle + Sample (m_2) g	856	867
Mass of Bottle + Sample + Water (m_3) g	1517	1525
Mass of Bottle full of water (m_4) g	1272	1292
Mass of Water used (m_3 – m_2) g	661	658
Mass of Sample used (m_2 – m_1) g	396	395
Specific Gravity, $Gs=\frac{m_2-m_1}{(m_4-m_1)-(m_3-m_2)}$	2.6	2.4
GS AVERAGE	**2.5**	

Table 8: Compressive Strength Test on block samples after 7 days of curing

Parameters	**No. Samples**	**Mix Ratio**	**Weight Of Sample (kg)**	**Crushing Load (KN)**	**Compressive Strength (N/mm^2)**
Sandcrete hollow blocks	S1	1:6	21.873	15.39	1.04
	S1	1:6	21.725	15.4	1.05
	S1	1:6	21.892	15.48	1.00
Laterite cement Blocks	S1	1:6	21.310	25.9	1.75
	S2	1:6	21.738	26.64	1.80
	S 3	1:6	21.064	25.61	1.73
Polystyrene And cement hollow blocks	S 1	1:6	5.581	8.44	0.57
	S 2	1:6	5.743	6.36	0.43
	S3	1:6	5.620	10.51	0.71
Cement+ sand+ laterite+	S1	1:2:2:2	16.094	16.72	1.13
	S2	1:2:2:2	16.685	16,28	1.10
	S3	1:2:2:2	16.347	17.17	1.16

Polystyrene hollow blocks					

Table 9: The average compressive strength of each block type for day 7 of curing.

Block Type	**Mix Ratio**	**Average Weight of Sample (kg)**	**Average Crushing Load (Kn)**	**Block Dimensions (Mm^2)**	**Average Compressive Strength (N/mm^2)**
Sandcrete hollow blocks	1:6	21.830	15.24	450*225*150	1.03
Lateritic cement blocks	1:6	21.371	26.20	450*225*150	1.77
Polystyrene and cement blocks	1:6	5.648	8.44	450*225*150	0.57
Cement+ sand+ laterite+ polystyrene blocks	1:2:2:2	16.375	16.72	450*225*150	1.13

Table 10: Compressive Strength Test on block samples after 14 days of curing

Paramaters	**No. of samples**	**Mix Ratio**	**Weight of Sample (kg)**	**Crushing Load (Kn)**	**Compressive Strength (N/mm^2)**
Sandcrete Hollow Blocks	S1	1:6	22.053	28.42	1.92
	S2	1:6	19.659	28.12	1.90
	S3	1:6	20.729	28.27	1.91
Laterite Cement Blocks	S1	1:6	20.695	42.77	2.89
	S2	1:6	21.275	42.92	2.90
	S3	1:6	20.595	41.88	2.83
Polysterene and Cement Hollow Blocks	S 1	1:6	4.494	18.06	1.22
	S 2	1:6	5.684	16.43	1.11
	S 3	1:6	5.721	14.95	1.01
Cement+ Sand+ Laterite+ Polysterene Hollow Blocks	S1	1:2:2:2	16.428	27.23	1.84
	S 2	1:2:2:2	16.620	28.71	1.94
	S3	1:2:2:2	16.358	27.97	1.89

Table 11: The average compressive strength of each block type for day 14 of curing.

Block Type	**Mix Ratio**	**Average Weight Of Sample(kg)**	**Average Crushing Load (KN)**	**Block Dimensions (mm^2)**	**Average Compressive Strength (N/mm^2)**
Sandcrete hollow blocks	1:6	20.813	28.27	450*225*150	1.91
Lateritic cement blocks	1:6	20.855	42.62	450*225*150	2.88
Polystyrene and cement blocks	1:6	5.299	16.43	450*225*150	1.11
Cement+ sand+laterite+ polystyrene	1:2:2:2	16.489	27.97	450*225*150	1.89

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blocks					

Table 12: Compressive Strength Test on block samples after 21 days of curing

Parameters	No. of Samples	Mix Ratio	Weight Of Sample (kg)	Crushing Load (KN)	Compressive Strength (N/mm^2)
Sandcrete Hollow Blocks	S1	1:6	22.083	28.42	2.50
	S2	1:6	22.317	28.12	2.70
	S3	1:6	21.293	28.27	2.69
Laterite Cement Blocks	S1	1:6	21.219	56.24	3.80
	S2	1:6	20.073	59.94	4.05
	S3	1:6	22.007	59.94	4.05
Polysterene And Cement Hollow Blocks	S1	1:6	5.864	42.77	1.70
	S2	1:6	5.713	42.92	1.76
	S3	1:6	5.011	41.88	1.70
Cement+ Sand+ Laterite+ Polysterene Hollow Blocks	S 1	1:2:2:2	16.823	18.06	2.33
	S2	1:2:2:2	16.343	16.43	2.30
	S 3	1:2:2:2	16.682	14.95	2.33

Table 13: The average compressive strength of each block type for day 21 of curing.

Block Type	Mix Ratio	Average Weight of Sample (Kg)	Average Crushing Load (KN)	Block Dimensions (mm^2)	Average Compressive Strength (N/mm^2)
Sandcrete hollow blocks	1:6	21.898	38.92	450*225*150	2.63
Lateritic cement blocks	1:6	21.099	58.76	450*225*150	3.97
Polystyrene and cement blocks	1:6	5.529	25.50	450*225*150	1.72
Cement+ sand+laterite+ polystyrene blocks	1:2:2:2	16.610	34.20	450*225*150	2.31

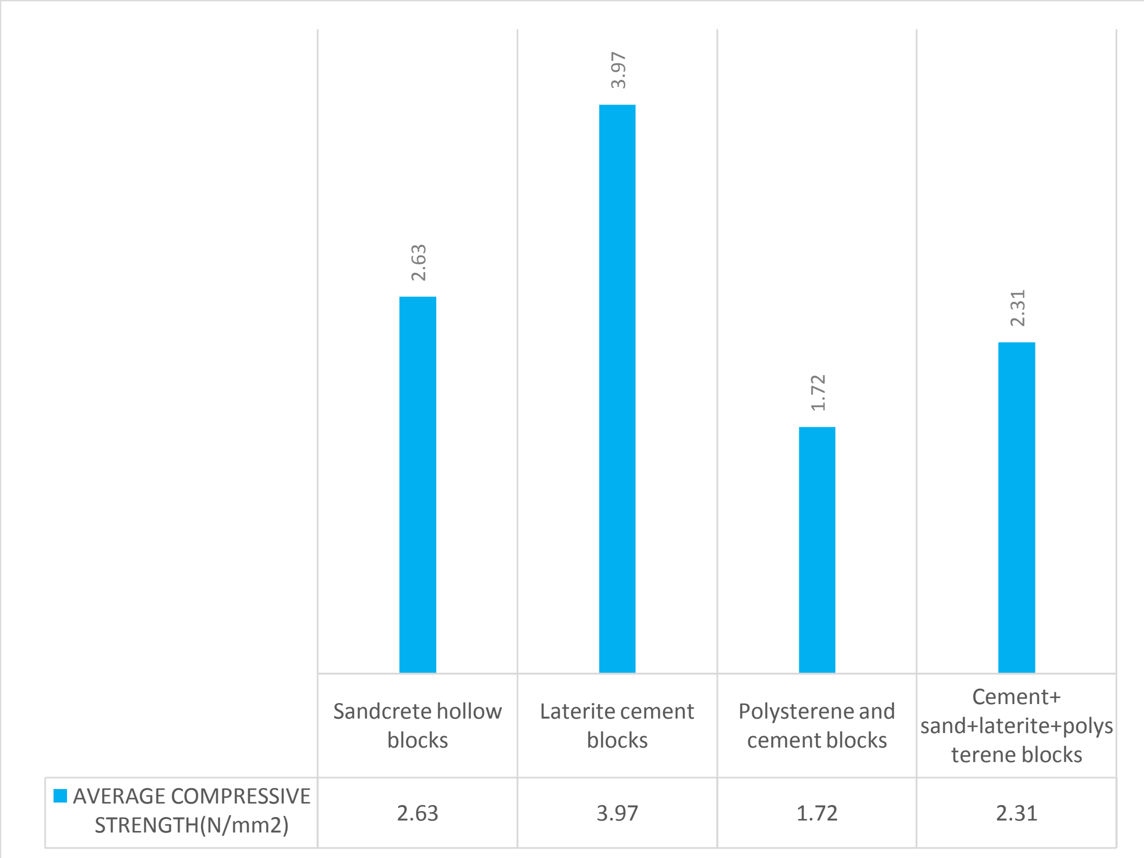

Fig. 1: shows the comparison of the average compressive strength of the hollow blocks after 21 days of curing.

Table 14: Compressive Strength Test on block samples after 28 days of curing

Parameters	**No. of samples**	**Mix Ratio**	**Weight Of Sample(kg)**	**Crushing Load (Kn)**	**Compressive Strength (N/mm^2)**
Sandcrete Hollow Blocks	S 1	1:6	21.922	50.76	3.43
	S2	1:6	21.927	51.80	3.50
	S3	1:6	21.904	48.84	3.30
Laterite Cement Blocks	S1	1:6	21.476	82.88	5.60
	S2	1:6	20.825	83.77	5.66
	S3	1:6	20.960	82.88	5.60
Polysterene and Cement hollow blocks	S1	1:6	5.018	34.04	2.30
	S2	1:6	5.020	35.37	2.39
	S3	1:6	5.217	34.04	2.30
Cement+ Sand+ Laterite+ Polystyrene Hollow Blocks	S1	1:2:2:2	16.525	53.28	3.60
	S 2	1:2:2:2	16.441	51.95	3.51
	S3	1:2:2:2	15.547	57.72	3.90

Table 15: The average compressive strength of each block type for day 28 of curing.

Block Type	**Mix Ratio**	**Average Weight of Sample (kg)**	**Average Crushing Load (KN)**	**Block Dimensions (mm^2)**	**Average Compressive Strength (N/mm^2)**
Sandcrete hollow blocks	1:6	21.918	50.47	450*225*150	3.41
Lateritic cement blocks	1:6	21.087	83.18	450*225*150	5.62
Polystyrene and cement blocks	1:6	5.085	34.48	450*225*150	2.33
Cement+ sand+laterite+ polystyrene blocks	1:2:2:2	16.172	54.32	450*225*150	3.67

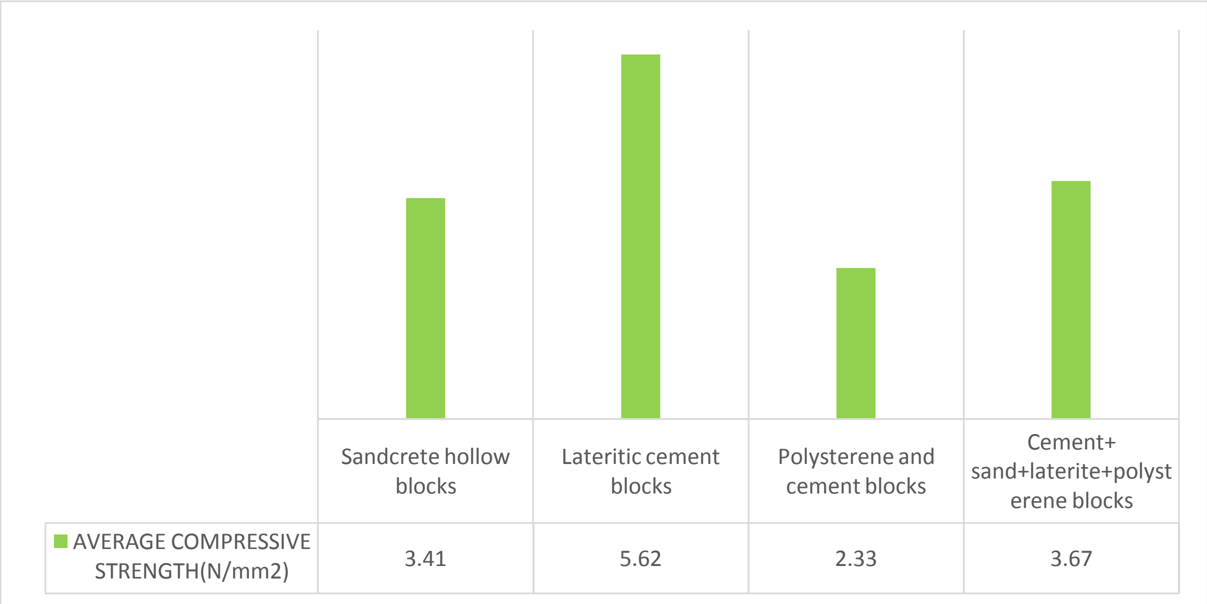

Fig. 2: shows the comparison of the average compressive strength of the hollow blocks after 28 days of curing.

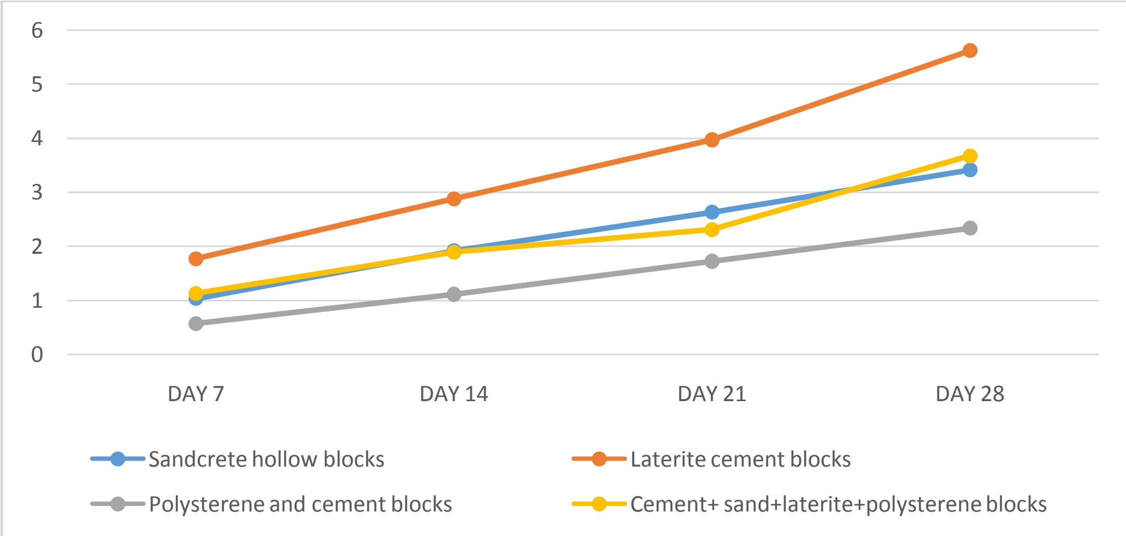

Fig. 3: shows the compressive strengths of the various types of hollow blocks under consideration after different days of curing.

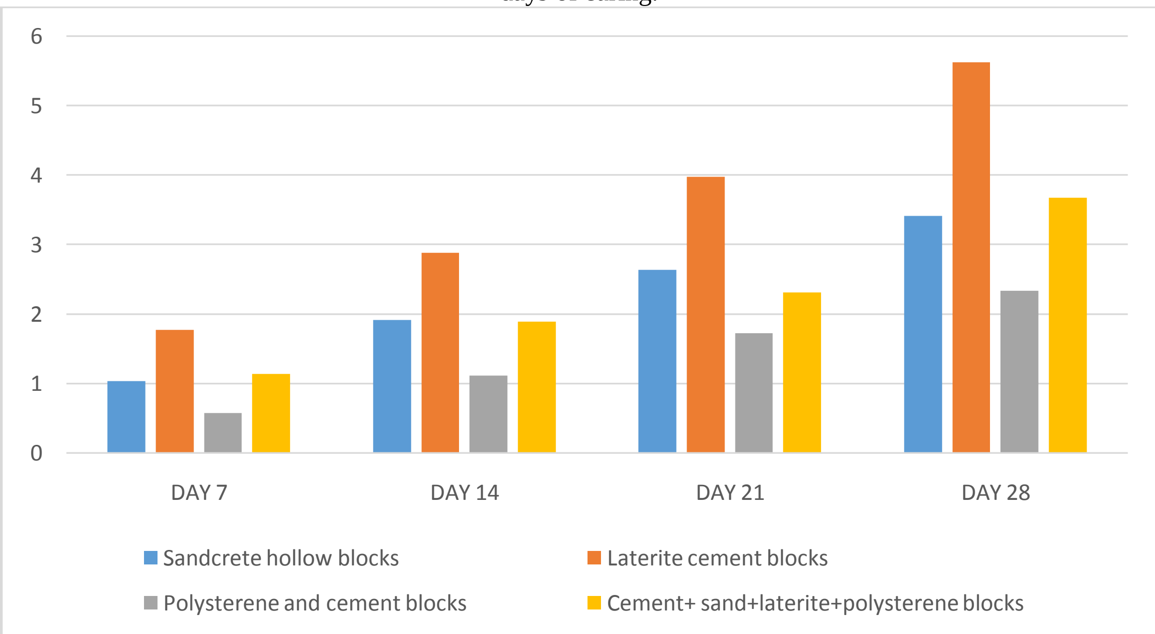

Fig. 4: shows the compressive strengths of the various types of hollow blocks under consideration after different days of curing.

Water Absorption

The following results were obtained during the water absorption tests carried out on the various samples of hollow blocks.

Parameters	Blocks	Dry mass (kg)	Wet mass (kg)	Water absorption (%)
Sandrete Hollow Blocks	Block 1	21.108	22.815	8.09
	Block 2	21.053	22.514	6.94
Cement And Laterite Blocks	Block 1	20.106	22.550	10.84
	Block 2	19.386	21.903	12.98
Cement And Polystetene Blocks	Block 1	5.570	5.714	2.59
	Block 2	5.619	5.764	2.58
Cement+ Sand+	Block 1	16.063	16.551	3.04

Laterite+ Polysterene Hollow Blocks	Block 2	16.468	17.116	3.93

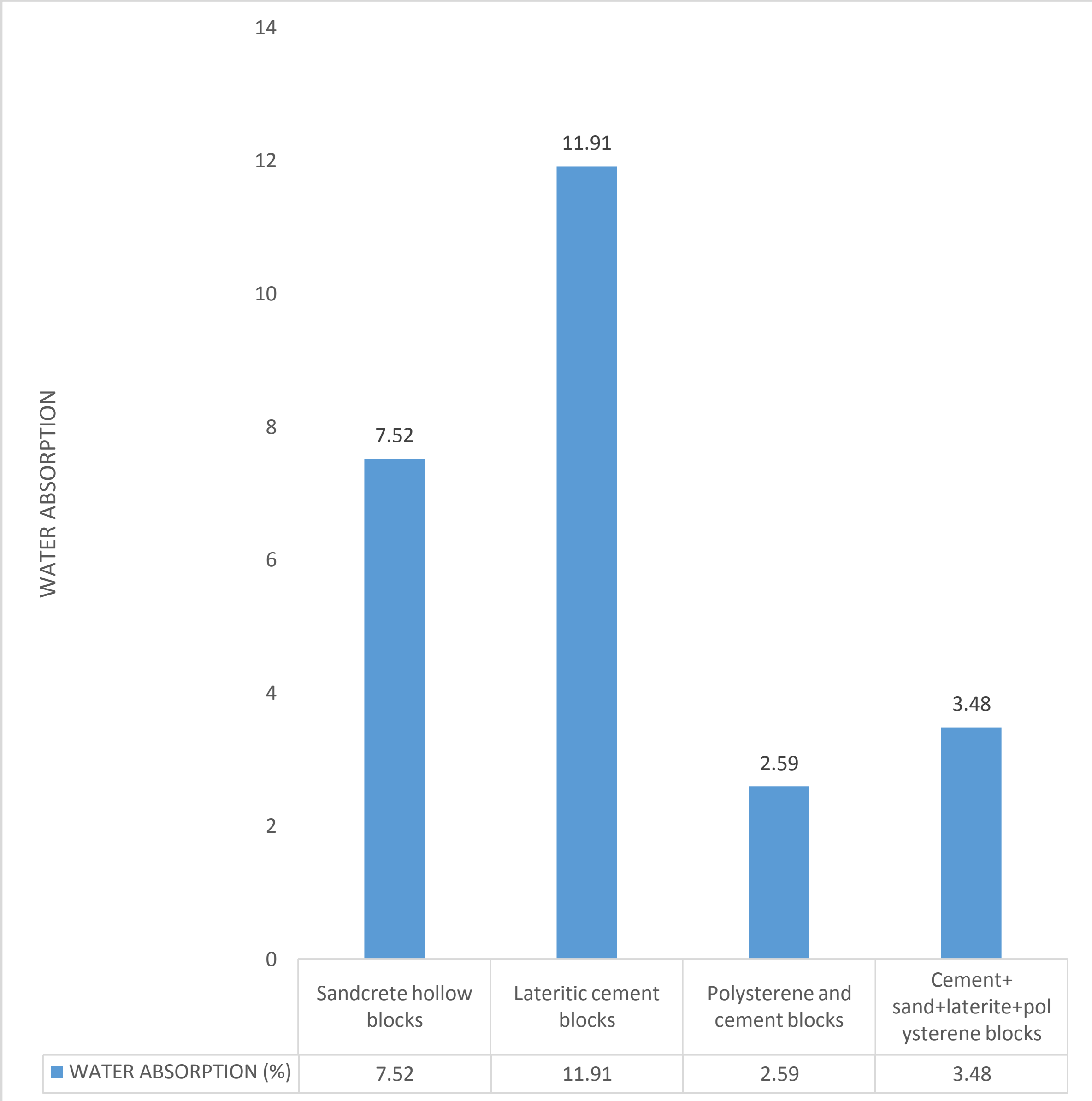

Fig.5: shows the representation of the water absorption of the different block samples.

IV. DISCUSSIONS

The results revealed that the average compressive strength of hollow cement sandcrete blocks at 28days of curing was 3.41N/mm^2 which falls within the range of the specifications of NBRRI (2006), which proposes a minimum compressive strength of sandcrete hollow blocks within the range of 2.5N/mm2 to 3.45N/mm^2.The laterite cement hollow block is observed to have the highest compressive strength when being compared with the other blocks as its strength ranges from 1.77N/mm2 to 5.62N/mm^2. This is in line with the minimum requirement proposed by the Nigerian Industrial Standard (NIS 87, 2000).Polystyrene blocks proved to be the weakest in compressive strengths with strength values ranging from 0.57N/mm^2 to 2.33N/mm^2 between days 7 and 28 of curing respectively. While the compressive strength of the cement+ laterite+ sand+ polystyrene combined hollow blocks had strength values ranging from 1.13N/mm^2 to 3.67N/mm^2.This research study confirmed that the quality of aggregates used were suitable for block making. The low compressive strength of polystyrene blocks means it is not suitable for application in load bearing walls as its workability is poor and is more suitable for use as partition walls also due to its lightweight. The blocks attained higher strength levels with the increase in the period of curing as it attained peak strengths by day 28 of curing. Laterite blocks have the highest water absorption percentage with a value of 11.91% this is due to the high amount of clay content present in laterite as it tends to absorb water much more easily than other materials. The other blocks; sandcrete blocks, polystyrene blocks and cement+laterite+sand+polystyrene blocks had water absorption of 7.52%, 2.58% and 3.48% respectively. The low water absorption level of polystyrene blocks is due to the water resistance of polystyrene as it is impermeable to water as its addition to blocks improves its water resistance.

V. CONCLUSION

The following conclusions were drawn from the study:

1. The compressive strengths of laterite cement hollow blocks were higher than that of the other block mixes in consideration. The strengths obtained from three out of four of the different block types under consideration meet the minimum requirement for building according to the specifications of Nigerian Building and Road Research Institute (2006), Nigerian Building Code (2006), and Nigerian Industrial Standards (2000).
2. Curing done on the blocks helped it attain peak strengths by day 28.
3. From the water absorption tests carried out, polystyrene hollow blocks have the least water absorption this could largely be due to the impermeable properties of polystyrene. Laterite cement blocks have the highest water absorption due to its high proportion of clay contained within.

RECOMMENDATIONS

1. Extensive research should be carried out on polystyrene hollow blocks to thoroughly study its properties and determine its application in building construction in Nigeria.
2. Other sizes and types of building blocks with these same materials should be researched on in a bid to enhance construction in the country.
3. Government should provide funding to tertiary institutions to aid research work.
4. Materials and equipment's needed for carrying out research should be made available to researchers by the institution.

REFERENCES

[1]. Abdullahi, M. (2005). Compressive Strength of Sandcrete Blocks in Bosso and Shiroro Areas of Minna, Nigeria, AUJT. 9(2), 126-131.
[2]. Abdel Wahid Hago, Amer Ali Al-Rawas and Awadh Al-Sidairi (2002). Effect of the Fineness of Artificial Pozzolana (Sarooj) on the Properties of Lime-Pozzolana Mixes, Science and Technology, 7 (2002) 251-258
[3]. American Association of State Highway and Transportation Officials. Standard Specification for Materials, fine aggregate for bituminous paving mixtures, AASHO designation, 29-83, part 1 specifications, 14th edition, 1986.
[4]. American Society for Testing Materials (ASTM) C150: Standard Specification for Portland Cement.
[5]. Anosike, M. N. (2011). Parameters for Good Site Concrete Production Management Practice in Nigeria. Unpublished PhD Thesis, Covenant University, Ota, Nigeria.
[6]. Babu DS, Babu KG, Wee TH. Effect of polystyrene aggregate size on the strength and moisture migration characteristics of lightweight concrete. Cem Concr Compos 2006;28:520–.
[7]. Baiden, B. K. and Tuuli, M. (2004). Impact of quality control practices in sandcrete blocks production, Journal of Architectural Engineering, 10(2), 55-60.
[8]. British Standard (BS) 12-Specification for Portland cement. BSI, London.
[9]. British Standard Institution: Specification for Aggregates from natural Sources for Concrete, BS 882. 2 Park Street, London, 1983.
[10]. BS 12 (1996). Specification for Portland Cement. 389, Cheswick High Road, London, British Standard Institution.
[11]. Chen B, Liu J. Properties of lightweight expanded polystyrene concrete reinforced with steel fiber. Cem Concr Res 2004;34:1259– 63.
[12]. Cook DJ. Expanded polystyrene beads as lightweight aggregate for concrete. Precast Concrete 1973;4:691–3.

[13]. Devi, M and Kannan, K. (2011). Strength and corrosion resistive properties of concrete containing quarry dust as fine aggregate with GGBFS. Advanced MaterialResearch, Vols. 243 – 249 pp 5775 – 5778
[14]. Duggal, S.K. (2003). Building Materials, New Age International Publishers, New Delhi, India.
[15]. Duna, S and Matawal, D.S (2007). Properties of Hollow Sandcrete Blocks Using Metakoalin as Partial Replacement for Cement. Journal of Environmental Science, 11(1): 106 - 116.
[16]. Ewa, D. E. &Ukpata, J. O. (2013), Investigation of Compressive strength of commercial sandcrete blocks in Calabar Nigeria. International journal of engineers and technology III(4)4777.782 Nigerian industrial standard (N1587-2004). Standard for sancrete blocks, standard organization of Nigeria, Lagos, Nigeria.
[17]. FHWA (2003). Recycled Materials in Portland Cement Concrete. Federal Highway Administration, Department of Transportation, Washington D.C.
[18]. Ganesh Babu K, Saradhi Babu D. Behaviour of lightweight expanded polystyrene concrete containing silica fume. Cem Concr Res 2003;33:755–62.
[19]. Ilangovan, R., Mahendran, N. and Nagamani, K. (2006). Strength and Durability Properties of Concrete containing Quarry Rock Dust as Fine Aggregates. ARPN Journal of Engineering and Applied Science. .3(5): 20-26
[20]. Jaywardena, U. De S. and Dissanayake, D. M. S. (2008). Use of quarry dust instead of river sand for future constructions in Sri Lanka. IAEG Paper No 38. TheGeological Society of London, 1 – 4.
[21]. Jones MR, McCarthy A. Preliminary views on the potential of foamed concrete as a structure material. Mag Concr Res 2005;57:21–31.
[22]. Khamput, P. (2006). A study of compressive strength of concrete using quarry dust to replace sand. Technology and Innovation for Sustainable Development Conference, Faculty of Engineering KhonKaen University, Thailand. 108-110
[23]. M. N. Anosike and A. A. Oyebade
[24]. NIS 2000. NIS 87: 2004. Nigerian Industrial Standard: Standard for Sandcrete Blocks. Standards Organisation of Nigeria, Lagos, Nigeria.
[25]. NIS 444-1 (2003). Cement – Part1: Composition, Specification and Conformity Criteria for Common Cement. Nigeria Industrial Standard, Lagos, Standard Organisation of Nigeria (SON).
[26]. NIS 444-1: 2003- Standard for Ordinary Portland cement; XXX: 2007-Test Sieves; 9001: 2008-Quality Standard Certification and 584: 2007-Methods of Testing Sandcrete Blocks.
[27]. NIS 87 (2000). Specification for Standard Sandcrete Blocks. Nigeria Industrial Standard, Lagos, Standard Organization of Nigeria (SON).
[28]. Olusola, K.O. (2005). Factors Affecting Compressive Strength and Elastic Properties of Laterized Concrete. Unpublished PhD Thesis, Department of Building, Obafemi Awolowo University, Ile-Ife, Nigeria.
[29]. Saradhi Babu D, Ganesh Babu K, Wee TH. Properties of lightweight expanded polystyrene aggregate concretes containing fly ash. Cem Concr Res 2005; 35:1218–23.
[30]. Taylor, G. O. (2002). Materials in construction principles practice and performance. Pearson published, www.personed.co-UK ISBN-13:978-0-582-36934-4
[31]. Wee Tionghua, Babu DanetiSaradhi, Tamilselvan T, Lim Hweesin. Air-void system of foamed concrete and its effect on mechanical properties. ACI Mater J 2006;106:45–52.