

Assessment of Compressive Strength of Sandcrete Blocks produced from Sea Sand with Varying Percentages of Mud as Admixtures

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Abstract:

This work assesses long-term strength and durability investigations of sandcrete blocks produced from sea sand, which appears to have significant gaps in literature. Buildings constructed with sea sand blocks in the Niger Delta region of Nigeria experienced serviceability complications with massive deterioration and degradation of strength in blockwalls that appears in powder form with associated cracks and exhibits failure modes in the buildings due to high salinity. The study focused on the use of 10% and 25% of Locally Sourced Mud (LSM) as admixture in the production of sandcrete blocks with Sea Sand. The mud used in the study was based on the mineralogy content to neutralize the salt in the sea sand blocks. A total of 36 units of Sea Sand blocks; 18 units of River Sand blocks; 36 units each of 10%-LSM, 25%-LSM, as admixtures with Sea Sand at varying curing days investigated. Comparison of 25%-LSM of 4.23 N/mm² and control blocks of 4.01 N/mm² at 28day showed remarkably close agreement, quantitatively and qualitatively. However, 25%-LSM addition by volume of Sea Sand produced more blocks in return with a cost saving of 21.4% per bag of cement and Strength of 4.23N/mm² at 28 days; 4.27N/mm² at 56 days, 4.27N/mm² at 100 days.

Keywords — **Compressive Strength; Locally sourced mud; Sandcrete block**

I. INTRODUCTION

Sea sand generally has the characteristics of fine and round granules, which are uniform and contain salts that are not beneficial for sandcrete blocks, so many are advised not to be used in making sandcrete blocks. Smooth and round granules and uniform gradation, can reduce adhesion and affect the strength and durability of sandcrete blocks. However, people who live on the coast still use sea sand as one of the fine aggregates on sandcrete and concrete for reasons of easy to obtain as reported in Akinkunmi Joel Olukunle (2022) and Ashwini Manjunath B T, Lakshmi, Kiran M S, Sahana C K.(2018).

Sea sand is a material used as a substitute for ordinary sand for a mixture of cement, fine or coarse aggregate and water, with the mixture when poured into a mold and then allowed to stand hard. By using sea sand, the most important thing is the compressive strength of the sandcrete. Factors that influence the compressive strength of sandcrete blocks consist of the quality of the material, cement water, aggregates, how to process it such as mixing, compaction, and age of the test or curing. Sandcrete is a result of mixing cement, water and fine aggregate.

This research is to provide information about the use of sea sand as a substitute for river sand by using 10% and 25% of mud as admixture and also to predict the strength of sandcrete blocks, as well as

new breakthroughs in the world of civil engineering that are still needed M. Ayung Tama, M. I. Setiawan, and S. Budi Wasono (2021) Research on local materials as alternatives for the construction of useful, but affordable homes is becoming increasingly important, especially among urban and coastal residents of Nigeria's Niger Delta, where prices of construction materials continue to rise daily with population growth as reported in the works of Wenapere A.D and Yabefa B.E (2021); Sri Lakshmi P., Rambabu Ch, Giri Prasad G, Nandamuru V. I. E.T, Andhra Pradesh, (2017).

II. MATERIAL AND METHOD

Sea sand is sand taken from the shores of the beach, the shape of the grains is smooth and round due to friction with each other as presented in the work of Wenapere A. D (2024). This sand is bad because it contains a lot of salt. This salt absorbs water content from the air and causes the sand to always be rather wet and cause volume expansion when used on buildings. However, sea sand in this study is mix with mud as admixture, which is by adding 10% and 25% of mud to the sea sand mixture so that the salt content is reduced or lost.

A. Locally Sourced Mud:

Material utilized in the research is the mud sourced locally from Sangana-Akassa. The mud was used as an admixture in the production of sandcrete blocks to explore its potential for enhancing the properties and performance of the blocks.

B. Cement:

Cement, a fundamental binder material in concrete and sandcrete block production, was used in the study. The specific type and properties of the cement used were determined based on regional availability and standard practices as stated in BS EN 197-1:2011, NIS 87 (2000) and reports from Ewa, D. E.



Figure 1: Mud sample collection



Figure 2: Mud sample identification

C. River Sand (RS):

River sand, distinct from the sea sand used as the primary material, was utilized as a control in the experiments. This comparison allowed for evaluating the specific impact of using sea sand in sandcrete block production. The River Sand (RS) was gotten from Amassoma Community River, Nigeria.

D. Water:

Water, a crucial component for the hydration process in cement-based materials, was sourced from the Niger Delta University for use in the experiments. This is was the view of Kucche K. J. et al (2015) and Sri Lakshmi P., Rambabu Ch, Giri Prasad G, Nandamuru V. I. E.T, Andhra Pradesh, (2017).

E. Steel Block Mold:

A 150 mm x 225 mm x 450mm steel block mold was used to produce the sandcrete blocks in a standardized size and shape for testing purposes.

1) Data Collection Method for Locally Sourced Mud and Sea Sand:

A material identification tour of selected communities in the Coastal region of Niger Delta, Nigeria was conducted for five weeks, four travel days. Akassa clan communities of Bayelsa State were selected for this study based on similar materials properties along the Atlantic Ocean. The Plates 1 and 2 showing locally sourced material selection and collection tour of Sangana- Akassa of Bayelsa State.

A 150 mm X 225 mm X 450mm size moulds boxes in the Niger Delta State University Structures laboratory were used to cast the Sandcrete Blocks of mix proportion 1:6. The water content used in Sea Sand and Locally Sourced Mud was 0.5 by mass accordingly, in both cases, that is, Sea Sand Sandcrete and Sea Sand / Locally Sourced Mud samples, wet curing was carried out for 7,14, 21, 28, 56 and 100 days at room temperature. Ten percent (10%) locally sourced mud by volume of the fine aggregate (sea sand) was added for the first set of blocks and followed other set by a percentage addition of 25%, to the sand with the locally sourced mud. Four (4) block samples were made, cured, weighed, and tested for compressive strength at seven (7), fourteen (14) to twenty-one (21) to Fifty-six (56) days, and one hundred (100) days as shown in Figure 3. The average values of the closest three (3) strength range values were used as the actual parameters.



Figure 3: Team members taking mass readings of block specimens

2) Methods for the tests

The various samples were prepared and tested for parameters prepared for. The locally sourced mud was prepared at 10% and 25% to mix with the sea sand to mould the 150 mm X 225 mm X 450mm blocks. The blocks were all weighed to record the mass in Kg. The crushing was done at varying ages of 7, 14, 21, 28, 56 and 100 days. The machine used in the Compressive Strength test was the HFI compression machine STYE-2000 ANALOGUE TYPE OKHARD MACHINE TOOL in the Structures Laboratory as shown in Figure 4. The compressive strength results were compared to the National Building Code's (2006) standards for a conventional sandcrete block in terms of strength.



Figure 4: Crushing

III. RESULTS AND DISCUSSION

The presentation and discussion of the study's findings are covered here. Furthermore, experimental results were analyzed using design expert software and statistical tools for better understanding of the actual test results. The results are further analyzed accordingly.

TABLE 1: COMPRESSIVE STRENGTH TEST RESULTS AT VARYING % OF MUD AND SEA SAND AFTER CURING FOR 7, 14, 28, 56 AND 100 DAYS OF AGE

DURATION (DAYS)	f _{cu} of RIVER SAND 100%	COMPRESSIVE STRENGTH		
		SEA SAND WITH LOCALLY SOURCED MUD AS ADMIXTURE - N/mm ²		
	f _{cu} 100% RS	f _{cu} at 10% LSM	f _{cu} at 25% LSM	f _{cu} at 0% LSM
0	0.00	0.00	0.00	0.00
7	0.90	0.21	1.33	1.00
14	2.28	0.70	3.28	2.56
21	3.42	2.18	3.70	3.66
28	4.01	3.13	4.23	4.08
56	4.01	3.28	4.27	3.98
100	4.01	2.90	4.27	3.22

Data source: Wenapere A. D (2024)

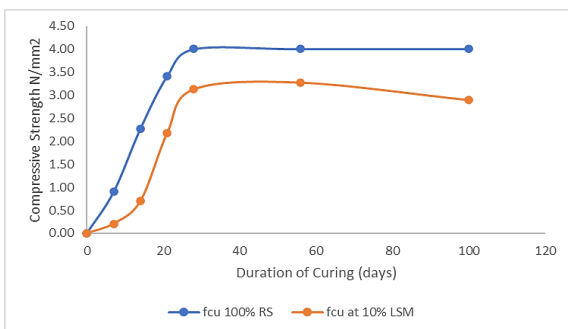


Figure 5: Graph of 10% LSM showing predicted and experimented f_{cu}

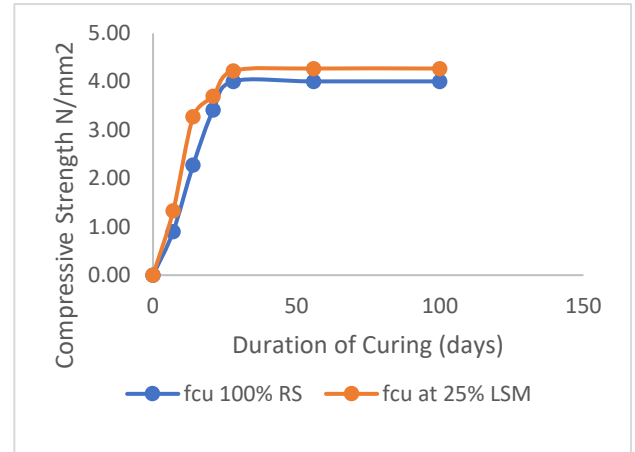


Figure 6: Graph of Compressive Strength Test Results of River (Fresh Water) Sand

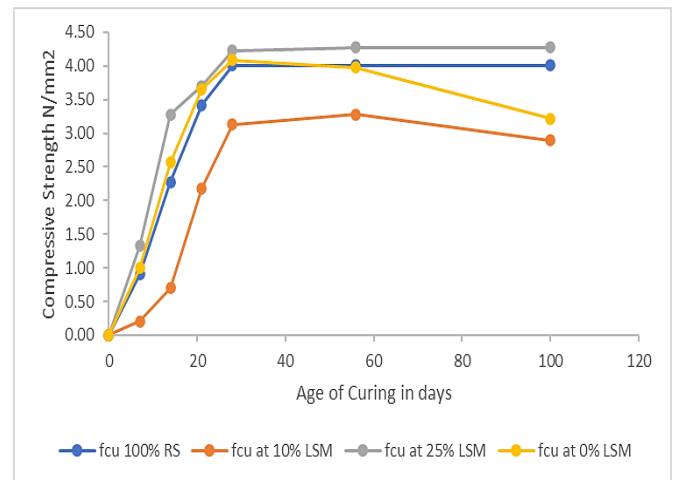


Figure7: Compressive Strength Test Results at Varying % of Mud and Sea Sand

TABLE 2: TABLE OF VALIDATED EXPERIMENTAL MODELS WITH VARYING % OF LSM BLOCKS

Day	fcu 10% LSM	fcu 25% LSM	fcu 100% RS	fcu 100% SS 0% LSM
7	0.189	1.344	0.889	0.996
10	0.331	2.251	1.578	1.776
14	0.781	3.116	2.358	2.610
17	1.251	3.553	2.845	3.099
21	1.968	3.915	3.374	3.594
24	2.524	4.059	3.688	3.864
28	3.227	4.132	4.005	4.110
31	3.688	4.127	4.174	4.224
34	4.067	4.093	4.290	4.288
37	4.346	4.050	4.358	4.311
40	4.510	4.010	4.383	4.302
43	4.551	3.987	4.370	4.268
46	4.463	3.991	4.325	4.215
49	4.247	4.029	4.254	4.151
52	3.908	4.106	4.160	4.079
56	3.279	4.271	4.011	3.980
59	2.693	4.441	3.888	3.907
62	2.032	4.646	3.760	3.839
65	1.318	4.880	3.634	3.778
68	0.581	5.134	3.513	3.724
71	-0.146	5.394	3.405	3.679
74	-0.825	5.648	3.313	3.640
77	-1.414	5.878	3.244	3.608
80	-1.866	6.064	3.202	3.581
83	-2.129	6.184	3.192	3.554
86	-2.148	6.213	3.221	3.526
89	-1.861	6.124	3.292	3.491
92	-1.205	5.886	3.413	3.445
95	-0.109	5.467	3.586	3.382
98	1.502	4.832	3.819	3.295
100	2.900	4.270	4.010	3.220

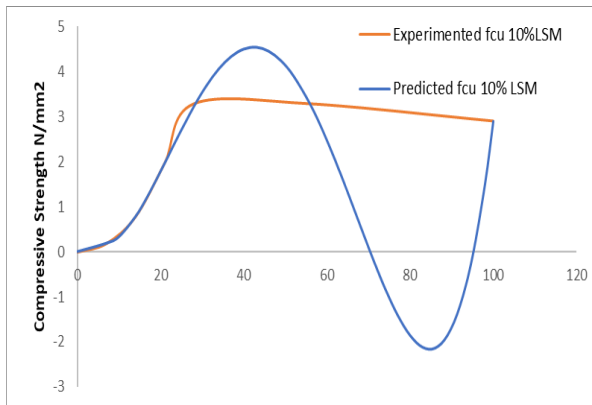


Figure 8: Graph of 10% LSM showing predicted and experimented f_{cu}

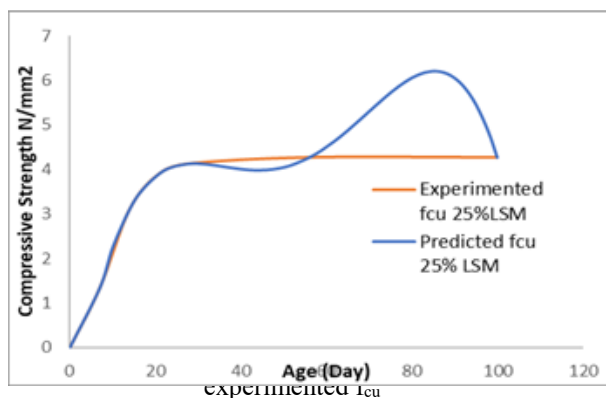
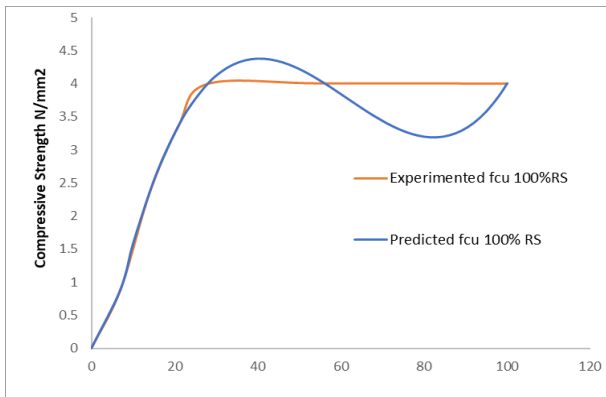


Figure 10: Graph of 25% LSM showing predicted and experimented f_{cu}

Graphs presented in Figure 5 and Figure 6 shows the strength pattern of 10% LSM and 25% LSM sandcrete blocks respectively of Sand gotten from Sangana- Akassa sea side. It clearly shows that 25% LSM admixture provides a better strength than the first control (100% RS) and second control (100% SS).

Referring to Figures 7, 8, 9 and 10, it is clear that the initial curing period, the blocks produced with river sand exhibited a lower compressive strength compared to those produced with sea sand. This suggests that the river sand sandcrete blocks were initially weaker in terms of their ability to withstand compression forces.

However, as the study progressed and the blocks reached 100 days of age, an interesting trend emerged. The compressive strength of the sea sand sandcrete blocks decreased by approximately 24% compared to their strength at the initial curing period. This implies that over time, the sea sand sandcrete blocks experienced a significant reduction in their ability to withstand compressive forces.

The observed decrease in compressive strength for the sea sand sandcrete blocks raises concerns about their long-term durability and structural stability. It suggests that the initial strength advantage they possessed over the river sand sandcrete blocks diminished over time, potentially making them less reliable for applications that require sustained strength over extended periods and usage. Figures 8, 9 and 10 further shows the validated models with equation 1.

$$f_c = -2.394 + 0.454\alpha + 0.09277\beta - 0.000558\alpha\beta - 0.00899\alpha^2 - 0.00246\beta^2 - 5.03 \times 10^{-6}\alpha^2\beta + 0.000013\alpha\beta^2 + 0.000052\alpha^3\beta^3 + 0.000015\beta^3 \quad (1)$$

where:

α = Duration of curing in days

β = % of Locally sourced mud addition

IV. CONCLUSION AND RECOMMENDATIONS

The study clearly shows the compressive strength of 25% locally sourced mud with sea sand sandcrete block units in both Sangana -Akassa at 56 and 100 days appears to be constant or asymptotically respectively at 4.27N/mm² which is even higher than the control (River Sand) of 4.01N/mm² for 28-, 56- and 100-days curing.

This further prove that cost of producing sandcrete blocks for building has been saved by 1,540 naira per bag of cement and strength increased by 22%, as more blocks are produced with better strength in all cases of 25% LSM added to the Sea Sand.

1) Conclusions

The study also investigated the strength attributes of sandcrete blocks made from river sand as control; sea sand with locally sourced mud as an admixture with varying percentages of mud.

Model Equation is developed and validated to be correct for the variation in compressive strength of sandcrete blocks from sea sand and locally sourced mud samples as admixtures at 7, 14, 21, 28, 56 and 100 days of curing with proportions of 10% and 25%.

Data from the study indicates that during the initial curing period, the blocks produced with river sand exhibited a lower compressive strength compared to those produced with sea sand. This suggests that the river sand sandcrete blocks were initially weaker in terms of their ability to withstand compression forces. However, as the study progressed and the blocks reached 100 days of age, an interesting trend emerged. The compressive strength of the sea sand sandcrete blocks decreased by approximately 24% compared to their strength at the initial curing period. This implies that over time, the sea sand sandcrete blocks experienced a significant reduction in their ability to withstand compressive forces.

According to the study, the addition of mud as an admixture to sea sand had varying effects on the strength of the sandcrete blocks. Different percentages of mud were added to the sea sand, and the resulting changes in compressive strength were

observed and analyzed. Here is a breakdown of the findings:

1. When 10% of the locally sourced mud added to sea sand; the strength of the sandcrete blocks decreased by 10%. This suggests that the presence of a small amount of mud negatively impacted the overall strength of the blocks.
2. When 25% of mud was added to the sea sand: Surprisingly, compared to sea sand without any mud, this addition increased compressive strength by 23.33%. This indicates that a moderate amount of mud acted as a beneficial admixture, enhancing the strength of the sandcrete blocks with 37 blocks per bag produced instead of 30 blocks per bag. This is cost saving of 21.4% per bag of cement and a breakthrough in the building industry in the coastal region.

Based on these findings, the study recommends the use of 25% mud as the optimal admixture with sea sand. This percentage resulted in the highest increase in compressive strength while considering the trade-off between strength enhancement and practical considerations. It appears that a higher concentration of mud beyond 25% did not proportionally increase the strength, and lower concentrations had either negative or minimal effects.

These findings suggest that the addition of mud as an admixture can positively influence the strength of sandcrete blocks made with sea sand. However, further research and experimentation may be necessary to determine the exact mechanisms through which mud interacts with sea sand and to ensure that the desired strength enhancement is consistently achieved in practical construction applications.

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