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Effects of Curing on the Compressive Strengths of Commercial Sandcrete Blocks in Calabar Nigeria

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ABSTRACT

This study considered the effects of curing on the compressive strength property of 150mm thick sandcrete blocks produced by commercial block industries in Calabar South-Eastern Nigeria. Commercial sandcrete blocks were randomly selected from ten (10) block moulding sites and cured in the Concrete and Materials Laboratory of the Cross River University of Technology, Calabar for 7, 14, 21 and 28 by watering every morning and evening up to the testing dates. The 28 day compressive test results were compared with those cured in the sites. The results indicated that the 28-day compressive strengths of blocks cured at site by the producers range from 0.23N/mm^2 to 0.58N/mm^2, while those cured in the University Laboratory range from 1.08 N/mm^2 to 1.15 N/mm^2. Although the compressive strengths of all the blocks were below the minimum requirements of 1.75N/mm^2 by the Nigerian National Building Code (2006) for individual block, and 2.8N/mm^2 by the British Standard BS 6073, improved curing resulted in increased strength of the commercial blocks by 98.28%.The study concludes that poor curing practices and low cement content are responsible for the poor quality of commercial sandcrete blocks produced in Calabar.

Keywords: *Sandcrete Blocks, Compressive Strength, Curing.*

1. INTRODUCTION

Sandcrete blocks appear to be the most commonly utilized walling unit in the South-South region of Nigeria. Perhaps due to the heavy rains experienced in this part of the country, earth block technology is not popular around the Niger Delta region of the country. This has placed a high demand on inert materials such as sandcrete blocks for housing development. According to Abdullahi (2005), over 90% of physical infrastructures in Nigeria are being constructed using sandcrete blocks. However, operators of commercial blocks tend to take advantage of this high demand to deliver low quality products. Sometimes due to demand pressures, the blocks are not adequately cured among other practices such as poor compaction and inadequate cement content. The focus of the present study is the effect of curing on the compressive strengths of blocks supplied from the various commercial block industries in Calabar. 150mm thick blocks have been chosen for the study being the most commonly used in the study area.

2. PREVIOUS STUDIES

A number of studies have been conducted on the significance of curing to the strengths of sandcrete blocks. According to Hamza (2009), to gain enough strength before being laid, sandcrete blocks should be allowed to mature for at least 28 days. During this period, the blocks are cured to prevent loss of moisture needed for hydration reaction to continue. However, commercial blocks producers hardly keep to this practice as the blocks are usually hurriedly sold to meet demands of mostly ignorant customers. Curing produces good quality blocks, prevents premature drying out with radiation and wind. Curing could be done by covering the blocks with polythene, by spraying with water and or with hot steam (Yusuf, 2011).

Okafor (2012) found that in order to minimise cost and maximize profits, producers of sandcrete blocks in Nigeria reduce the quantity of cement needed to give acceptable quality of sandcrete blocks, leading to the flooding of low – strength blocks in the commercial markets. According to Abdullahi (2005), the compressive strengths of sandcrete blocks in Minna, Nigeria range between 0.11N/mm^2 and 0.75N/mm^2, while Ewa and Ukpata (2013) also found that the compressive strengths of sandcrete blocks produced by commercial block industries in Calabar range between 0.23 N/mm^2 and 0.58 N/mm^2. A number of reasons including poor curing have been suggested for the low strengths of these blocks.

Similarly, Anosike & Oyebande (2012) have argued that there is a low compliance in the compressive strength of sandcrete blocks produced commercially in parts of Nigeria. Inadequate curing period by the manufacturers accounts for the negative results in the strengths of blocks. This is supported by Ewa and Ukpata (2013) in a similar study in Calabar Nigeria.

3. METHODOLOGY

Commercial sandcrete blocks were randomly selected from ten (10) blocks moulding sites in Calabar and cured in the Concrete and Materials Laboratory of the Cross

River University of Technology Calabar. Collection of blocks was done three days after production and initial curing at sites. Curing continued for 7, 14, 21 and 28 by sprinkling water on the blocks every morning and evening up to the testing periods already stated. The compressive strengths of the blocks were determined in accordance with BS 6073. The cement used by all manufacturers was the UNICEM ordinary Portland cement manufactured by the United Cement Company of Nigeria. The mix ratios observed in all the sites range from 1:18 to 1:20 (cement: sand), producing between 40 to 56 blocks per bag of cement. These ratios are more than 1:9 in Akeem *et al* (2012) and 1:12 in Raheem (2006).

4. RESULTS AND DISCUSSION

4.1 Chemical Properties of Cement Used

Table 1 shows the properties of cement used by all ten sites for moulding of the blocks meets the specification for Ordinary Portland Cement, Neville (2000).

Table 1: Chemical Properties of Cement used

Constituent	Cao	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	K_2O	NaO_2
Percentage	64.34	20.79	4.51	2.64	1.66	1.48	1.26	0.18

The specific gravity of the cement used was 3.51.

4.2 Density of Blocks

The results of the dry densities of the blocks are presented in Appendices 1 to 10. The densities range from 1827.16 kg/m^3 to 2119.66 kg/m^3. These values are far below 2146.46 kg/m^3 to 2209.60 kg/m^3 recorded in Akeem, Ayodeji & Aliu (2012) with mix ratio of 1:9 and 2041.3 kg/m^3 to 2160.9 kg/m^3 recorded in Raheem (2006) with mix ratio of 1:12. The poor mix ratio in order to maximize profits reduces the cement contents in the blocks. As cement which has a higher specific gravity than sand is reduced in the mix, the weights of the blocks are also reduced; this is responsible for the low density blocks in the commercial market. The low densities also indicate low vibrations. Vibrations tend to compact aggregate and reduce pore spaces between aggregate. This has a tendency to increase the strength of the block.

4.3 Compressive Strength

Table2 and Figure1 show the results of the compressive strength for the site-cured blocks. The values for the 28 day strengths range from 0.23N/mm^2 to 0.58N/mm^2. Table3 and Figure 2 present the results of the compressive strengths of blocks cured in the University by spraying the blocks every morning and evening. The 28 day values range from 1.08 N/mm^2 to 1.15 N/mm^2. Again, these values are less than the 1.48 N/mm^2 at 7 days, 3.35 N/mm^2 at 28 days obtained in (Akeem, Ayodeji, & Aliu, 2012), and 0.53 N/mm^2 to 1.59 N/mm^2 recorded in Raheem (2006) due to their better mix ratios. It can be observed that improving the curing of the blocks by consistent watering also increased the strength of the commercial blocks by 98.28%.

Table2: Compressive Strength of Site Cured Blocks

	Curing Period in days / compressive strengths (N/mm2)			
	3days	7 days	14 days	28 days
site1	0.04	0.18	0.2	0.32
site2	0.04	0.23	0.35	0.47
site3	0.05	0.08	0.15	0.34
site4	0.05	0.13	0.29	0.52
site5	0.03	0.11	0.11	0.23
site6	0.04	0.19	0.33	0.47
site7	0.05	0.17	0.29	0.45
site8	0.05	0.08	0.34	0.54
site9	0.04	0.13	0.33	0.47
site10	0.04	0.07	0.35	0.58

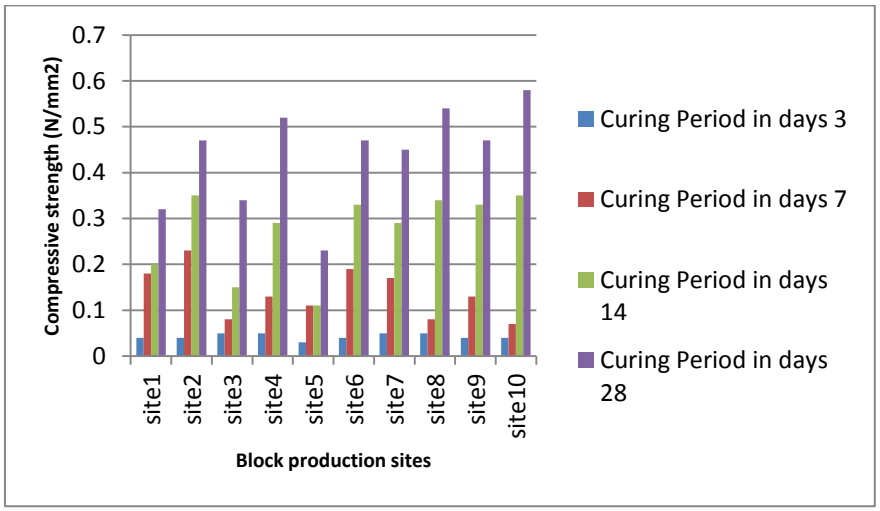

Figure1: Compressive Strength of Site Cured Blocks

Table3: Compressive Strength of University Cured Blocks

	Curing Period in days / compressive strengths (N/mm2)			
	3days	7days	14days	28days
site1	0.28	0.38	0.80	1.11
site2	0.29	0.39	0.80	1.16
site3	0.29	0.40	0.67	1.08
site4	0.31	0.41	0.79	1.17
site5	0.28	0.38	0.83	1.17
site6	0.29	0.41	0.84	1.08
site7	0.28	0.39	0.80	1.12
site8	0.29	0.38	0.81	1.10
site9	0.31	0.42	0.81	1.12
site10	.28	0.36	0.81	1.15

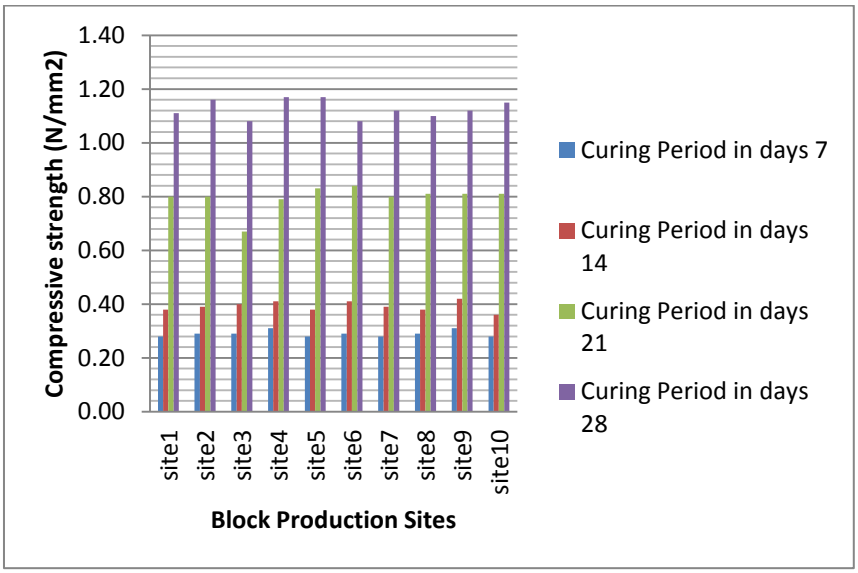

Figure2: Compressive Strength of University Cured Blocks

5. CONCLUSION

This research has shown that the available commercial sandcrete blocks in Calabar Metropolis do not meet the minimum requirements for compressive strength set by the Nigerian Industrial Standard (NIS) and that of the British Standard Institution for masonry blocks. The study has also found that curing plays a vital role in improving on the compressive strengths of sandcrete blocks. It concludes that with improved curing and appropriate cement content, the sandcrete blocks produced in commercial block industries in Calabar can be improved.

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APPENDICES

Appendix 1

Compressive Strength Results For University Cured Blocks							
SITE 1							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.20	1846.15	1834.76	11	0.29	0.28
		16.10	1834.76		11	0.29	
		16.00	1823.36		10	0.27	
2	14	16.80	1914.53	1887.94	15	0.40	0.38
		16.40	1868.95		14	0.37	
		16.50	1880.34		14	0.37	
3	21	17.00	1937.32	1948.72	29	0.77	0.80
		17.20	1960.11		31	0.83	
		17.10	1948.72		30	0.80	
4	28	18.40	2096.87	2077.87	45	1.20	1.11
		18.20	2074.07		40	1.07	
		18.10	2062.68		40	1.07	

Appendix 2

Compressive Strength Results For University Cured Blocks							
SITE 2							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.10	1838.95	1839.95	10	0.27	0.29
		16.10	1834.76		11	0.29	
		16.20	1846.15		12	0.32	
2	14	16.80	1914.53	1895.54	15	0.40	0.39
		16.60	1891.74		15	0.40	
		16.50	1880.34		14	0.37	
3	21	17.20	1960.11	1952.52	31	0.83	0.80
		17.10	1948.72		29	0.77	
		17.10	1948.72		30	0.80	
4	28	18.80	2142.45	2104.46	48	1.28	1.16
		18.20	2074.07		40	1.07	
		18.40	2096.87		42	1.12	

Appendix 3

Compressive Strength Results For University Cured Blocks							
SITE 3							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.40	1868.95	1842.36	12	0.32	0.29
		16.10	1834.76		11	0.29	
		16.00	1823.36		10	0.27	
2	14	16.80	1914.53	1899.34	16	0.43	0.40
		16.70	1903.13		15	0.40	
		16.50	1880.34		14	0.37	
3	21	16.50	1880.34	1918.33	15	0.40	0.67
		17.00	1937.32		30	0.80	
		17.00	1937.32		30	0.80	
4	28	18.20	2074.07	2062.68	42	1.12	1.08
		18.00	2051.28		40	1.07	
		18.10	2062.68		40	1.07	

Appendix 4

Compressive Strength Results For University Cured Blocks							
SITE 4							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.60	1891.74	1868.95	12	0.32	0.31
		16.40	1868.95		12	0.32	
		16.20	1846.15		11	0.29	
2	14	17.00	1937.32	1887.94	18	0.48	0.41
		16.20	1846.15		14	0.37	
		16.50	1880.34		14	0.37	
3	21	17.20	1960.11	1952.52	30	0.80	0.79
		17.20	1960.11		31	0.83	
		17.00	1937.32		28	0.75	
4	28	18.20	2074.07	2119.66	44	1.17	1.17
		19.20	2188.03		46	1.23	
		18.40	2096.87		42	1.12	

Appendix 5

Compressive Strength Results For University Cured Blocks							
SITE 5							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.10	1834.76	1830.96	10	0.27	0.28
		16.10	1834.76		11	0.29	
		16.00	1823.36		10	0.27	
2	14	16.60	1891.74	1914.53	14	0.37	0.38
		16.40	1868.95		14	0.37	
		17.40	1982.91		15	0.40	
3	21	17.20	1960.11	1967.71	30	0.80	0.83
		17.20	1960.11		31	0.83	
		17.40	1982.91		32	0.85	
4	28	18.80	2142.45	2112.06	48	1.28	1.17
		18.40	2096.87		42	1.12	
		18.40	2096.87		42	1.12	

Appendix 6

Compressive Strength Results For University Cured Blocks							
SITE 6							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	15.80	1800.57	1846.15	10	0.27	0.29
		16.40	1868.95		11	0.29	
		16.40	1868.95		12	0.32	
2	14	17.00	1937.32	1982.91	16	0.43	0.41
		18.80	2142.45		16	0.43	
		16.40	1868.95		14	0.37	
3	21	17.40	1982.91	1975.31	32	0.85	0.84
		17.20	1960.11		30	0.80	
		17.40	1982.91		32	0.85	
4	28	18.20	2074.07	2074.07	42	1.12	1.08
		18.20	2074.07		40	1.07	
		18.20	2074.07		40	1.07	

Appendix 7

Compressive Strength Results For University Cured Blocks							
SITE 7							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.40	1868.95	1838.56	11	0.29	0.28
		16.00	1823.36		10	0.27	
		16.00	1823.36		10	0.27	
2	14	16.40	1868.95	1884.14	14	0.37	0.39
		16.40	1868.95		14	0.37	
		16.80	1914.53		16	0.43	
3	21	17.20	1960.11	1960.11	30	0.80	0.80
		17.40	1982.91		32	0.85	
		17.00	1937.32		28	0.75	
4	28	18.20	2074.07	2074.07	42	1.12	1.12
		18.20	2074.07		42	1.12	
		18.20	2074.07		42	1.12	

Appendix 8

Compressive Strength Results For University Cured Blocks							
SITE 8							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.20	1846.15	1846.15	11	0.29	0.29
		16.20	1846.15		11	0.29	
		16.20	1846.15		11	0.29	
2	14	17.00	1937.32	1891.74	15	0.40	0.38
		16.40	1868.95		14	0.37	
		16.40	1868.95		14	0.37	
3	21	17.10	1948.72	1952.52	30	0.80	0.81
		17.20	1960.11		31	0.83	
		17.10	1948.72		30	0.80	
4	28	18.10	2062.68	2074.07	40	1.07	1.10
		18.40	2096.87		44	1.17	
		18.10	2062.68		40	1.07	

Appendix 9

Compressive Strength Results For University Cured Blocks							
SITE 9							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.00	1823.36	1853.75	11	0.29	0.31
		16.40	1868.95		12	0.32	
		16.40	1868.95		12	0.32	
2	14	16.80	1914.53	1914.53	15	0.40	0.42
		16.80	1914.53		16	0.43	
		16.80	1914.53		16	0.43	
3	21	17.10	1948.72	1948.72	30	0.80	0.81
		17.10	1948.72		31	0.83	
		17.10	1948.72		30	0.80	
4	28	18.20	2074.07	2081.67	40	1.07	1.12
		18.20	2074.07		40	1.07	
		18.40	2096.87		46	1.23	

Appendix 10

Compressive Strength Results For University Cured Blocks							
SITE 10							
SN	**Age at Curing in days**	**Weight of Block (Kg)**	**Density of Block (Kg/m3)**	**Average Density of Block (Kg/m3)**	**Crushing Load (KN)**	**Compressive strength (N/mm2)**	**Average Compressive strength (N/mm2)**
1	7	16.00	1823.36	1827.16	10	0.27	0.28
		16.10	1834.76		11	0.29	
		16.00	1823.36		10	0.27	
2	14	16.20	1846.15	1853.75	13	0.35	0.36
		16.40	1868.95		14	0.37	
		16.20	1846.15		13	0.35	
3	21	17.40	1982.91	1975.31	30	0.80	0.81
		17.20	1960.11		31	0.83	
		17.40	1982.91		30	0.80	
4	28	18.40	2096.87	2096.87	45	1.20	1.15
		18.20	2074.07		40	1.07	
		18.60	2119.66		44	1.17	