

A Study of The Quality of Cement Sand Mix in Sandcrete Block Moulding in Ondo State Nigeria

Elijah O. Ayodele

Department of Quantity Surveying
Rufus Giwa Polytechnic, Owo; Ondo State, Nigeria.

Adeleye O. Akinmusire

Department of Quantity Surveying
Rufus Giwa Polytechnic, Owo; Ondo State, Nigeria.

Samuel O. Williams

Department of Quantity Surveying
Rufus Giwa Polytechnic, Owo; Ondo State, Nigeria.

Moses O. Olofinsawe

Department of Quantity Surveying
Rufus Giwa Polytechnic, Owo; Ondo State, Nigeria.

Modupe M. Ologunagba

Department of Quantity Surveying
Rufus Giwa Polytechnic, Owo; Ondo State, Nigeria.

Michael O. Alabi

Department of Quantity Surveying
Rufus Giwa Polytechnic, Owo; Ondo State, Nigeria.

Benson A. Ogunbode

Department of Quantity Surveying
Rufus Giwa Polytechnic, Owo; Ondo State, Nigeria.

ABSTRACT

This study determined the quality of the mix ratio of sand and cement in sandcrete block in Ondo State of Nigeria. This involved the determination of number of headpans of sand that are mixed with one headpan of cement and the ratio of cement sand mix in sandcrete blocks produced in Ondo State. This study was carried out through interview of labourers at the 90 spots of block moulding in Ondo State. Thirty spots were taken each of the three senatorial districts in Ondo State. The study showed the cement sand mix ratio to be 1:11. This implies that there is 83% increase of sand in the mix above the standard. Very weak sandcrete blocks have arisen from this mix ratio over the years and must have contributed to the incessant building

collapses. The followings are the recommendations: Sandcrete blocks should be made on the site in an approved machine to be provided by the contractor or an approved supplier and should have a minimum crushing strength of 273.4 tonner per square of gross area at 28 days in case of hollow blockwork. The blocks should be composed of 1:6 cement and sand measured by volume unless otherwise specified or directed on the site, turned three times until an even colour and consistency occur throughout. Water should be added gently from a watering can through a rose, the quantity of water added being just sufficient to secure cohesion. After wetting, the mixture shall be turned over three times and well rammed into moulds and smoothed from the machine on pellets, the blocks should be made to mature under shade in different rows, one block high, with a space between each block and for at least 24 hours. Then they should not be stacked up or removed from shade for at least a further 7 days then stacked up not more than 5 blocks high in shade for a minimum of 14 days. No block should be built into any part of the building until they have been cured for at least 14 days. The faces of blocks except where otherwise described should be left rough for plastering. The concrete blocks generally shall be 450 mm long, 225mm or 150mm deep and of the required thickness.

Keywords: Cement, Sand, Cement Sand Mix, Sandcrete Block, Ondo State Nigeria.

INTRODUCTION

The quality of a product is defined as its ability to fulfill the customers' needs and expectations, or better still the degree or level to which a set of inherent characteristics fulfill customers' requirements (ISO 9000:2005). Quality of a product is the level or degree of fitness for purpose (Ayodele 2017). A client will normally want the highest level of quality which is excellence. However this is not the case all the time, that's why the quality of a product is in levels or degree – poor quality, low quality and high quality. For sandcrete block the highest (excellence) quality is defined by any user as specified by the British standard users as stated by Jagboro (1996) and is cement sand ratio 1:6. This means one portion of cement to six of sand by volume.

Cement

Cement is a powder of alumina, silica, lime, iron oxide and magnesium oxide burnt together in a kiln and firely pulverized and used as ingredients of motor, concrete and blocks (Swedberg and Agevall, 2016). It has been defined as any of the various calcined mixtures of clay and limes stone, usually mixed with water, sand and gravel to form concrete (Rogers Lucy (17 December 2018) en.m.wikipedia.org retrieved 17 December 2018). It has also been defined as powdery substance made by calcivining lime and clay mixed with water to form mortar or mixed with sand gravel and water to make concrete (Qwety, 2000 simple.m.wikipedia.org) Cement is a binder, substance used in construction that sets and hardens and can bind other materials together (Bye, 1999, Francis, 1977). The most important forms of cement used in construction are usually inorganic, often lime based and can be categorized as either hydraulic or non-hydraulic. Hydraulic cement (e.g. Portland cement) is the one that sets and become adhesive due to a chemical reaction between dry ingredients and water. Non-hydraulic is the form of cement that will not set in wet condition or

underwater, rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting (Hewlett, 2003, Bye, 1999). The form of the types of cement used in the block moulding spots is the non-hydraulic form of cement.

Sand

Sand is defined as loose granular materials that result from the disintegration of rocks. It consists of particles smaller than gravel (<https://www.marriam-webster.com/dictionary/sand> Assessed 28 January 2021)

Sand is referred to as soil particles that range in diameter from 0.2 mm to 2.0 mm. Most of the rock forming minerals that occur on the earth's surface are found in sand, but only a small member are common in this form. In some places, feldspar, calcareous, iron ores and volcanic materials are major constituents of sand. Quartz is the most common, it is abundantly present in rocks, it is comparatively hard, it has no cleavage so that it is not readily worn down, it is almost insoluble in water and does not decompose. Many quartzose are sands contain a small quantity of feldspar as well as small plates of white mica, which though soft, decompose gently (Constable, Harriet, 3 September 2017)

Sands contain little amount of heavy rock-forming materials including garnet, tourmaline, zircon, rutile, topaz, pyroxenes and amphiboles. In some shores and river sand beds these heavier constituents as well as some of the heavy native elements become concentrated as a result of actions by the, currents and the removal by the light constituents. All sands contain mineral particles organic matter, water and air. Soil properties are determined by its texture, structure, porosity, chemistry and colour. Soil is made up of different size of particles, and sand particles seem to be the biggest (www.nature.com/scitable/blog Retrieved Oct 22, 2013). The chemistry name of sand is Silicon dioxide also known silica, with the formula SiO_2 . Silica is very hard, and is mostly found in nature as sand or quartz as well in the cell of walls of diatoms (Science Dictionary, 2011). Sand is the result of breakdown of earth crust. Sand is formed over a long period of time by water, wind, gravity and tectonics among other forces. It is made up of various quantities of materials, weathered from inland rocks and transported to the beach on the wind or in rivers and or shells and other hard parts precipitated out of the ocean water by marine organisms (www.nature.com/scitable/blog Retrieved Oct 22, 2013). Sand is defined as a loose granular material that results from the disintegration of rocks. It consists of particles smaller than gravel. The particles range from 0.2 mm to 2.0mm (www.nature.com/scitable/blog Retrieved Oct 22, 2013). Sand contain little amount of heavy rock-forming materials including garnet, tourmaline, zircon, rutile, topaz and river and amphiboles. In some constituents as well as some of the heavy native elements became concentrated as a result of actions by the cements and removal by the light constituents (Collins English Dictionary, 2014)

BACKGROUND TO THE STUDY

Sandcrete block moulded in the cement and sand ratio of 1:6 is one of the major building construction materials in Nigeria. A, 5 storey building under construction in Kano state Nigeria, collapsed in July 2009 as a result of poor quality building materials (Akinjogun & Balogun 2013). In Ilesa, Osun State Nigeria, a residential building collapsed in March 2009 as a result of substandard building materials incorporated into the works and one person died (Akinjogun & Balogun 2013).

A research report indicated that 45% of building collapses were caused by poor quality material and workmanship, while 30% of the collapsed were caused by procedural errors (Bamidele 2002). Also Bangbopa (2002) asserted that poor quality job in building project resulting from the use of substandard materials and workmanship have generally been responsible for building collapses in Ondo State of Nigeria. The assertion of Bamgbopa (2002) as just stated and the reports on building collapses in Nigeria stimulated the need to determine the contribution of cement sand mix in the building collapses. The findings from this research will help proffer solutions to curb the incessant building collapses in Nigeria.

AIM & OBJECTIVES

The aim of this study is to determine the quality of cement sand mix in sandcrete block in Ondo State Nigeria.

The objectives of this research are to

- i. Determine the number of head pans of sand that mix with one headpan of cement on the moulding of sandcrete blocks in Ondo State.
- ii. Determine the ratio of the cement sand mix in sandcrete blocks produced for use in Ondo State.

RESEARCH QUESTIONS

- i. What number of headpans of sand are mixed with one headpan of cement in each of the sandcrete block moulding spots in Ondo State?
- ii. What is the cement sand ratio in sandcrete block moulding in Ondo State?

RESEARCH METHOD

In the study area which was Ondo State, interviews were administered to sandcrete block moulders in 90 block moulding spots. That is 30 block moulding spots were selected from each of the three Senatorial Districts. The interview included asking the respondents of the number of headpans of sand that are mixes with one bag of cement in the sandcrete block moulding process. The results of the interview were recorded and formed the basis of analysis. The data collected were analysed by mean and percentages.

The Study Area

The study area is Ondo State of Nigeria, located on the world map between Latitude $5^{\circ} 45^1$ N and $8^{\circ} 0^1$ N and between Longitude $4^{\circ} 15^1$ E and $6^{\circ} 15^1$ E. Ondo State has an area of 15,500 square kilometers and is about 250 meters above sea level with a population of about 4,011,407. It is the 25th state created out of the 36 states of Nigeria (www.distancefrom.com en.m.wikipedia.org). It consists of 18 local governments shared into three Senatorial Districts namely: Ondo North Senatorial District, Ondo Central Senatorial District and Ondo South Senatorial District, with each having six local governments. Ondo State which is one of the South West States is a link to the Middle Belt of Nigeria. Figure 1 shows the Map of Ondo State of Nigeria with the three senatorial districts.

Sampling Technique

It is not practically possible to collect data from every block moulding spot in Ondo State in the situation being investigated. Asika (2000) follows the saying that 'You do not have to eat the whole ox to know that the meat is tough.' The block moulding spots that participated in this investigation

were sampled through purposive or judgemental sampling. In this case participants must have been in operation for at least five consecutive years. Purposive sampling is combined with random sampling and this provided a means of collecting data that is representative of the population. Data collected from these sampling techniques were representative of the population and were reliable.

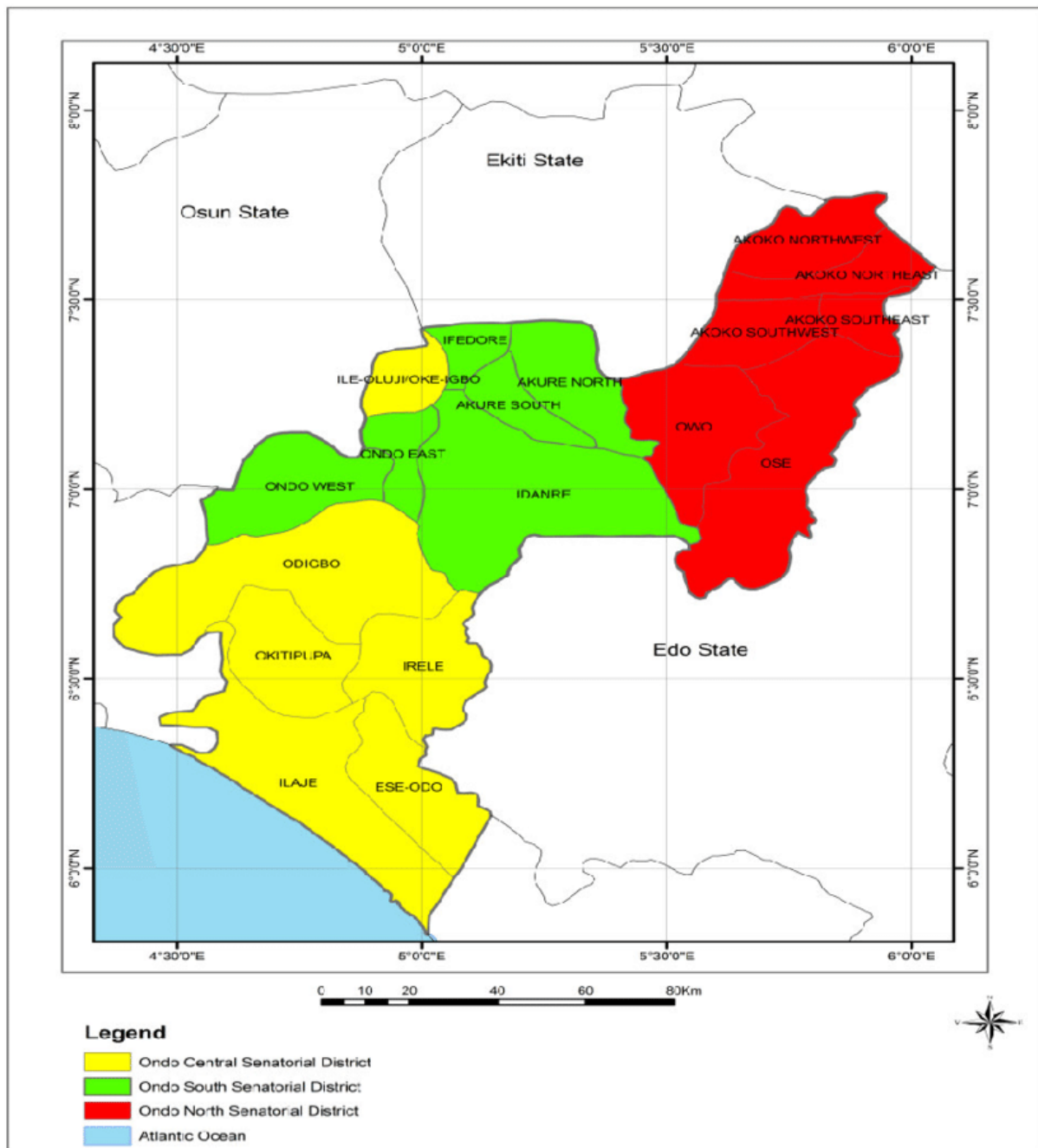


Figure 1: Map of Ondo state showing the 3 senatorial districts (Distance Calculator, n.d.)

Data Presentation

The data collected from 90 block moulding sites are recorded as in Table 1 below: (These data lead to answer for research question number 1)

Table 1: Block Moulding Sites and Cement Sand Ratio

BLOCK MOULDING SITES	CEMENT SAND RATIO
1	1:13
2	1:10
3	1:13
4	1:9
5	1:13
6	1:12
7	1:13
8	1:12
9	1:11
10	1:12
11	1:13
12	1:12
13	1:10
14	1:11
15	1:12
16	1:11
17	1:12
18	1:11
19	1:9
20	1:8
21	1:11
22	1:10
23	1:13
24	1:11

25	1:13
26	1:8
27	1:13
28	1:14
29	1:8
30	1:13
31	1:14
32	1:13
33	1:11
34	1:13
35	1:11
36	1:9
37	1:14
38	1:12
39	1:8
40	1:9
41	1:13
42	1:10
43	1:11
44	1:13
45	1:12
46	1:13
47	1:12
48	1:13
49	1:8
50	1:13
51	1:12
52	1:11
53	1:8

54	1:13
55	1:11
56	1:8
57	1:13
58	1:9
59	1:8
60	1:14
61	1:11
62	1:13
63	1:13
64	1:11
65	1:12
66	1:11
67	1:13
68	1:12
69	1:13
70	1:9
71	1:11
72	1:9
73	1:12
74	1:13
75	1:9
76	1:11
77	1:13
78	1:11
79	1:13
80	1:13
81	1:12
82	1:10

83	1:11
84	1:12
85	1:11
86	1:8
87	1:11
88	1:8
89	1:12
90	1:12

The Decision Rule

The standard mix ratio of cement sand in the moulding of sandcrete block is 1:6; i. e. one part of cement to six parts of sand (Opatunji, 2018; Jagboro, 1996; Barry, 1999). Any cement sand ratio apart from this, is abnormal.

The 90 data on cement sand mix ratio were grouped into seven, with each group having the same mix ratio as in Table 2 below. These data give answer research question number 2

Table 2: Cement Sand Ratio grouped according to frequencies of occurrence

GROUP	RATIO OF HEAD PAN OF SAND TO ONE HEAD PAN OF CEMENT (R)	FREQUENCIES (F)	RF
1	1 : 13	25	13 X 25 = 325
2	1 : 10	5	10 X 5 = 50
3	1: 9	7	9 X 7 = 63
4	1 ; 11	20	11 X 20 = 220
5	1 : 12	19	12 X 19 = 228
6	1 : 8	10	8 X 10 = 80
7	1 : 14	4	14 X 4 = 56
		90	1022

RESULT

From Table 2, the total number of spots visited is 90 while the total number of frequencies is 1022, therefore the average

$$= \frac{1022}{90} = 11.355$$

The average of cement sand mix is 1: 11

Mean of cement sand mix ratio in Ondo State is 1: 11

DISCUSSION

The research finding of cement sand mix ratio of 1:11 in block moulding in Ondo State is similar to what is obtained in the production of concrete on construction sites in Ondo State. According to Ayodele (2010) the mix ratio of cement sand and gravel is 1:4:8 as foundation concrete, which is supposed to be 1:3:6 (the standard). For floor concrete, a study carried out by Ayodele (2010) found this to be 1:5:10 as against the standard of 1:2:4. With the use of cement sand mix 1:11 in block moulding, very weak blocks are produced and used up in the construction process, which results in building collapses. The issues of building collapse are very common in Nigeria. Examples abound like the followings:

In Ilesa Osun State, a residential building under construction collapsed in 2009 as a result of the use of poor quality materials (Akinjogun & Balogun, 2013). In April, 2010, a 2 storey market plaza collapsed in Oshodi, Lagos State because of the use of substandard building materials (Akinjogun & Balogun 2013).

A, 2 storey residential building on road 3, plot 10, Funbi-Fagun Street, Abeokuta Ogun State collapsed in November 1998 as a result of the use of poor quality building materials (Fadamiro, 2012).

CONCLUSION

The standard mix ratio of cement sand in the moulding of sandcrete block is 1:6; i. e. one part of cement to six parts of sand (Opatunji, 2018; Jagboro, 1996; Barry, 1999). From the study in Ondo State the cement sand, mix ratio is 1:11 instead of 1:6. This interpretes to be that the quantity of sand in the sandcrete block is 83% above the standard which leads to the production of weak sandcrete blocks.

RECOMMENDATIONS

Recommendations include the followings:

The followings are the recommendations: Sandcrete blocks should be made on the site in an approved machine to be provided by the contractor or an approved supplier and should have a minimum crushing strength of 273.4 tonner per square of gross area at 28 days in case of hollow blockwork. The blocks should be composed of 1:6 cement and sand measured by volume unless otherwise specified or directed on the site, turned three times until an even colour and consistency occur throughout. Water should be added gently from a watering can through a rose, the quantity of water added being just sufficient to secure cohesion. After wetting, the mixture shall be turned over three times and well rammed into moulds and smoothed from the machine on

pellets, the blocks should be made to mature under shade in different rows, one block high, with a space between each block and for at least 24 hours. Then they should not be stacked up or removed from shade for at least a further 7 days then stacked up not more than 5 blocks high in shade for a minimum of 14 days. No block should be built into any part of the building until they have been cured for at least 14 days. The faces of blocks except where otherwise described should be left rough for plastering. The concrete blocks generally shall be 450 mm long, 225mm or 150mm deep and of the required thickness (Jagboro, 1995).

ACKNOWLEDGEMENT

This work was aided by research grant, awarded by Tertiary Education Fund (TETFUND). The authors of this research appreciate TETFUND for this kind gesture.

TETFUND is a creation of the Federal Government of Nigeria.

References

<https://www.merriam-webster.com/dictionary/sand> Assessed 28 January, 2021

Akinjogbin I O & Balogun K (2013) Quality assurance and it's effect in preventing building collapse in Nigeria, First International Conference of Faculty of Environmental Studies, Rufus Giwa Polytechnic Owo Nigeria: Emerging Environmental Challenges and City Sustainability in the 21st Century. Conference proceedings, 12th-13th February, 2013.

Ayodele E. O. (2010) Quality of mix of concrete utilized in building projects development by private owners in Ondo State Nigeria. *International Journal of Pure and Applied Science* (3)1, 108-114.

Asika N (2000) *Research Methodology in the Behavioural Science*. Paraclete Publishers, Yola Nigeria

Ayodele E. O (2017) Development of a framework for minimizing errors in construction documents in Nigeria, PhD Thesis, School of Built Environment, University of Salford, U. K.

Bamgbopa O (2002) An assessment of building regulations and standards and the implications for building collapse in Nigeria, In ed. Ogunsemi D R (2002) *Building collapse: causes, prevention and remedy*. Conference proceedings of Nigerian Institute of Building Ondo State chapter

Bamidele A (2002) Major causes of collapse of building structures, cited in Fadamiro J A (2002). An assessment of building regulations and standards and the implications for building collapse in Nigeria, In ed. Ogunsemi D R (2002) *Building collapse: causes, prevention and remedy*. Conference proceedings of Nigerian Institute of Building Ondo State chapter

Barry R. (1999a) *The Construction of Buildings I*, Sixth edition. Affiliated East – West Press Private Ltd. New Delhi.

Barry R. (1999b). *The Construction of Building 4*, Fourth edition, Affiliated East – West Press Private Ltd, New Delhi.

Bye G C (1999) *Portland cement*, 2nd edition. Thomas Telford. ISBN 0-7277-27664 Constituents of sand [www.nature.com/scitable>blog](http://www.nature.com/scitable/blog) Retrieved Oct 22, 2013

Collins English Dictionary- Complete and unabridged (2014) 12 Edition, Harpers Collins Publishers UK
Constable, Harriet (3 September, 2017) How demand for sand is killing rivers. *BBC News Magazine*, Retrieved 3 September, 2017.

Distance Calculator, (n. d). Retrieved January 22, 2021 from <https://www.distancefrom.com>

Fadamiro J A (2012) Some selected reported incidences of building failures/collapses in Nigeria (1974-2001) cited in Fadamiro J A (2012) *Assessment of building regulations and implications for building collapse in Nigeria*, In (ed) Ogunsemi D R (2012) *Building Collapse: causes, prevention and remedies*. Proceedings of workshop organized by NIOB Ondo State, Akure, Nigeria.

Francis A (1972) *The cement industry 1976-1914: A history*. David & Charles ISBN 0- 7153-7386-2. International Standard Organization (2005), ISO 9000: 2005

Hewlett P (2003) *Leas Chemistry of Cement and Concrete*, Butterworth - Heinman

Jagboro G. O. (1996) *Measurement and Specifications of Building Works*. Fancy Publishers, Ile-Ife, Nigeria.

Opatunji O A (2018) *Building works and Specifications*. Ede Publishers, Nigeria.

Qwenty xy (2000) [simply.m.wikipedia](https://www.wikipedia.org)

Rodgers, Lucy (17 December 2018) The massive CO₂ emitter you may not know about [en.m.wikipedia.org](https://www.wikipedia.org) Retrieved 17 December 2018

Swedberg R and Agevall O (2016) Max Weber Dictionary: Key Words and Central Concepts. 2nd edition, Stanford, CA: Stanford University Press.

The American Heritage @ Science Dictionary (2011) Houghton Mifflin Harcourt publishing Company