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RESEARCH ARTICLE OPEN

A Study For Quality of Fine Aggregates for Civil Engineering Construction In Sokoto State (North – Western Nigeria)

[1]Adamu Yunusa, [2]Tunde Abioye
Department Of Civil Engineering; Umaru Ali Shinkafi Polytechnic Sokoto. P.M.B. 2356 Sokoto, NIGERIA.

ABSTRACT:
Quality of aggregate needs to be checked, from time to time, due to high percentage of the material (about 70 %) that is involved in civil engineering constructions. Hence there was need to check and compare their properties with the standard with a view to preventing problems that might emanate due to incompliance with the standard. Aggregate most of which pass through 5.00 mm BS sieve is known as fine aggregate. Fine aggregate shall consists of natural sand, crushed stone sand, crushed gravel sand stone dust or arable dust, fly ash and broken brick (burnt clay). Samples were collected from four different locations within the study area; i.e. Gwadabawa, Rima, Wamakko and Wurno. Some physical properties like Bulk density, moisture content, water absorption, particle size distribution were determined in accordance with BS 1377: Part 2; 1990. Results have shown that the values of Bulk density of the samples range between 1.39 g/cm^3 – 1.55 g/cm^3, Fineness Modulus value range between 1.5 – 2.1; with Wurno samples having the highest value of 2.1. The particle density values range between 2.61 – 2.68 kg/m^3. Moisture content values range between 1.2 – 3.1% with Wurno samples having the least value of 1.2% being the coarsest. The Particle gradation zoning of Wurno samples fall under zone 3, the remaining samples fall under zone 4. Consequently, it was found that only Wurno samples could be considered suitable for civil engineering works in Sokoto State while the remaining samples are considered unsuitable for nominal mix proportion because of their failure to meet the standard.
Keywords: aggregates, particle density, moisture content, bulk density, particle size distribution

I. INTRODUCTION

A. General

Natural aggregates are formed by the process of weathering, or by artificially crushing a larger parent mass (Neville, A.M. and Brooks, J.J., 1990). "Aggregate" is a collective term for sand, gravel and crushed stone mineral materials in their natural or processed state. Fine aggregates are extensively used in various structures in different forms for instance, in building structures, canals, water tanks, dams, bridges, retaining walls, roads and other heavy structures. Aggregates are also used as base material under foundations, roads, and railroads. Aggregates are used as a stable foundation or road/rail base with predictable, uniform properties (e.g. to help prevent differential settling under the road or building), or as a low-cost extender that binds with more expensive cement or asphalt to form concrete

B. Objectives of the Study.

The main objective of this research work was to determine the quality of fine aggregates used in Sokoto State through the determination of some physical properties of these aggregates such as particle size analysis, specific gravity test, bulk density, moisture content, water absorption and deleterious/organic materials that may affect their proper performance. All the determined values were compared with what was obtained from the standard.

C. Scope

The scope of the study was restricted to the study of the quality of fine aggregates used for civil engineering activities in Sokoto with a view to ascertaining its suitability. The fine aggregate materials were sampled in accordance with BS 1377: Part 2:1990 to some physical properties like specific gravity, bulk density, moisture content, water absorption, fineness modulus and particle size distribution.

D. Soil Classification.

Soil classification enables the engineer to assign a soil to one of a limited number of groups, based on the material properties and characteristics of the soil. The classification groups are then used as a system of reference for soils. Soils can be classified in the field or in the laboratory. Field techniques are usually based upon visual recognition. Laboratory techniques include several specialized tests (Karl *et al.*, 1996)

II. MATERIALS USED IN THE STUDY

The materials used for the study were collected from four different locations in Sokoto

where trucks source their fine aggregates for civil engineering activities. The locations names are as follows; Gwadabawa, Rima, Wamakko and Wurno. Fine aggregates collections were made at each location from several points to ascertain the uniformity or otherwise of the material at that given location. A total of twelve samples were collected with each location having three samples. Fine aggregates materials were transported to laboratory for further analysis.

III. TESTING OF MATERIALS

A. Sieve Analysis

Determination of particle size distribution, fineness modulus of fine aggregates material found in Sokoto was performed. The apparatus used are as follows in accordance with BS 1377 ; sieves (10 mm, 5.0 mm, 2.36 mm, 1.18 mm, 600 microns, 300 microns, 150 microns).

B. Particle Density

Determination of particle density for the fine aggregates materials collected was conducted. The apparatus are small pyknometer, balance, vacuum desiccators, drying oven, and test sieve 2 mm.

C. Moisture Content

Moisture content determination was conducted to ascertain the moisture content in the fine aggregates materials. The apparatus used are, a drying oven with temperature of 105^{o}C – 110^{o}C, a balance readable 0.1 g, a metal container, a desiccators.

IV. RESULTS AND DISCUSSION.

Table 1: Result of Particle Density value for Wurno sample

Specimen reference	WURNO		
Pyknometer number	3		
Mass of bottle + soil + water	m_3	G	1605.7
Mass of bottle + soil	m_2	G	955.5
Mass of bottle full of water	m_4	G	1272.7
Mass of density bottle	m_1	G	455.5
Mass of soil	$m_2 - m_1$	G	500
Mass of water in full bottle	$m_4 - m_1$	G	837.2
Mass of water used	$m_3 - m_2$	G	650.2
Volume of soil particles	$(m_4 - m_1) - (m_3 - m_2)$	mL	187
Particle Density	$\rho_s = \frac{1000 \times m_2 - m_1}{(m_1 - m_1) - (m_3 - m_2)}$	kg/m^3	2.67
Average Value	ρ_s	kg/m^3	

Table 2: Result of Particle Density for Wamakko sample

Specimen reference	WAMAKKO		
Pyknometer number	4		
Mass of bottle + soil + water	m_3	G	1607.4
Mass of bottle + soil	m_2	G	955.5
Mass of bottle full of water	m_4	G	1293.8
Mass of density bottle	m_1	G	455.5
Mass of soil	$m_2 - m_1$	G	500
Mass of water in full bottle	$m_4 - m_1$	G	838.3
Mass of water used	$m_3 - m_2$	G	651.9
Volume of soil particles	$(m_4 - m_1) - (m_3 - m_2)$	mL	186.4

Particle Density	$\boldsymbol{\rho_s = 1000 \times m_2 - m_1}$ $\boldsymbol{(m_1 - m_1) - (m_3 - m_2)}$	kg/m^3	2.68
Average Value	$\boldsymbol{\rho_s}$	kg/m^3	

Table 3: Result of Particle Density for Gwadabawa sample

Specimen reference	GWADABAWA		
Pyknometer number	8		
Mass of bottle + soil + water	$\boldsymbol{m_3}$	G	1635.0
Mass of bottle + soil	$\boldsymbol{m_2}$	G	1005.5
Mass of bottle full of water	$\boldsymbol{m_4}$	G	1294.9
Mass of density bottle	$\boldsymbol{m_1}$	G	455.5
Mass of soil	$\boldsymbol{m_{2-} m_1}$	G	550
Mass of water in full bottle	$\boldsymbol{m_{4-} m_1}$	G	839.4
Mass of water used	$\boldsymbol{m_{3-} m_2}$	G	629.5
Volume of soil particles	$\boldsymbol{(m_{4-} m_1) - (m_{3-} m_2)}$	mL	209.9
Particle Density	$\boldsymbol{\rho_s = 1000 \times m_2}$ $\boldsymbol{(m_1 - m_1) - (m_3}$	kg/m^3	2.62
Average Value	$\boldsymbol{\rho_s}$	kg/m^3	

Table 4: Result of Particle Density for Rima sample

Specimen reference	RIMA		
Pyknometer number	12		
Mass of bottle + soil + water	m_3	G	1618.8
Mass of bottle + soil	m_2	G	977.6
Mass of bottle full of water	m_4	G	1297.0
Mass of density bottle	m_1	G	455.5
Mass of soil	$m_{2-} m_1$	G	522.1
Mass of water in full bottle	$m_{4-} m_1$	G	841.5
Mass of water used	$m_{3-} m_2$	G	641.2
Volume of soil particles	$(m_{4-} m_1) - (m_{3-} m_2)$	mL	200.3
Particle Density	$\rho_s = 1000 \times m_2 - m_1$ $(m_1 - m_1) - (m_3 - m_2)$	kg/m^3	2.61
Average Value	ρ_s	kg/m^3	

Table 5: Result of Moisture Content values for all the samples

Sample Names	Wurno	Rima	Wamakko	Gwadabawa
Container Nos:.	3	6	9	12
Wt of wet soil and container……..g	125.4	118.3	121.1	135.4
Wt. of dry soil and container……g	124.4	116.2	118.7	132.9
Wt. of container…….g	40.4	40.5	40.7	40.5
Wt. of dry soil……..(Wd)……...g	84.0	75.7	78.0	92.4
Wt. of moisture……(Wm)……g	1.0	2.0	2.4	2.5
Moisture Content….(100x[Wm/Wd])....%	1.2	2.6	3.1	2.7

Table 6: Summary of the Results of some properties of Fine Aggregates within the Study Area

S/No.	Names of samples	Bulk Density (g/cm^3)	Particle Density (kg/m^3)	Fineness Modulus	Water Absorption	Moisture Content	Particle Gradation Zones
1.	Gwadabawa	1.52	2.62	2.0	0.03	2.7	Zone 4
2.	Rima	1.39	2.61	1.5	0.10	2.6	Zone 4
3.	Wamakko	1.44	2.68	1.9	0.12	3.1	Zone 4

4.	Wurno	1.55	2.67	2.1	0.07	1.2	Zone 3

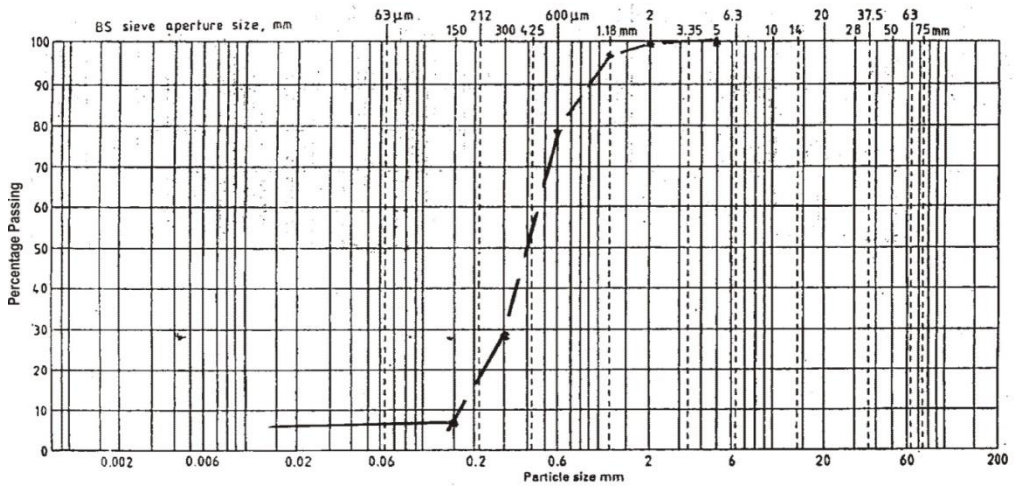

Fig. 1; Particle size distribution curve for Wamakko Sample

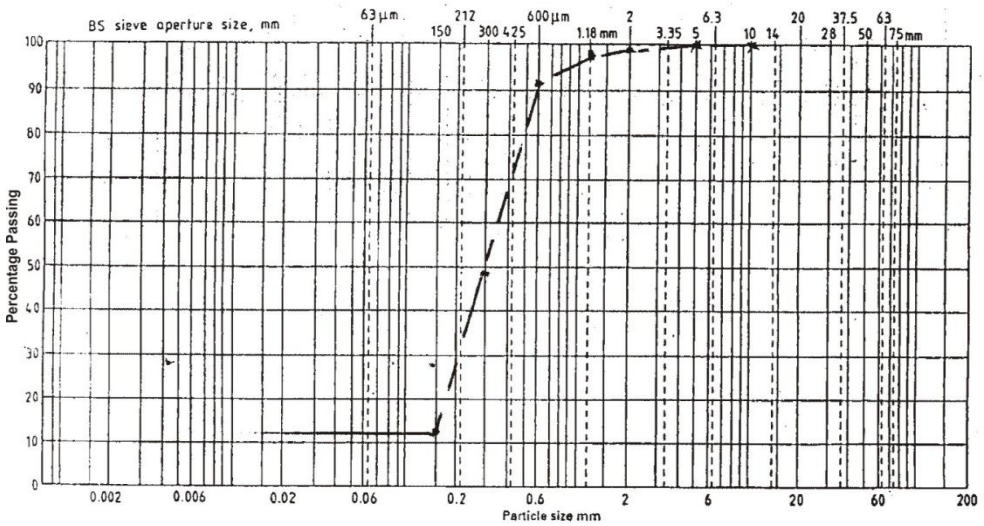

Fig. 2; Particle size distribution curve for Rima Sample

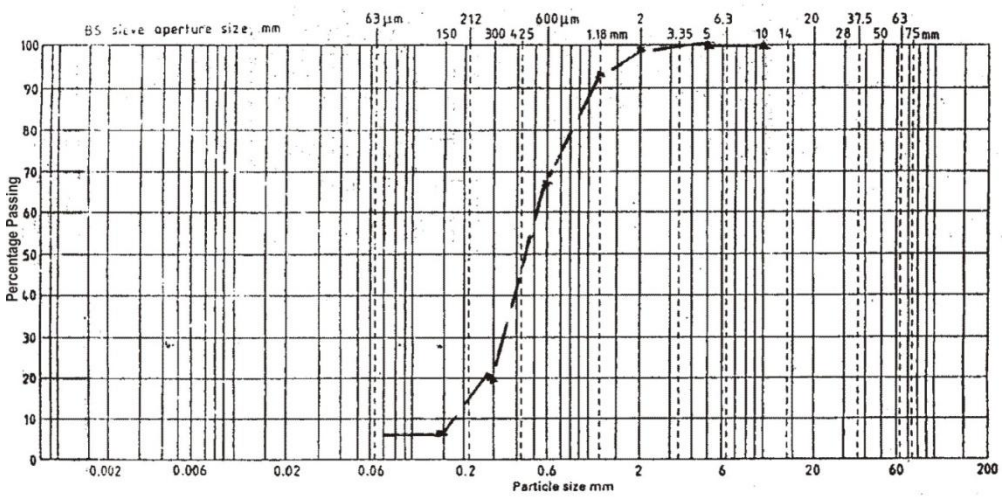

Fig. 3; Particle size distribution curve for Wurno Sample

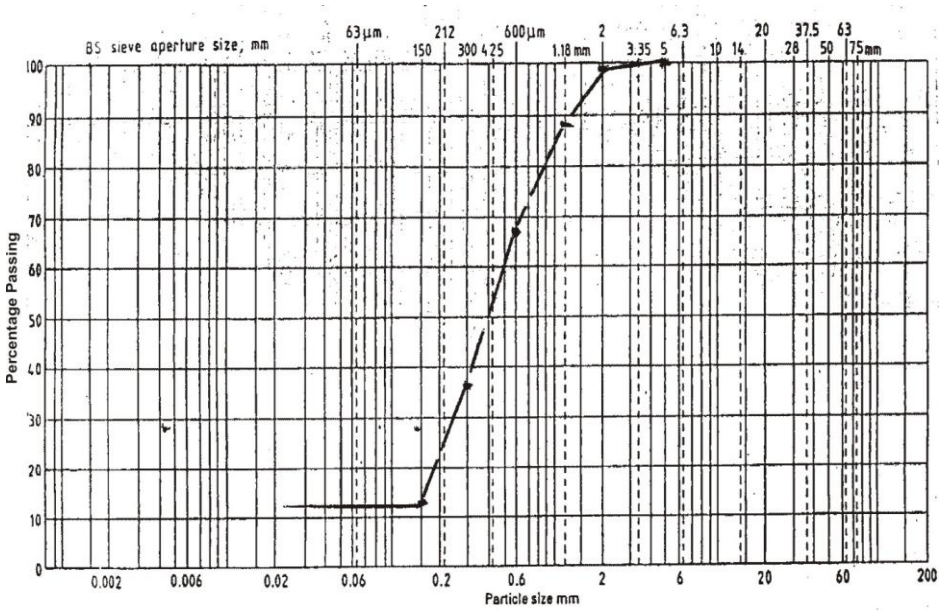

Fig. 4; Particle size distribution curve for Gwadabawa Sample

V. CONCLUSIONS

Based on the findings of this research work on the quality of fine aggregates used in Sokoto in accordance with BS 1377: Part 2: 1990; the following were arrived at.

- The particle density values of all the samples have fallen within the range 2.61 to 2.68 kg/m^3. The Wamakko sample has the highest of 2.68 kg/m^3 and Rima with the lowest of 2.61 kg/m^3. Wurno and Gwadabawa have 2.67 kg/m^3 and 2.62 kg/m^3 respectively. However, Wamakko samples have exhibited higher particle density values compared to the remaining samples.
- The moisture content of all the samples from Rima, Gwadabawa, Wurno and Wamakko varies significantly; Wurno samples having the lowest value of 1.2 % and Wamakko with the highest of 3.1 %. The values for Rima and Gwadabawa were 2.6 % and 2.7 % respectively. Hence, Wamakko samples exhibit higher value mainly due to presence of deleterious materials with some percentage of clay content.
- The percentage absorption of the samples also varies, with the highest value of absorption by Wamakko (0.12). The percentage of water absorption for Gwadabawa was the lowest (0.03).
- The particle size distribution of all the samples exhibited close or similar values. The samples from Rima, Gwadabawa, and Wamakko fall under Zone 4 of gradation zoning of fine aggregates. Whereas, Wurno falls under zone 3 of the zoning gradation. Consequently, only Wurno sample could be suited for plastering because it falls under zone 3. The remaining samples that fall under zone 4 are not suitable for civil engineering works, hence are considered rejected.
- The values for the fineness modulus (FM) of all the samples vary with Wurno samples having the highest values of 2.1. However, the values for Gwadabawa, Wamakko and Rima were found to be 2.0, 1.9, and 1.5 respectively. All the values being below 2.2 are considered to be very fine sand. Hence, fine aggregates with different FM than the base value should require an adjustment in the concrete mix.
- The bulk density for all the samples were determined and found that Wurno has the highest value of 1.55 g/cm^3 while Rima samples had the lowest of 1.39 g/cm^3. The bulk densities for Wamakko and Gwadabawa were found to be 1.44 and 1.52 g/cm^3 respectively

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