QUALITY OF FINE AGGREGATES USED FOR MASONRY WORKS IN KADUNA METROPOLIS

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ABSTRACT: *This study investigates the engineering properties of fine aggregates which are used in masonry works in Kaduna metropolis. Five samples of fine aggregates used in this study were obtained from five different locations and transported to the Material Laboratory of Civil Engineering Department, Kaduna Polytechnic, Kaduna, for experimentation. Tests carried out on the fine aggregate samples include specific gravity, sieve analysis, bulk density, silt content and mortar cube compressive strengths. Test results revealed that the specific gravity of the samples falls between 2.59 and 2.70. The bulk density varies from 1413.46 to 1486.5g/m³and silt content was found to be 0.67 to 0.97%. From the result of the sieve analysis of the sand samples, the fineness modulus ranges from 3.89 to 3.97. It is known that the fineness modulus of aggregates used in building construction usually varies between 2.1 and 3.5. The mortar cube strength after curing for three days varies between 19.75 N/mm² for sample E, 20.8N/mm² for sample C, 21.57N/mm² for sample D, 22.95N/mm² and 23.78N/mm² for samples B and A respectively.*

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INTRODUCTION

The term aggregate is used to describe natural or crushed gravels, stones and sand which are mixed with water to produce concrete (Jackson and Dhir, 1996). Aggregates which account for 70 to 80 percent of the total volume of concrete can be classified as coarse and fine on the basis of their sizes. The size of aggregates bigger than 4.75mm is considered as coarse aggregates and aggregates whose size is 4.75mm and less is considered as fine aggregates (Salau, 2008). Since about three quarter of the total volume of concrete is occupied by aggregates, its quality is considerably important. Aggregates were earlier viewed as chemically inert materials, but

it has now been recognized that some aggregates are chemically active, exhibiting chemical bond at the interface of aggregates and cement paste (Neville and Brooks, 1994). Aggregates give body to concrete, reduce shrinkage and affect economy, as such, their impact on various characteristics and properties of concrete are undoubtedly considerable. The study of concrete will be incomplete without the study of aggregates in depth and range (Dahiru, 2008). Fine aggregates which is also known as sand, is a granular material not larger than 4.75mm diameter produced by natural disintegration of rock, referred to as natural sand or by crushing a stone or rock, referred to as crushed stone or rock and is relatively cheap. It can be obtained from the river bed, stream, pit and sea. A fine coating of impurities such as silt or clay on the aggregates can result in a poor bond. It is, therefore, important that the sand to be used should be as clean as possible and free of deleterious material. According to the Nigerian Industrial Standard (NIS 87: 2004), the fine aggregates to be used for mortar production shall be river, crushed or pit sand, clean and sharp and free from clay, loam, dirt, organic or chemical matter of any description and shall mainly pass through 4.75mm.

Neville (1996) observed that all natural aggregate particles formed a part of a large mass. This may have been fragmented by natural processes of weathering and abrasion or artificially by crushing. Thus, many particles of the aggregate depends entirely on the properties of the parent rock, such as chemical and mineral composition, petrologic character, specific gravity, hardness, strength, physical and chemical stability, pore and structure and colour. Strength, durability, hardness, voids and density have significant effect on concrete. Grading of sand will determine the value of sand in a mix. The density of a batch of sand depends on a variety of sizes of grains in a batch. A batch of sand containing grains of approximately the same size would have voids between the grains which would lower the concrete strength and density. Sand material containing various grain sizes would result into increased concrete strength because the small grains would fill the voids between the larger grains to make a satisfactory dense material (James, 1985). The particle shape and texture of aggregates have significant influence on the properties of mortar. The particle shape of an aggregate is grouped as rounded, irregular, flaky and elongated. Aggregates with flaky and elongated shapes should as much as possible be avoided as they are source of weakening when used in making concrete mortar. Abdullahi (2008) concluded in his study that the most suitable aggregate for concrete mortar would appear to be one

that is well graded with a balance between rounded and angular particles and surface texture that is not too smooth. The overall relevance and dominance of aggregates in all civil engineering and building construction works cannot be neglected. Civil Engineering practice and construction works in Nigeria depend to a large extent on aggregates for concrete. The realization of the relevance and effect of fine aggregates on concrete, sandcrete and mortar has challenged engineers and researchers to bring up this aspect of civil engineering to the front burner of engineering research into the quality of the aggregate materials used in the production of concrete.

MATERIALS AND METHODS

The samples of fine aggregates which is also referred to as sand used for this study were collected from five different locations which are the main sources of fine aggregates currently in use for construction purposes in Kaduna. The five study locations are: Kawo, Sabo, Nasarawa, Tudun Wada and Rigasa as shown in Table 1. These sand samples were taken to the Materials laboratory of Civil Engineering Department, Kaduna Polytechnic, Kaduna, for experimentation. The tests carried out were Bulk density and silt content in accordance with (BS 2812: 1989); whereas specific gravity and sieve analysis were in accordance with (BS 1377:1990).

TABLE 1: LOCATION OF SOIL SAMPLES

Sample No	A	B	C	D	E
Location	Kawo	Sabo	Nasarawa	Tudun Wada	Rigasa

RESULTS AND DISCUSSIONS

Specific Gravity of Soil Samples

The results for the specific gravities of soil samples are presented in Table 2. The average specific gravity of the sample varies from 2.59 to 2.70. These values are within standard specification of 2.50 to 2.75.

TABLE 2: SPECIFIC GRAVITY OF SOIL SAMPLES

Sample No	A	B	C	D	E
Location	Kawo	Sabo	Nasarawa	Tudun Wada	Rigasa
Test 1	2.61	2.70	2.56	2.45	2.60
Test 2	2.59	2.67	2.57	2.52	2.50
Test 3	2.63	2.73	2.67	2.80	2.70
Average	2.61	2.70	2.60	2.59	2.60

Bulk Density of Soil Samples

The results for the bulk densities are as presented in Table 3. The bulk densities of the aggregates are in the range of 1413.46 and 1486.50kg/m^3.

TABLE 3: BULK DENSITY OF SOIL SAMPLES

Sample No	A	B	C	D	E
Location	Kawo	Sabo	Nasarawa	Tudun Wada	Rigasa
Test 1	1435.52	1461.48	1485.50	1413.26	1442.80
Test 2	1435.40	1461.72	1487.50	1413.66	1442.82
Average Kg/m^3	1435.46	1461.60	1486.50	1413.46	1442.81

Silt Content of Soil Samples

The result of the silt content is tabulated in Table 4. The sand samples have silt content ranging from 0.67% to 0.96%. This result indicates that the silt content is within specifications of (BS 882 1992) which limits silt content to a maximum of 4%. The low values of the silt content, means that the sand samples have inadequate fines and may require large amount of cement to attain a good workability. Suitable finer aggregates may have to be sourced from other sources to blend with sand samples that very low silt content if they are to be used for construction work (Abdullahi, 2006)

TABLE 4: SILT CONTENT OF SOIL SAMPLES

Sample No	A	B	C	D	E
Location	Kawo	Sabo	Nasarawa	Tudun Wada	Rigasa
Test 1	0.65%	0.72%	0.82%	0.95%	0.95%
Test 2	0.69%	0.74%	0.88%	0.99%	0.97%
Silt Content (%)	0.67%	0.73%	0.85%	0.97%	0.96%

Sieve Analysis of Soil Samples

The result of the sieve analysis for the sand samples is as tabulated below: from the result of sieve analysis, the fineness modulus of the sand material ranges from 3.89 to 3.97. This indicates that the sand material is good and should be used in building construction since it is within the specified range of 2.1 and 3.5 as recommended by BS 882 (1992).

TABLE 5: DETAILS OF SIEVE ANALYSIS FOR SAMPLES OF FINE AGGREGATES – WEIGHT = 1500g

		Percentage Passing Finer (%)				
Sieve Size (mm)		Kawo A	Sabo B	Nasarawa C	Tudun Wada D	Rigasa E
5	5.00	97.13	97.07	97.00	97.20	97.13
7	3.36	95.20	94.93	94.93	95.20	95.27
14	1.18	83.47	80.93	82.93	82.27	83.40
22		57.47	56.53	56.93	56.13	57.53
30	0.6	36.60	35.20	36.13	35.47	36.93
60	0.30	11.27	10.87	10.67	10.93	11.33
100	0.15	5.20	4.60	4.93	4.93	5.20
120		3.87	3.27	3.93	3.47	3.73
150		3.20	2.60	2.93	2.67	3.07
170		2.67	2.00	2.27	2.27	2.53
240		0.67	0.67	0.47	0.53	0.67
Pan		0.00	0.07	0.03	0.00	0.00

Total	396.75	388.74	392.95	390.94	396.79
Fineness Modulus	3.97	3.89	3.93	3.91	3.97

TABLE 6: GRADING LIMITS FOR FINE AGGREGATE (DERIVED FROM BS 882, 1992)

BS Size	Sieve	Grading Zones (BS 882, 1992)			
		Percentage by weight passing BS Sieve			
		Zone 1	Zone 2	Zone 3	Zone 4
10mm	3/8in	100	100	100	100
5mm 3/16in		90 - 100	90 – 100	90 – 100	95 – 100
2.36	No. 7	60 - 95	75 – 100	85 – 100	95 – 100
1.18mm	No. 14	30 - 70	55 – 90	75 – 100	90 – 100
600µm	No. 25	15 - 34	35 – 59	60 – 79	80 – 100
300µm	No. 52	5 – 20	8 – 30	12 – 40	15 – 50
150µm	No. 100	0 – 10	0 – 10	0 – 10	0 – 15

Compressive Strength of Mortar Cubes

Mortar cubes with mix ratio 1:3 were prepared and casted in a 70mm x70mm x 70mm mould and tested for compressive strength after curing for 3, 7, 14, 21, and 28 days. The result is presented in table 7. From the result, the compressive strength for the mortar cube after three days curing ranges between 19.75 and 23.78N/mm^2. According to BS4550, the compressive strength of sandcrete at 3 days shall be 23N/mm^2. The result indicates that sand samples taken from Kawo and Sabo satisfy specification in this regard.

TABLE 7: COMPRESSIVE STRENGTH OF MORTAR CUBE

			Average Cube Strength (N/mm^2)				
S/No.	Cube Size (mm)	Crushing Age (Days)	Kawo	Sabo	Nassarawa	T/Wada	Rigassa
1	70 x 70	3	23.78	22.93	20.8	21.57	19.75
2	70 x 70	7	25.17	23.92	23.1	24.09	23.74
3	70 x 70	14	27.07	25.64	26.3	26.46	26.05
4	70 x 70	21	27.82	27.62	27.1	27.14	26.59
5	70 x 70	28	29.25	28.96	27.8	27.89	27.55

CONCLUSION

The specific gravities of the sand samples were found to be between 2.59 and 2.70. The bulk densities of the aggregates were found to be within the range of 1413.46kg/m^3 and 1486.50kg/m3. All the five sample of aggregates have sieve content less than 4%. The finest moduli of the aggregates range between 3.89 and 3.97 which indicate the suitability of the fine aggregate for masonry work. The compressive strength of the mortar cube prepared using a mixed ratio 1:3 and tested after three days curing were between 19.75 and 23.78N/mm2. Based on these results, the sand samples can be used for masonry works.

RECOMMENDATION

From the results of the study, the following recommendations are made:

- Fine aggregates intended for construction works should be tested for their engineering properties before they are used for any masonry work.

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