Engineering and Technology Journal e-ISSN: 2456-3358
Volume 08 Issue 04 April-2023, Page No.-2124-2129
DOI: 10.47191/etj/v8i4.05, I.F. – 7.136

The Flexural Strength of Basalt Concrete Mix Compared with Granite Concrete Mix

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ABSTRACT: This work aims at comparing the flexural strength of basalt concrete mix with granite concrete mix. A total of 24 concrete beam specimen of breadth 100mm, depth 100mm and length 500mm were made in the laboratory. The British standard mix design method was used to obtain four different mix designs for batching the ingredients comprising ordinary Portland cement, river sand, water, granite and basalt with two mix designs each corresponding to basalt and granite samples. The specimens were cured for 28 days and tested for flexural strength. The results show higher values of flexural strength for basalt mix compared to granite samples by five percent. The results show that basalt aggregates are suitable coarse aggregates for concrete mix.

KEYWORDS: Flexural strength, Concrete, Basalt, Coarse aggregate, Granite.

1.0 INTRODUCTION

Basalt is a common type of extrusive igneous rock occurring at the earth surface which can be used as coarse aggregate for production of concrete including asphaltic concrete for highway construction [1]. Basalt is usually dark, fine grained and columnar structure usually formed from fast cooling of magnesium – rich and iron – rich lava rising to the top [2].

The discovery of new materials is important to technological improvement thereby solving the problem of overdependence on the conventional materials. Mix design is based on critical technical principles to achieve desired output. The purpose of any mix design method is to select an optimum and economical quantities of the various ingredients of concrete to produce concrete of desired characteristics. The production and usage of concrete over the years keep increasing thus increasing the utilization of natural aggregates since aggregates constitute about a greater percentage of concrete volume. To predict the behavior of concrete under all loading and exposure conditions require a deep knowledge of the type, size and aggregate content which can be made possible through laboratory testing and observations [2].

The coarse aggregate for making concrete can be classified by its shape, nature of surface texture, grading of particle, water absorption, bulk density and amount of impurities and other deleterious materials such as silt, clay and organic matter. The basic engineering properties of coarse aggregate such as texture shape, specific gravity, moisture content, grading, water absorption, alkali-silica reactivity, particle size distribution and bulk density should be known to design concrete of high durability, high strength coupled with high workability [3].

Crushed basalt has been used as coarse aggregate for concrete making across the world. The basic properties of basaltic aggregate include water absorption of 1.0%, crushing value of 15%, and particle density of 2,890kg/m3 [4].

[5] Reported that the crushing strength of basalt coarse aggregate is approximately 200 MPa, the crushing value is about 12% while the specific gravity is 2.85 on average. The need to improve on the behavior of fresh and hardened concrete is desired day by day by construction Professionals. However, the basic principles associated with concrete technology remain the same even as concrete has undergone many transformations. Cement and other ingredients including aggregate manufacturers normally strive for improved quality materials leading to a robust and more efficient concrete. Hence, a wide variety of chemical admixtures have been proposed so as to alter concrete characteristics and behaviour.

2.0 MATERIALS AND METHODS

The materials used include river sand, cement, water, crushed basalt (20mm) and crushed granite (20mm). The basalt samples were obtained from three locations in Ikom, Cross River State of Nigeria while the granite samples were obtained from Akamkpa, Cross River State of Nigeria. Basalt samples from location one were labelled B1 and B2, basalt samples from location two were labelled B3 and B4 while basalt samples from location three were labelled B5 and B6. The granite samples were labelled G1 and G2.

The summary of mix design showing all the mix ratio is presented in Table 2.1

Table 2.1: Summary of mix design.

S/N	Sample No.	Mix ratio	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (kg/m^3)
1	B1, B3, and B5	1:1.96:2.81	410	802	1153	205
2	B2, B4, and B6	1:2.25:2.75	394.23	887	1084	205
3	G1	1:1.80:2.75	410	736	1127.5	205
4	G2	1:2.07:2.76	394.23	815	1088	205

Sieve analysis performed on the fine aggregate is presented in Table 2.2.
Sample Type: Fine Aggregate (River sand)
Weight of Sample = 500g
Absolute weight of sample = 498g

Table 2.2: Sieve analysis of river sand.

Sieve (mm)	Mass (g)	% retained	% passing of Sand	Minimum Limit by BS410	Maximum Limit by BS410
2.360	5	1.0	99.0	90	100
1.180	21	4.2	94.8	75	100
0.600	77	15.5	79.3	55	90
0.300	179	35.9	43.4	35	59
0.150	160	32.1	11.3	8	30
0.075	46	9.2	2.1	0	10
PAN	10	2.0			
TOTAL	**498**				

The graph of percentage passing against particle size known as particle size distribution curve for fine aggregate is presented in Figure 2.1

From Figure 2.1, it shows that the river sand used for the experiment as indicated by the red line located within the envelope meets the specification of the minimum and maximum sizes required by BS 410.

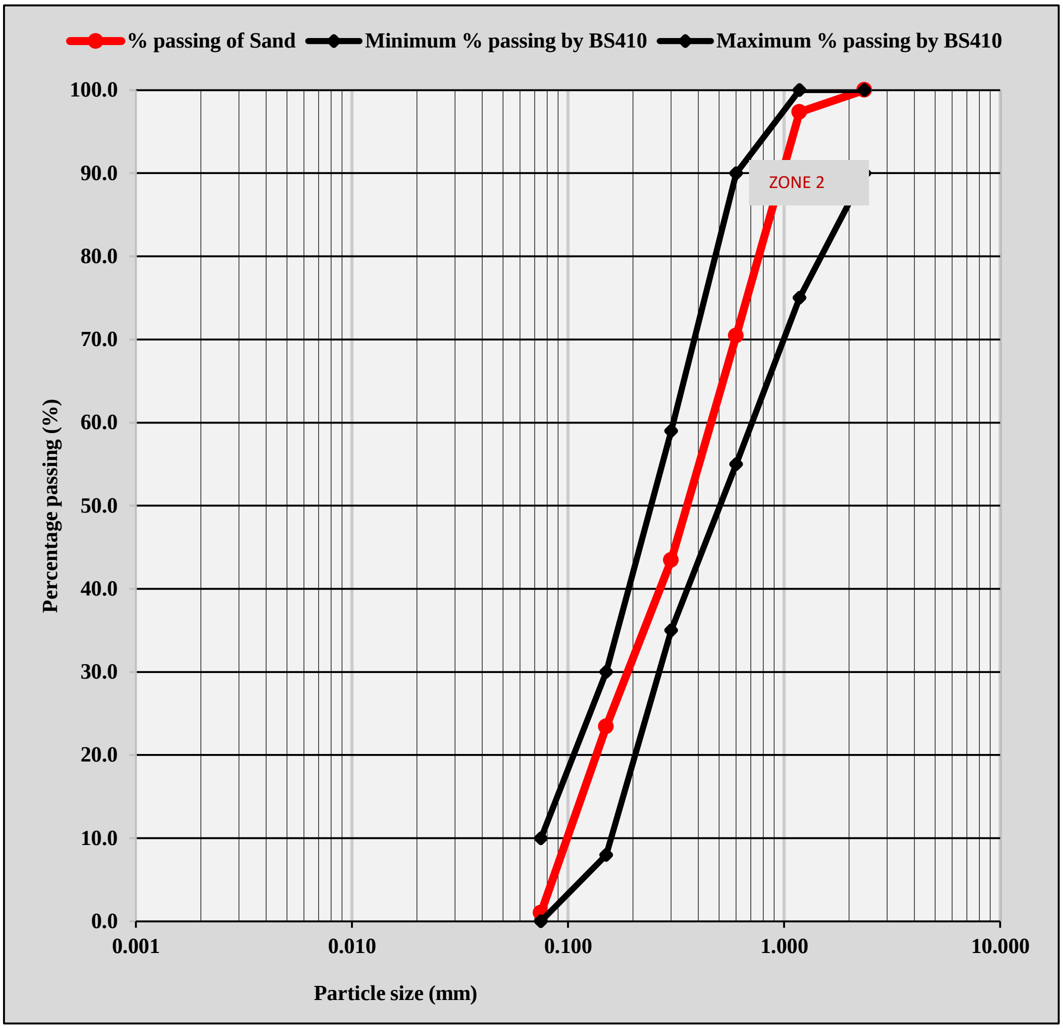

Figure 2.1: Particle size distribution curve for fine aggregate.

The flexural strength test was carried out in a flexural strength testing machine. The beam specimen was casted on a steel mould of breadth 100mm by depth 100mm and length 500mm. Concrete samples for same compressive strength test were taken for the experiment. Three beams each were made from B1, B2, B3, B4, B5, B6, G1 and G2 making a total of 24 beams. The beams were demoulded after 24 hours and cured in a curing tank for 28 days.

The flexural strength were computed from the expression

$$f_b = \frac{3pl}{2bd^2} \tag{2.1}$$

Where p is the applied load and l, b and d are the length, breadth and depth of the specimen respectively.

3.0 RESULTS AND DISCUSSION

3.1 Results

The results of flexural test carried out on the specimen are presented in Tables 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7and 3.8 for B1, B2, B3, B4, B5, B6, G1 and G2 respectively.

Table 3.1: Flexural strength of B1 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
B1	13840	10020	7.52	7.98
	15646	10850	8.14	
	14850	11035	8.28	

Table 3.2: Flexural strength of B2 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
B2	13814	9885	7.41	7.48
	15144	10052	7.54	
	14668	9975	7.48	

Table 3.3: Flexural strength of B3 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
B3	14788	10076	7.56	7.80
	15233	10150	7.61	
	14980	10976	8.23	

Table 3.4: Flexural strength of B4 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
B4	14860	9987	7.49	7.48
	14356	9925	7.44	
	15127	10015	7.51	

Table 3.5: Flexural strength of B5 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
B5	15068	10988	8.24	8.01
	14965	11024	8.27	
	14896	10030	7.52	

Table 3.6: Flexural strength of B6 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
B6	15120	9940	7.46	7.54
	14755	9766	7.32	
	14498	10445	7.83	

Table 3.7: Flexural strength of G1 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
G1	14253	10040	7.53	7.56
	14168	1020	7.59	
	13875	10080	7.56	

Table 3.8: Flexural strength of G2 at 28 days.

Sample No	Weight (g)	Crushing Load (N)	Flexural Strength N/mm^2	Average Flexural Strength N/mm^2
G2	14030	9987	7.49	7.47
	14146	9973	7.48	
	13970	9907	7.43	

The summary of average flexural strength for samples at 28 days is presented in Table 3.9 while the summary of average flexural strength for samples B1, B2, B3, B4, B5, B6, G1 and G2 at 28 days are presented in Figure 3.1

Table 3.9: Summary of average flexural strength for samples at 28 days.

S/N	**Age of curing (Days)**	**Average flexural strength in N/mm^2**							
		B1	**B2**	**B3**	**B4**	**B5**	**B6**	**G1**	**G2**
1	28	7.98	7.48	7.80	7.48	8.01	7.54	7.56	7.47

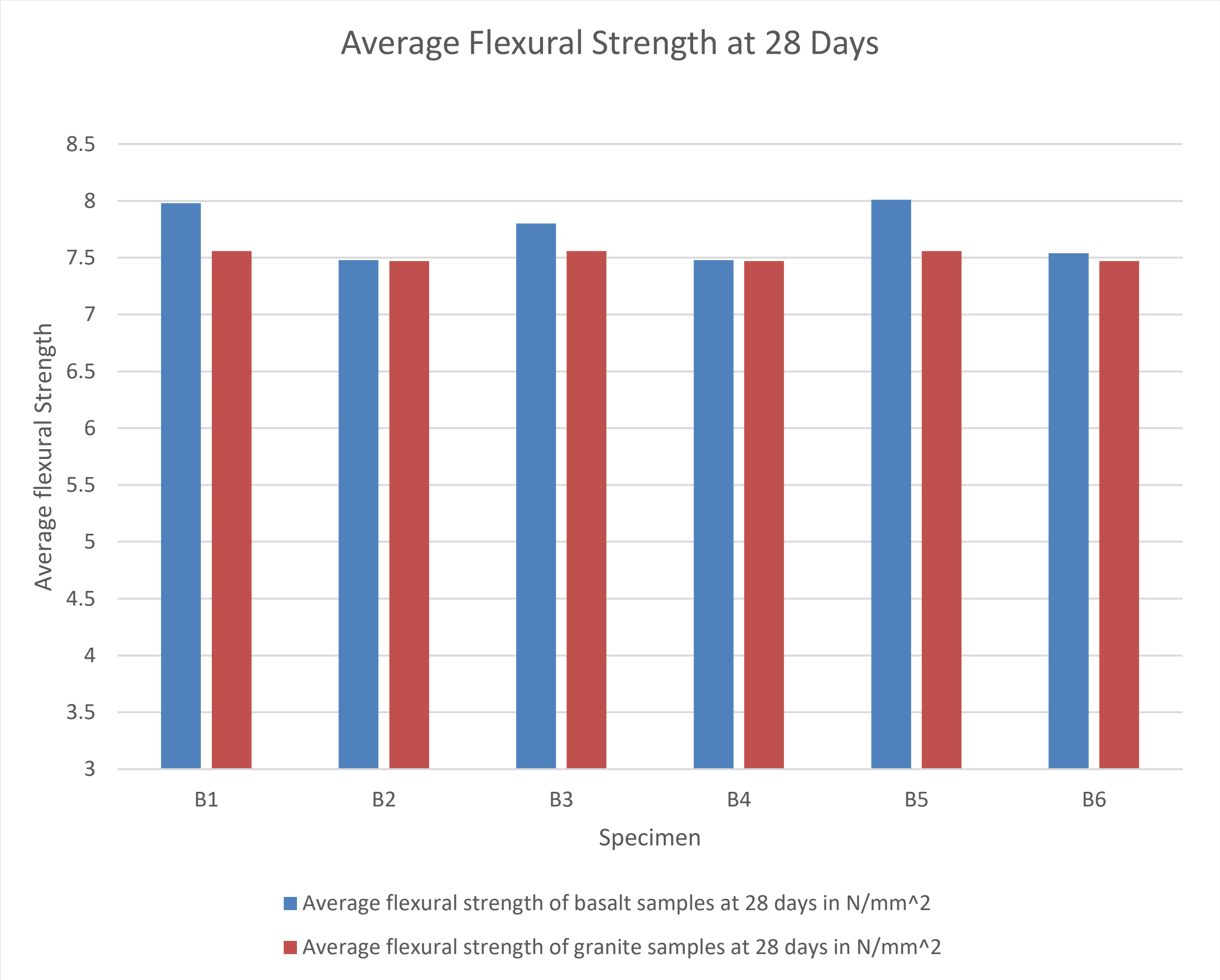

Figure 3.1: Summary of average flexural strength at 28 days for all samples.

3.2 Discussion

The flexural strength of B1, B3 and B5 were compared with the flexural strength of G1 since this category had the same cement content in the mix design while the flexural strength of B2, B4 and B6 were compared with the flexural strength of G2 since this category had same cement content in the mix design. The average flexural strength of concrete for B1, B3 and B5 is 7.93 compared to G1 which is 7.56. This shows a higher flexural strength for the basalt samples compared to the granite samples. This again shows a robust super performance of the basalt concrete samples compared to the granite concrete samples. Similarly, the average flexural strength of concrete for B2, B4 and B6 is 7.50 compared to G1 which is 7.47. This shows an equivalent flexural strength for the basalt samples in this category compared to the granite samples.

4.0 CONCLUSIONS

In conclusion, the flexural strength of the basalt samples is higher than the flexural strength of granite samples by five percent. The results show a higher modulus of rupture for basalt concrete samples compared to the granite concrete samples. From the flexural strength perspective of performance of basalt as coarse aggregate, it can be concluded that basalt coarse aggregate is suitable for use in concrete mix.

5.0 ACKNOWLEDGEMENTS

I sincerely acknowledge the contributions of Prof. David Ogbonna Onwuka, Dr. Mrs Joan I. Arimanwa and Mrs Ulari S. Onwuka for their contributions to the success of this research.

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