Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1304

Suitability of Fobur Biotite – Granite as an Aggregate Construction Material, Jos, North Central Nigeria

Abalaka Isaac Edimeh[1]* and Okopi Johnson Odumu[2]

[1]Department of Geology, Faculty of Natural Sciences, University of Jos, Nigeria
[2]Timadix Geomin Consults, Qualitrends Plaza, F.C.T, Abuja, Nigeria

Corresponding Author: abalakai4real@yahoo.com

ABSTRACT

The physical properties of the Fobur Granites in Plateau State were examined with the aim of determining their suitability as aggregates for construction. Some rock samples were collected from different points within the study area. Ten (10) samples were collected and their specific gravity values were determined using the pyncometre. Their specific gravity values range from 2.597 to 2.654. Its low percentage measured from the percentage pass indicates that more energy is needed to dislodge or disassemble the rock particle. The energy required to do this is called the comminution energy as compared to the specific gravities of different types of soil / rock aggregates. The average specific gravity of the granites in Fobur falls within the range of the standard specific gravity of rocks. As a result, the granites in Fobur community can be for use as construction aggregates. From literature, granites are composed of quartz, orthoclase, hornblende and biotite. The mineral composition of granites in Fobur gives them a specific gravity that is more than 2.50. The research objective is to determine the suitability of Fobur Biotite Granite as an aggregate construction material in Jos, North Central Nigeria.

Key Words: Pyncometre; Specific Gravity; Aggregates; Construction; Comminution Energy

INTRODUCTION

The suitability of granite for an aggregate quarry depends on factors that discriminate or qualify it as a construction material in building, civil and other engineering works. These factors are very important and must be considered when siting a quarry for aggregate production. These factors are grouped into three namely: physical, mechanical and the chemical properties of the granite. The physical properties include the electrical, magnetic and the radioactivity of the granite. The mechanical properties depend on the elastic modulus of the granite, the strength, stress and the strain of the granite. "Hook (1994)". In the above properties, the measured strength is considered using various testing machines. The chemical properties include the composition of the rocks and how they are packed during the crystallization of the magma which is called inter – crystallinity. The structure of the granite also contributes to the engineering properties which is a very important factor when considering a site for an aggregate quarry. These structures include the joint, fault, fracture, veins, lineation and foliations.

The term granite can be studied and defined according to users. Generally, it can be defined as a coarse grained, light colored, igneous rock composed of mainly feldspar and quartz with minor amounts of mica and amphibole minerals. In terms of petrology, granite is a plutonic rock in which the quartz makes up between 10 and 50 % of the felsic compound and alkali feldspar accounts for 65 to 90 % of the total feldspar content, Amethyst (2014). For commercial purpose, granite is

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1304

quarried or exploited by the people who sell and purchase cut stone for structural and decorative use. The durability property and the abundance of granite make it a preferred choice of mineral over the others especially for construction purposes. Granite is a natural product whose beauty comes from porosity, crystalline quartz structure, fissures and movement of the conglomerates, mineral composition and grain size. Granite is formed by molten magma deep within the earth crust under great pressure and heat, Wills (2006). Granite is very dense and is used in making large slab sizes and varieties all over the world. The physical and mechanical properties of granites are functions of its texture and mineralogy. These properties can affect the quarrying operation during tunnel mining, slope stability, etc.

However, the strength of granite rocks decreases with increase in the water content due to reduction in the coefficient of internal friction of the rock particles. In addition, the presence of water in the rock increases the rate of the deformability of the rock mass, Ojo and Olaleye (2004). Granite aggregates are crushed hard rocks of granular structure being the most common on earth. Good properties of granite make it an excellent construction material. It can be used as aggregate for high grade concrete and also as a decorative stone. Its raw form can occur as grey, red or pink with lots of shades. After polishing, it acquires a beautiful surface.

Location, Accessibility and General Geology

The study area (Fobur), lies approximately between latitudes N 9^0 00' 00" and N 9^0 00' 00" and between longitudes E 9^0 51' 00" and E 9^0 45' 00", covering a total area of 282 km^2. The area is easily accessible all year round because of the good road network of tared and graded roads within the area.

In terms of geology, the granitic rocks which are been investigated are located at Fobur village, Jos, Plateau State. The Nigerian basement complex extends Westwards and continues within the Dahomey – Togo – Ghana region. Falconer (1911, 1921). In terms of geology, Biotite Granite rocks dominate the study area. They are plutonic rocks which comprise of alkali feldspars, quartz, mica and small portion of mafic minerals. Wright (1971). The rocks found in the study area are classified based on the proportion of the mafic minerals in them. They include: Bukuru Biotite Granite, N'gell Biotite Granite, Jos Bukuru Biotite Granite, Rayfield Gona Biotite Granite and the Shell Biotite Granite. Macleod et al (1971).

The Geologic map of the study area is seen in Figure 1 which shows the various rock types that are delineated. The basement Complex rocks of Nigeria is composed predominantly of magmatic and granite gneiss, quartzites, slightly migmatised to unmigmatised to metasedimentary schist and metaigneous rocks, charnockites, gabbroic and dioritic rocks. Figure 1 and 2 shows the geologic map as well as the sample location map of the study area.

MATERIALS AND METHODS

The materials used for this investigation incudes: sledge hammer, pycnometer, marker, field vehicle, GPS, compass, geological maps and sample bags

In terms of method, the data used in this research were both from primary and secondary sources. The secondary data were obtained from textbooks, journals, internet, etc., while the primary data were obtained from the field during geological mapping. The strength of the aggregates was obtained using the specific gravity method.

Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041
E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1304

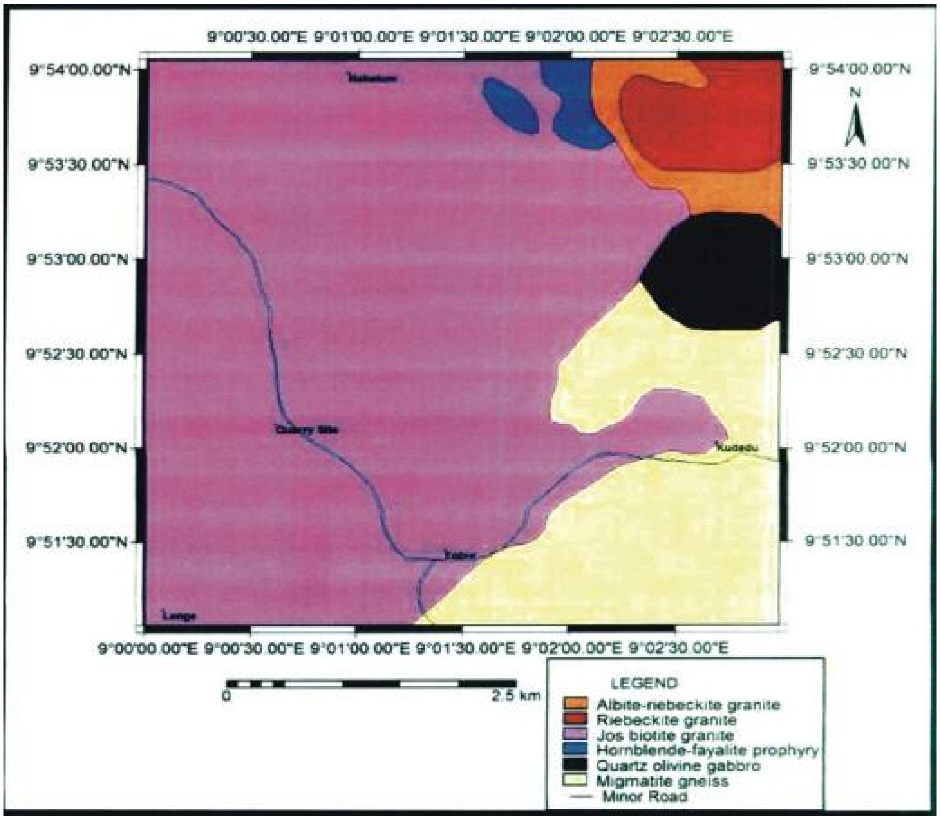

Figure 1: Geological Map of Fobur Area.

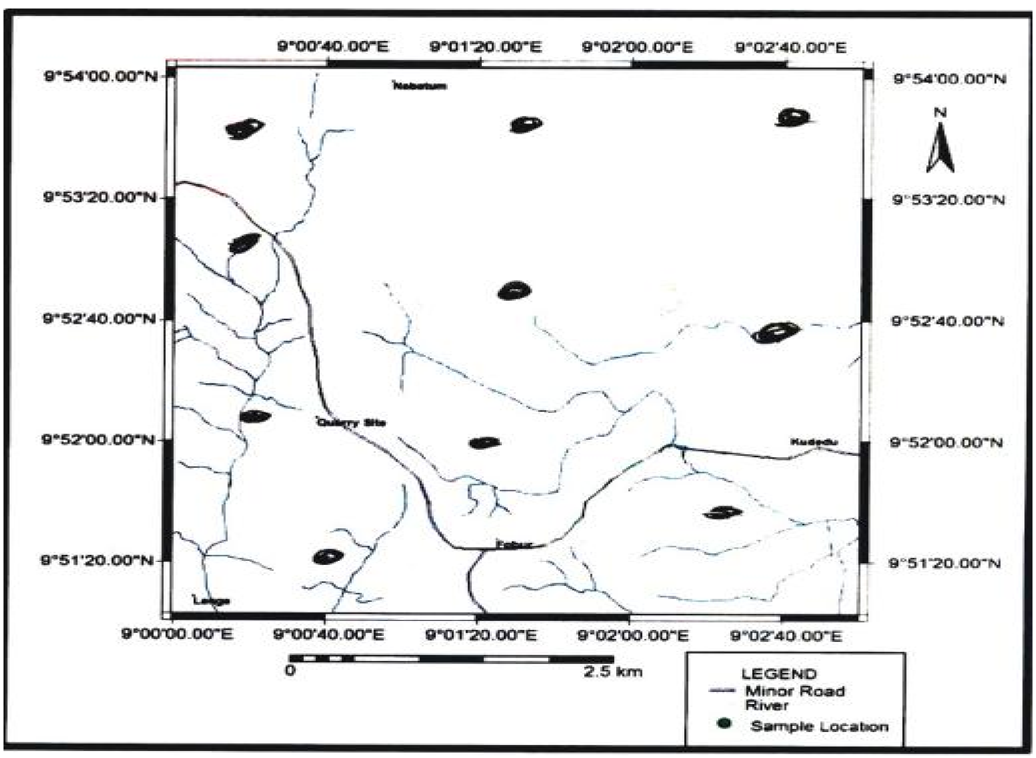

Figure 2: Sample Location Map of the Study Area.

Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041
E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1304

10 kg each of two (2) rock samples were picked from five (5) points using a sledge hammer on the rock body in other to realize boulder size by random sampling method, giving a total sample of ten (10) in all. Specific gravity of fine aggregates has been determined using the pycnometre test and their average specific gravity values were determined. Specific gravity is the ratio of the soil / rock density to that of density of water. Therefore, soil / rock parameters can be used to ascertain their properties like, soil density, void ratio, degree of saturation, etc. Specific gravity is a very important tool to consider in the design of foundations, quarries, etc. Generally, the specific gravity of granites ranges from 2.600 - 2.700.

The details are presented below;

G (Specific Gravity) = W2 - W1 / W2 – W1 (W3 – W4)
W1 = Weight of the empty pycnometre
W2 = Weight of the pycnometre + 1/3 of fine Aggregate
W3 = Weight of the pycnometre + 1/3 of fine Aggregate + Water
W4 = Weight of the pycnometre + Weight of Water Full of the pycnometre
Average Trial = G1 + G2 / 2

RESULTS AND DISCUSSIONS

For Station A,
At point 1,
W1 = 433.5, W2 = 775.8, W3 = 1096.6, W4 = 884.2. From the formula above, G = 2.615.
At point 2,
W1 = 433.9, W2 = 784.8, W3 = 1100.9, W4 = 884.2, G = 2.615.
Average Trials = 2.615 + 2.615 /2 = 2.615

Table 1: Crushed Rock Aggregate for Station A.

Number of trials	W1	W2	W3	W4	G
1	433.5	775.8	1095.6	884.2	2.615
2	433.9	784.8	1100.9	884.2	2.615
Average					**2.615**

For station B,
At Point 1,
W1 = 433.7, W2 = 704.0, W3 = 1050.8, W4 =884.2, G = 2.601
At Point 2,
W1 = 433.8, W2 = 709.1, W3 = 1054.8, W4 = 884.2, G 2.629

Table 2: Crushed Rock Aggregate for Station B.

Number of trials	W1	W2	W3	W4	G
1	433.7	704.0	1050.8	884.2	2.601
2	433.8	709.1	1054.8	884.2	2.629
Average					**2.615**

For Station 3,
At point 1,
W1 = 433.0, W2 = 756.3, W3 = 1083.0, W4 = 884.2, G = 2.597
At point 2,
W1 = 433.4, W2 = 803.4, W3 = 1112.6, W4 = 884.2, G = 2.613
Average Trials = 2.597 + 2.613 /2 = 2.603

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1304

Table 3: Crushed Rock Aggregate for Station C.

Number of trials	W1	W2	W3	W4	G
1	433.0	756.3	1083.0	884.2	2.597
2	433.4	803.4	1112.6	884.2	2.613
Average					**2.605**

For Station D,
At Point 1,
W1 = 434.0, W2 = 703.9, W3 = 1082.3, W4 = 884.2, G = 2.605
At Point 2,
W1 = 434.0, W2 = 756.7, W3 = 1082.3, W4 = 884.2, G = 2.603
Average Trial = 2.605 + 2.603 /2 = 2.604

Table 4: Crushed Rock Aggregate for Station D.

Number of trials	W1	W2	W3	W4	G
1	434.0	703.9	1050.5	884.2	2.605
2	434.0	756.7	1082.3	884.2	2.603
Average					**2.604**

For Station E,
At Point 1,
W1 = 433.4, W2 = 767.6, W3 = 1092.5, W4 = 884.2, G = 2.634
At Point 2,
W1 = 433.4, W2 = 772.1, W3 = 1096.3, W4 = 884.2, G = 2.654
Average Trial = 2.634 + 2.654 /2 = 2.644

Table 5: Crushed Rock Aggregate for Station E.

Number of trials	W1	W2	W3	W4	G
1	433.4	767.6	1092.5	884.2	2.634
2	433.4	772.1	1096.3	884.2	2.654
Average					2.644

For Station F,
At Point 1,
W1 = 433.4, W2 = 703.5, W3 = 1052.2, W4 = 884.2, G = 2.620
At Point 2,
W1 = 433.4, W2 = 751.6, W3 = 1083.2, W4 = 884.2, G = 2.649
Average Trial = 2.620 + 2.649 / 2 = 2.635

Table 5: Crushed Rock Aggregate for Station E.

Number of trials	W1	W2	W3	W4	G
1	433.4	703.5	1052.2	884.2	2.620
2	433.4	751.6	1083.2	884.2	2.649
Average					2.635

Figure 6: The specific gravity values of different soils / rock aggregates.

Rocks / Sand	2.50 – 2.80
Silt	2.20 – 2.35
Inorganic Clay	2.00 – 2.30
Organic Soil	1.00 – 2.00

After Beniawski, Z.T (Specific Gravity of Rock and Aggregates, 1973, 1976, 1978, 1984)

Table 1 to 5 shows the average values of the granite from different locations in Fobur using the pycnometre. Its low percentage measured from the percentage pass indicate that more energy is needed to dislodge or disassemble the rock particle. The energy required to do this is called the comminution energy. Table 6 tells us the specific gravities of different types of soil / rock aggregates. The average specific gravity of the granites in Fobur falls within the range of the standard specific gravity of rocks. As a result, the granites in Fobur community can be for use as construction aggregates. From literature, granites are composed of quartz, orthoclase, hornblende and biotite. The mineral composition of granites in Fobur gives them a specific gravity that is more than 2.50. From the low percentages measured from their percentage pass, a lot of energy will be needed to crush the Fobur Biotite Granite rocks. This indicates that they are very durable and competent for use as construction aggregates. Their specific gravity ranges also confirm that.

CONCLUSION

In conclusion, ten (10) samples were collected from different locations in Fobur community. Their specific gravity values were determined using the pyncometre. Their specific gravity values that were determined falls within the range of standard specific gravity of granite rocks in the study area. A lot of energy is required to crush them, this indicates that there are very durable and competent for use as construction aggregates.

REFERENCES

Amethyst Galleries Inc. *Mineral Gallery.* (2014). 2 (1) 21 – 23.

Beniawski, Z.T. (1973). Case Studies : Prediction of Rock Mass Behavior by Geomechanics Classification. *Proc. 2nd Aust – NZ., Conf. Geomech, Brisbon,* 36 -41

Beniawski, Z.T. (1976). Rock Mass Classification In Rock Engineering. *Proc. Symp, Exploration for Rock Engineering*, 1. 97 – 106

Beniawski, Z.T. (1978). Determination of Rock Mass Deformation. *Institute Journal of Rock Mechanics and Mineral Science.* 15. 237 - 247

Beniawski, Z.T. (1984). Rock Mechanics Design in Mining and Tunneling. *International Journal of Rock Mechanics and Mining Science.* 9 (6) 669 – 697.

Falconer,Z.D. (1911). The Geology and Geography of Northern Nigeria. *Mac Millan Press,* 165 – 180

Falconer, Z.D. (1921). The Geology and Geography of Northern Nigeria. *Mac Millan Press*, 135 – 138

Hook, B.C. (1994). Strength of Rocks and Rock Masses. *ISRM News Journal,* 2 (2) 4 -16

MaCleod, et al (1971). The Geology of the Jos Plateau. *Journal of Geosciences and Environment* 7 (2) Feb 2, 1971

Ojo, C.J and Olaleye, N.G. (2004). Classification of Ondo State Intact Rocks for Engineering Purpose. *Journal of Science Engineering and Technology.* 11 (3) 5733 – 5759

Wills,B.J. (200). Mineral Processing Technology, New York. *Elsevier Science and Technology Books* 6(1) 75 – 83.

Wright, C. (1971). Ring Complexes in The Younger Granite Province of Northern Nigerian. *Memo No. 1, Geological Society of London,* 65 - 76.