

A Study on Variation in Mineralogical and Strength Characteristics of Some Granitic Rocks

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Abstract:

Rock texture and mineralogical composition is of great importance in understanding engineering characteristics of a rock. In this study thin sections were used to assess the texture and mineralogical composition of some granitic rocks of Jabalpur and Bundelkhand regions of Madhya Pradesh state of India. The Brazilian tensile strength, point load index and unconfined compressive strengths (UCS) of these rocks samples were also found out. The test results showed that there are significant variations in the engineering properties of the granitic rocks. The UCS varies from 120 MPa to 175MPa for dry samples and 119 MPa to 170 MPa for saturated samples. Brazilian tensile strength also has variations from 9.6 MPa to 18.4 MPa for dry sample whereas in saturated the value varies from 8.5 MPa to 17.7 MPa similarly Point Load Strength Index 6.14 MPa to 9.26 MPa for dry sample and for saturated sample 5.70 MPa to 8.55 MPa conditions respectively. The possible reasons for such variations are due to the change in textural, structural and mineralogical composition of such rocks.

Keywords: Thin Section, Point Load, Brazilian Tensile Strength, Unconfined Compressive Strength

Introduction:

Rock characterization provides an important input parameter for the design of structure founded on rocks. Granitic rocks are the intrusive igneous rocks; they are widely used in the construction industries as dimension stone, aggregates etc. due to their high strength, abrasion resistance and durability. The strength and deformational behaviour of such rocks are essentially required for the design and construction of dams, tunnels, slope stability and foundations design of structures. The physical and engineering properties of such rocks are known to be affected by many factors. These factors include geological, lithological, environmental and mechanical (Ramamurthy, 2010).

The city of Jabalpur located between 23⁰10' North latitude and 79⁰29' East longitude in the state of Madhya Pradesh, India, has a unique position regarding the massive presence of granite rocks. Granite is present as the bed rock below the entire township at different levels where it is covered by thin layers of Gondwana and Lameta sediments. Granite is directly outcropped in the form of small and big hills of varying heights and long ridges.

A unique terrain of granitic rocks of varying types is found predominantly in the Bundelkhand region that forms the northernmost part of the Indian peninsula. Granites from the lower Precambrian era are the predominant geological rock material of the region. The Bundelkhand granite covers about 29000 sq km of the total area of the southern Uttar Pradesh and north-eastern Madhya Pradesh in central India. The major district/ places where granite is outcropped are Jhansi, Tikamagarh, Lalitpur, Khajuraho, Bijawar, Chhatarpur etc.

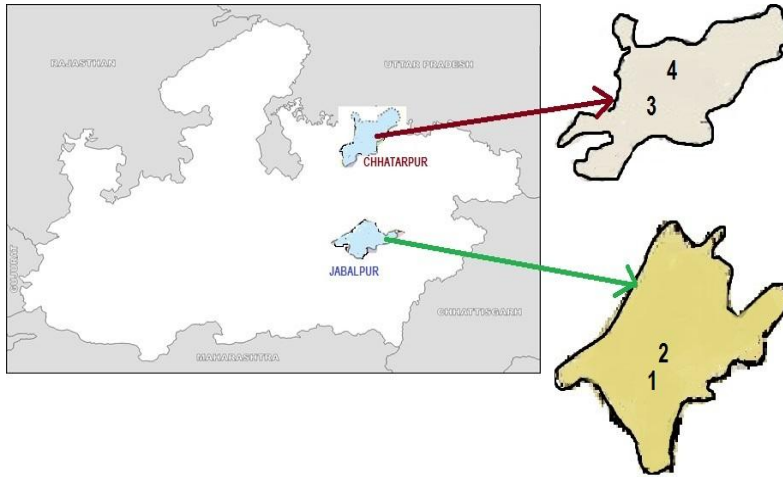
This paper envisages the study of textural and mineralogical characteristics of granitic rocks collected from some location of Jabalpur and Bundelkhand regions of Madhya Pradesh state. The variations in the engineering characteristics of such rocks have also been presented in this study.

Literature Review:

A number of studies are available on the relationship between petrographical and engineering behaviour of rocks. Gupta and Rao (2000) studied the deformational behaviour in terms of variation in tangent modulus and initial modulus due to weathering on Malajkhand granite, Nagpur basalt and Delhi quartzite. KeikhaTayebeh et al. (2013) established correlations between mineralogical characteristic and engineering properties of granitic rocks. They concluded that the grain size and mineralogical compositions influence the strength of granitic rock to a great extent. Ali Z. et al. (2013) studied petrographic characteristics and engineering behaviour of some igneous rocks of Baluchistan. The results of their study revealed that the mechanical properties of rocks can be estimated by using correlational equation between sonic wave velocity and petrographic characteristics. Several other researchers have studied the effect of moisture and petrographic features on strength and deformational behaviour of rocks (Broch, E. 1974, Gokhale, C.S.1994, Akesson, U. et al. 2001).

METHODOLOGY

The granite rocks samples were collected from granite outcrops near Medical College and BadaPathar, Ranjhi of Jabalpur city. Some samples were also collected from two locations in Chhatarpur district of Bundelkhand region. These samples were tested for specific gravity, water absorption, dry and saturated densities and Unconfined Compressive Strength as per the relevant IS code of practise/ ISRM suggested methods. These locations are shown in the map and given below.



Location Map

Location No 1 – Jabalpur Medical College.

Location No 2 – Jabalpur, Bada Pathar, Ranjhi.

Location No 3 – Buxwaha, Chhatarpur

Location No 4-BadaMalhara, Chhatarpur.

A number of thin sections of granite rock samples were prepared and examined under microscope in presence of polarised light. The strength properties of the granitic rocks were examined by laboratory testing. The test includes point load strength index, Brazilian tensile strength and uniaxial compressive strength and as per ISRM specification. And the result are summarised in Table No 1.

Results and Discussion:

The thin section study of the sample collected from BadaMalhara district Chhatarpur (Bundelkhand) reveals that the essential minerals are quartz and microcline, whereas the accessory minerals found were biotite, Fe ore and hornblende. It consists coarse grained porphyritic type texture. The thin section of location 1 is shown in figure 1.

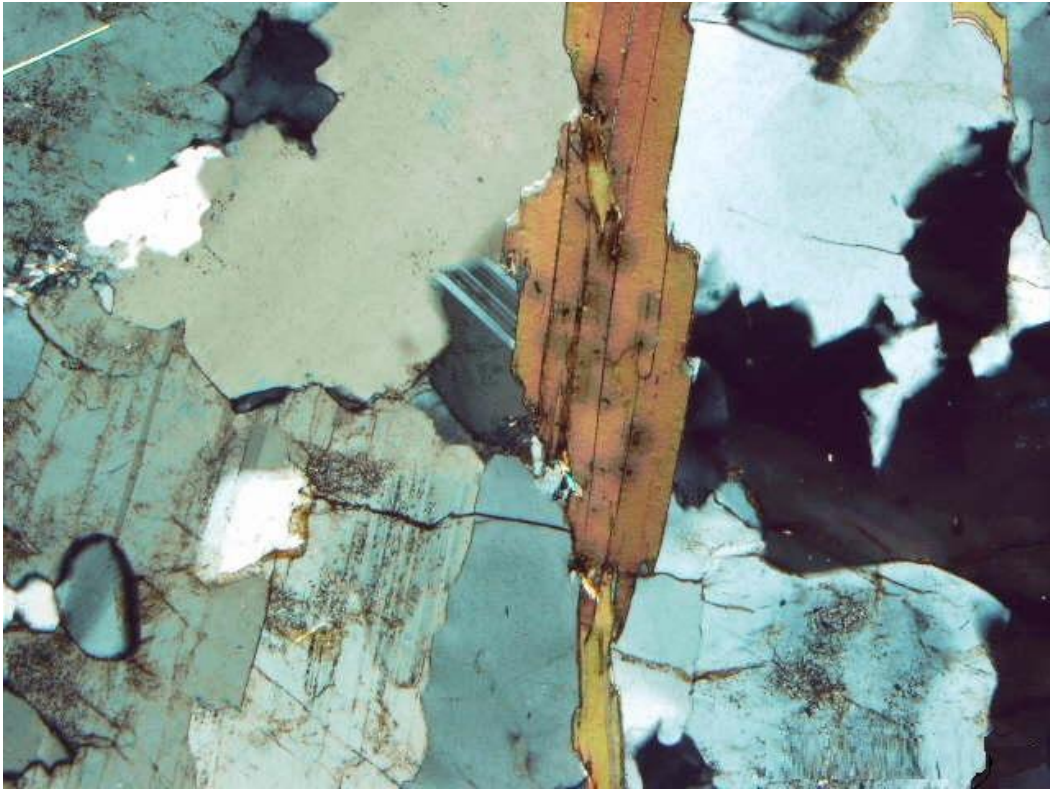


Figure 1. Thin section photograph of BadaMalhara, Chhatarpur (Bundelkhand)

The sample collected from Medical College Jabalpur area of Jabalpur city consist of Quartz and Orthoclase as an essential mineral. Biotite, Apatite and tourmaline as accessory minerals. It is a hollow crystalline, Equigranular coarse grained rock having subhedral grains. The special feature in this section is that the orthoclase mineral is getting altered into Kaolinite and montmorillonite minerals. As the boundaries of minerals are not distinguished very much this indicates sign of weathering in the rock. The thin section is shown in figure 2.

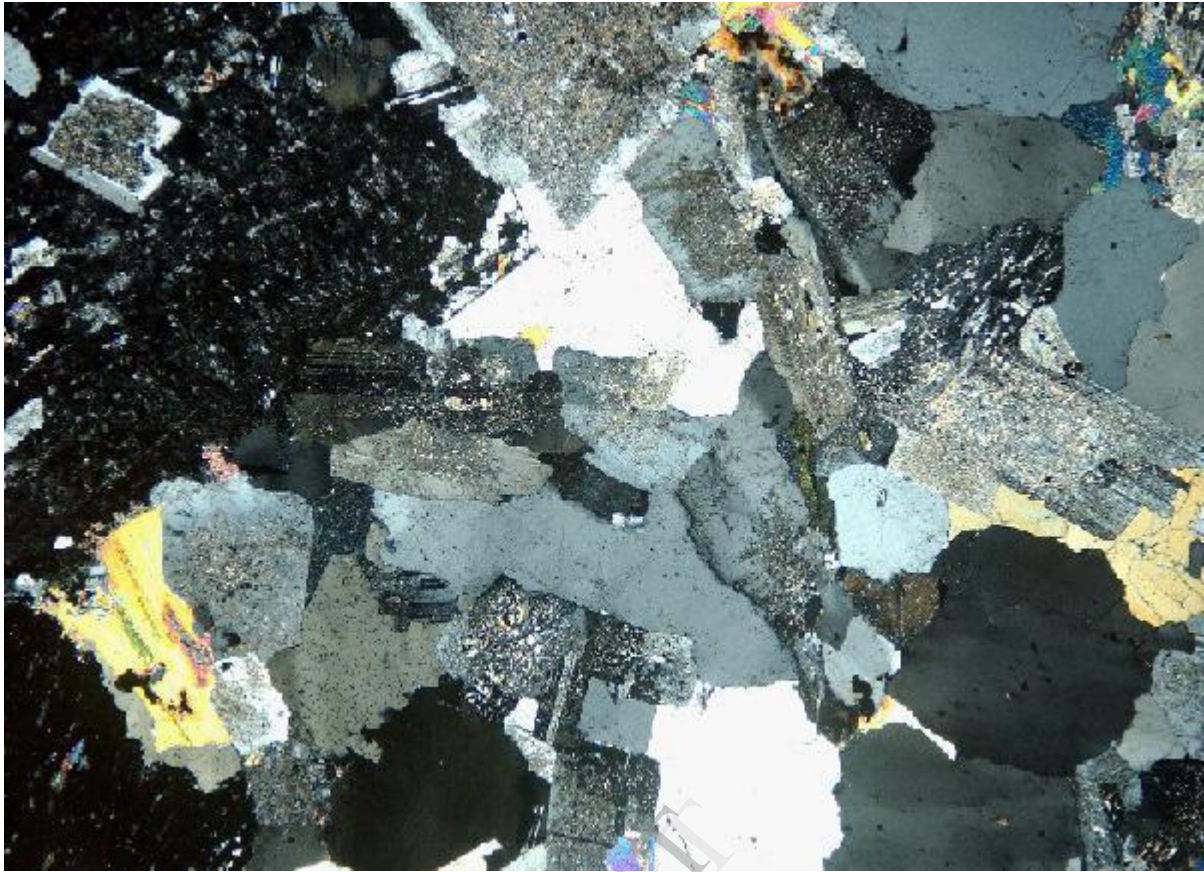


Figure 2. Thin section photograph of Medical College, Jabalpur

Table No. 1 Engineering Characteristic of Granite Rock Sample

S No	Detail of Sample	Brazilian Tensile Strength σ_{bt} Dry	^{sat} Saturated σ_{bt}	Point Load Strength Index Dry I_{s50}	Saturated I_{s50}	Unconfined σ_c Dry	Unconfined σ_c Saturated
1	JMC	9.80	9.20	6.80	6.20	132.0	129.0
2	JBR	9.6	8.50	6.15	5.70	120.0	119.0
3	BCB	18.4	17.70	9.25	8.55	175.0	170.0
4	BCBM	12.1	11.30	8.40	7.2	168.0	163.5

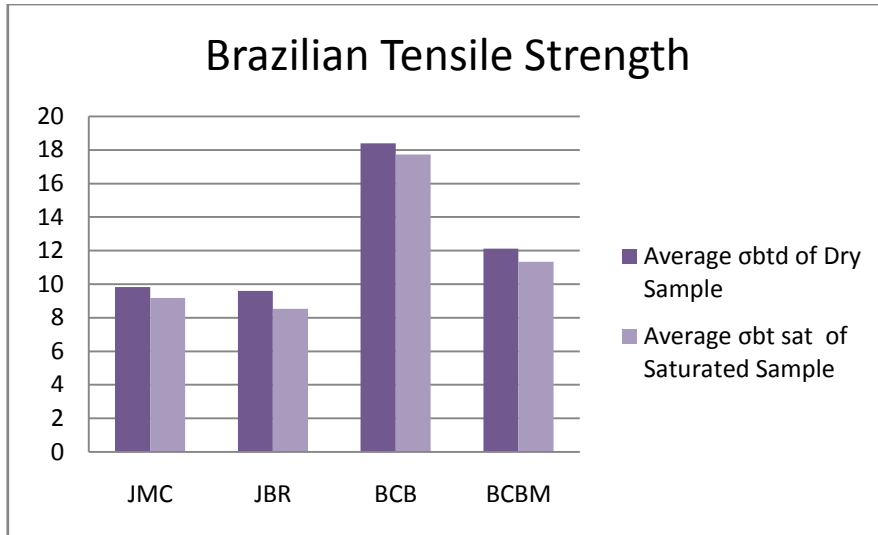


Fig. 3 Variation of Brazilian Tensile Strength of Dry and Saturated Samples

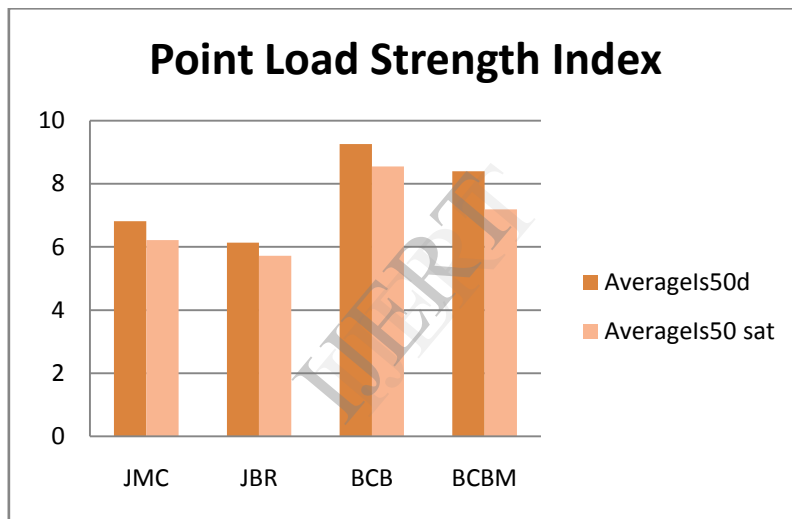


Fig. 4 Variation of Point Load Strength Index of Dry and Saturated Samples

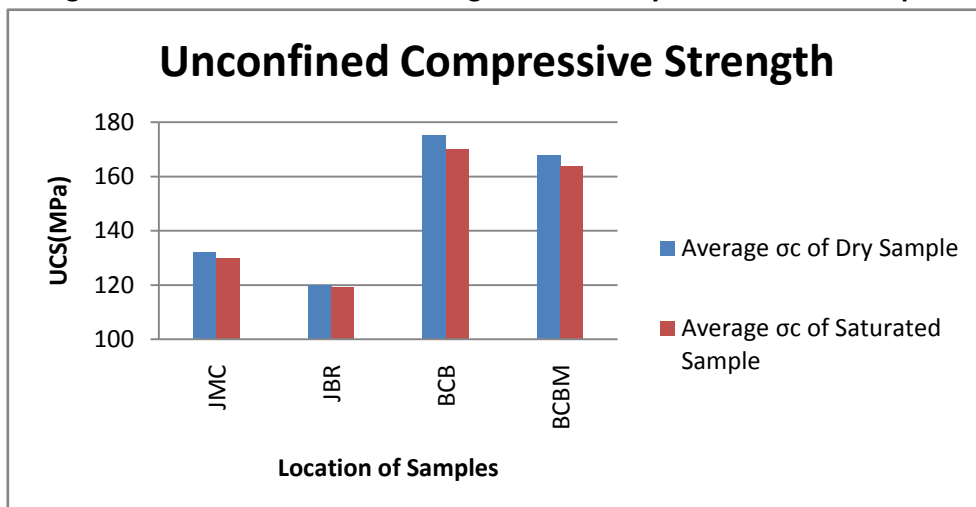


Fig.5 Variation of UCS of Dry and Saturated Samples

Conclusions: From the laboratory investigations made on granite samples of different locations of Jabalpur and Bundelkhand regions, the following conclusions can be drawn:

1. The engineering properties like Brazilian Tensile Strength and Point Load Strength Index of rock samples collected from different locations vary considerably (Fig 3 and 4).
2. The Unconfined Compressive Strength also has remarkable variation (Fig 5).
3. The possible reasons for such variations in the characteristics of granite are due to geological, lithological, physical and environmental factors. The textural and mineralogical composition, grain size, etc. influence these properties to a great extent.
4. The petrographic study reveals closely and equigranular texture packed grain provides great compressive strength to the rock if they are not altered.
5. There is small variation in the strength if the samples are tested in saturated conditions.

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