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Research Paper

A Study of Variation in Physical and Engineering Characteristics of Hybrid Granitic Rocks

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ABSTRACT: *Engineering behaviour of rock is influenced by mineralogical content, texture, structure, extent of weathering and other factors like hybridization, assimilation etc. The physical and strength characteristics of granitic rocks obtained from selected locations of MahaKaushal and Bundelkhand region of Madhya Pradesh state were studied. Petro-graphical studies using thin sections, physical and engineering properties of selected granite rock samples were carried out. The test results reveal that there is significant variation mineralogical Composition and texture of rock samples some evidences of hybridization are also found. The physical and engineering properties like specific gravity, water absorption porosity and point load strength, Brazilian tensile strength and unconfined confined strength (UCS) vary to large extent from location to location in dry and saturated conditions.*

KEY WORDS: *Granitic rocks, Hybridization, Engineering properties*

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I. INTRODUCTION:

Study of engineering behaviour of rocks is important for the design and Construction of foundations for civil engineering structures founded on rocks, tunnels in rocky areas, underground structures etc. A rational evaluation of physical and engineering characteristics of the intact rock is essential to assess the rock mass quality and its response under loading. Granite outcrops are found around Jabalpur city and many districts of Madhya Pradesh. Granite samples of selected locations were obtained for various studies, like

- Micrographic tests to indicate mineral content,
- Grain size,
- Texture, alteration, micro fracture etc.
- The physical properties like dry and saturated densities, water absorption, porosity, specific gravity,
- Strength properties like unconfined compressive strength (UCS), Brazilian tensile strength (BTS), and point load strength Index (PLSI), sound velocity test by elastic wave propagation of P-wave were also evaluated.

This paper envisages the variation in petrographical and engineering characteristics of various varieties of granitic rocks and their possible reason for such variations are discussed in this paper.

II. LITERATURE REVIEW:

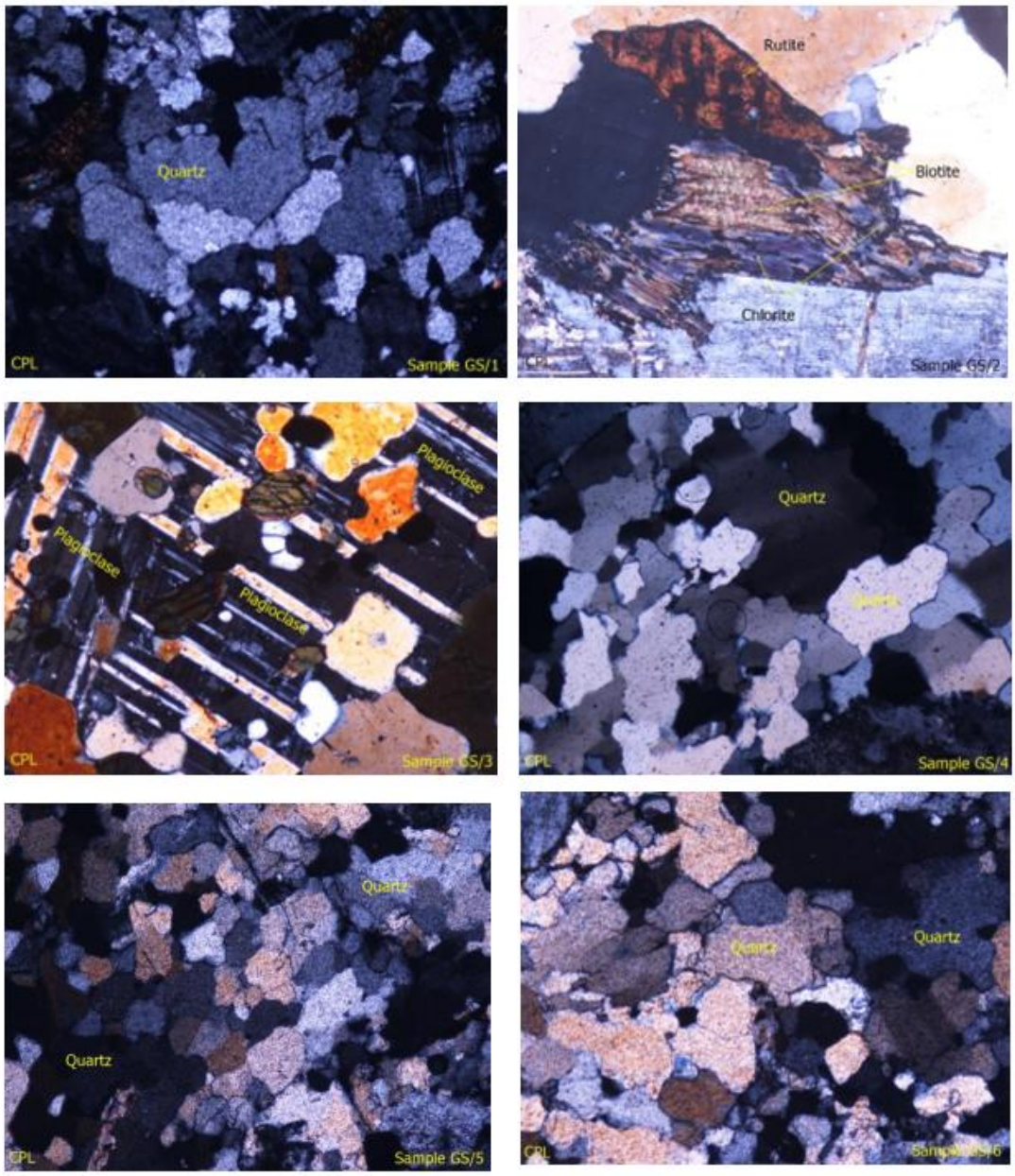
The behaviour of rock mass depends on many factors like geological, lithological, physical, mechanical and environmental factors (Ramamurthy, 1993). Gupta and Rao (2000) studied the deformational behaviour in terms of variation in elastic moduli due to weathering of Malajkhand granite. Basu (2009) evaluated the engineering Characteristics of varying altered granites in relation to their petrology from Brazil. Sausa et al. (2005) investigated the influence of microstructure and porosity on the physio-mechanical properties and alteration of ornamental granite from Portugal. Coggan el al. (2013) investigated the mineralogical controls on the engineering of hydrothermally altered granules under uniaxial Compression. Raisanen (2004) studied the relationship between petrographical and mechanical properties of rock aggregates raw material from hybridized rock of Jalla -Iitti complex of south eastern Finland. He concluded that abundance of fine-grained minerals and micro graphic inter growth texture with interlocking grain boundaries has positive influence on mechanical properties.

Experimental Study:
Granite samples were collected from different locations is discussed below.

1. Jabalpur Takshilla(JT)
2. Jabalpur Madan Mahal (JM)
3. Jabalpur Shobhapur (JS)
4. Jabalpur Vehicle factory estate(JV)
5. Bundelkhand Chhatarpur (BC1)
6. Bundelkhand Chhatarpur (BC2) (Raj Nagar)
7. Balaghat (BG)

Various Laboratory tests were conducted on the selected rock Samples as per ISRM standards.

Microscopic study: Mineralogical and petrological studies were carried out in order to identify the rock forming constituents. Studies pertaining to mineralogy, texture and structure are very much essential. The basic tool for the study of mineralogy and petrology is visual observations of thin sections under microscope. The thin sections of granite rock sample obtained from selected locations were prepared as per standard procedure. The study of these thin sections images are presented in Fig.1. The results are summarized in table 1.



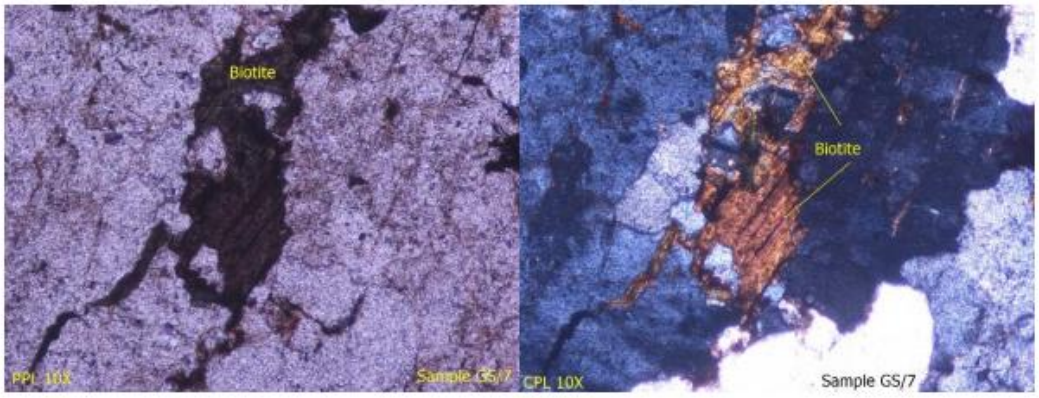


Fig.1 Representative Microstructures of granite samples

Physical properties: The physical properties such as specific gravity, dry and saturated unit weights, porosity, water absorption and p-wave velocity have been determined following the standard procedure of as per ISRM. The results are summarized in table 2.

Strength characteristics: To determine the strength of rock samples Brazilian tensile strength (BTS), point load strength Index (PLSI) diametral & axial and unconfined Compressive strength (UCS) tests were conducted on fully dry as well as saturated specimens. The test results are presented in table- 3.The variation in the physical and strength properties are presented in figure 2 to figure 8.

Table 1 Thin section study

Sample	Minerals Present	Alteration	Distinguished Property
1.	Microcline,Quartz, Biotite	Microcline to Kaolinite and Sericite Biotite altered to chlorite	Cross hatched twinning in Microcline
2.	Microcline, Plasioctase, Biotite, Orthoclase, Quartz, Chlorite	Orthoclase altered to Kaolinite Biotite altered to Chlorite Microcline and Plasioclase partially altered	Cross hatched twinning in Microcline
3.	Hornblende,Plasioclase, Microcline,Quartzand Orthoclase	Orthoclase altered to Kaolinite Plasioclase and Microcline partially altered	Lack of cleavage in Quartz Cross hatched twinning in Microcline
4.	Quartz, Plasioclase, Microcline, Chlorite, Biotite, Orthoclase	Biotite altered to Chlorite Orthoclase altered to Kaolinite	Carlsbad twinning in Orthoclase Cross hatched twinning in Microcline
5.	Quartz, Microcline, Orthoclase ,Plasioclase,	Orthoclase altered to Kaolinite Microcline and Plasioclase partially altered	Carlsbad twinning in Orthoclase Cross hatched twinning in Microcline
6.	Quartz, Microcline, Biotite, Plasioclase, Orthoclase	Biotite altered to Chlorite Orthoclase altered to Kaolinite	Carlsbad twinning in Orthoclase Cross hatched twinning in Microcline
7.	Quartz, Orthoclase, Plasioclase, Microcline, Biotite	Orthoclase altered to Kaolinite Biotite altered to Chlorite	Carlsbad twinning in Orthoclase Cross hatched twinning in Microcline

Table 2 Physical Properties

Sample	Dry Density (Kg/m^3)	Specific Gravity	Water Absorption (%)	Porosity	Vp (Dry)	Vp (saturated)
BG	25.66	2.63	1.49	0.61	3.78	4.0
JT	25.87	2.65	0.58	0.486	3.87	4.22
BC1	26.33	2.69	0.98	0.223	3.98	4.75
JS	26.10	2.67	0.80	0.354	3.92	4.39
JM	26.64	2.72	0.37	0.162	4.27	5.34
BC2	26.22	2.68	0.87	0.269	3.92	4.61
JV	25.74	2.64	0.55	0.543	3.80	4.11

Table 3 Strength Characteristics

Sample	BTS (d)	BTS (s)	PLSI,D (d)	PLSI,D (s)	PLSI (A)d	PLSI (A)s	UCS (d)	UCS (s)
BG	11.2	9.81	11.50	11.10	11.90	11.40	111.70	97.43
JT	12.9	10.9	11.80	11.35	12.30	11.66	124.66	107.26
BC1	14.39	13.3	12.86	12.36	11.59	15.95	148.35	128.26
JS	13.39	12.1	11.96	11.51	13.20	12.89	129.30	116.34
JM	15.1	14.4	13.30	12.90	17.40	17.10	151.86	134.49
BC2	13.64	12.37	12.10	11.70	14.08	13.65	145.31	124.65
JV	12.5	10.36	11.65	11.20	11.91	11.32	121.15	116.3

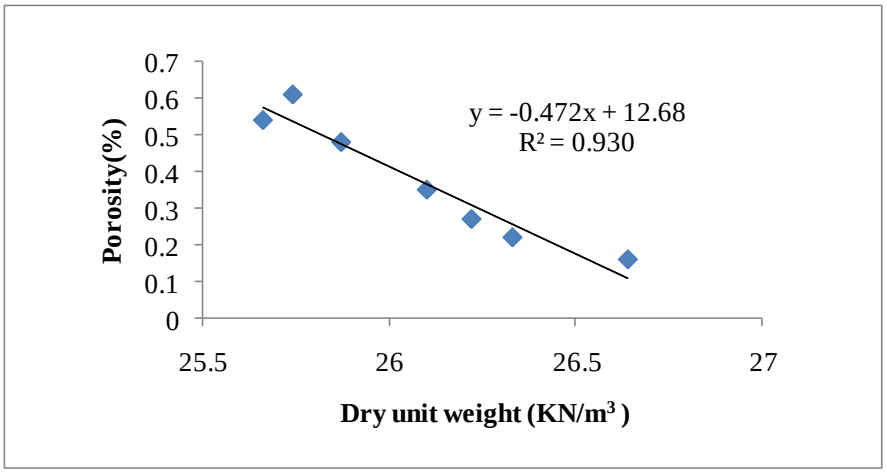


Fig.2 Variation of porosity with dry unit weight

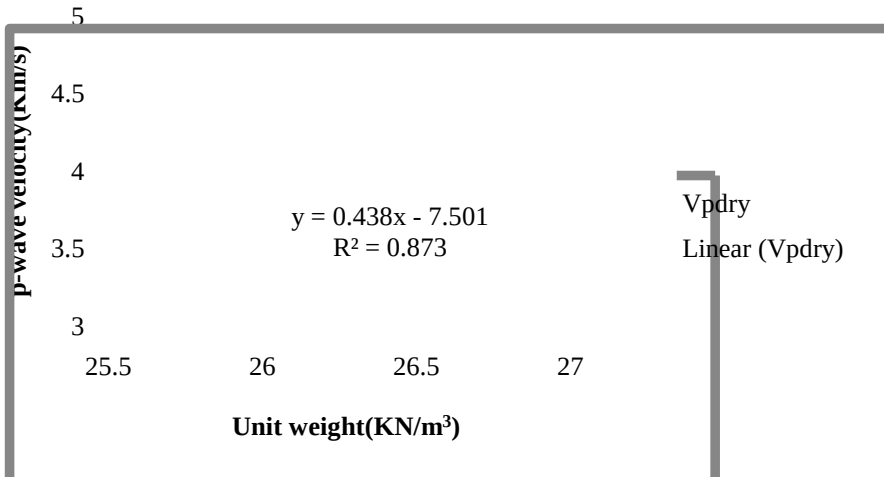


Fig.3 Variation of p-wave velocity with unit weight

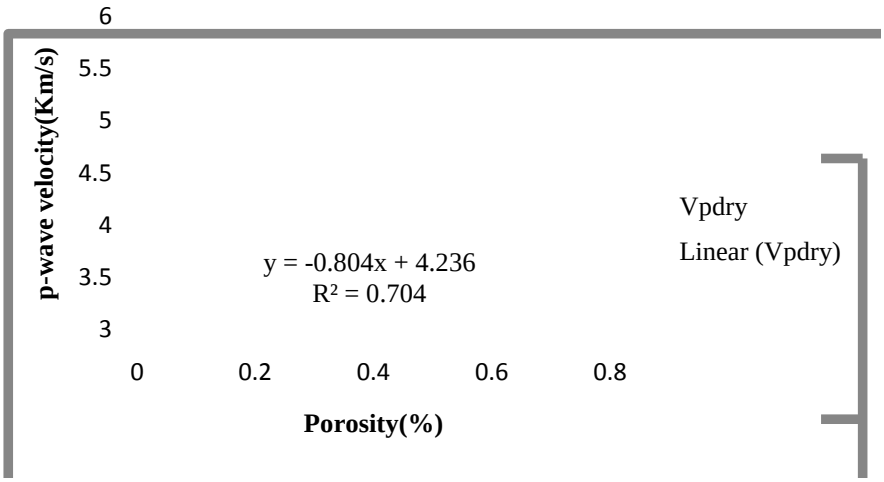


Fig.4 Variation of p-wave velocity with porosity

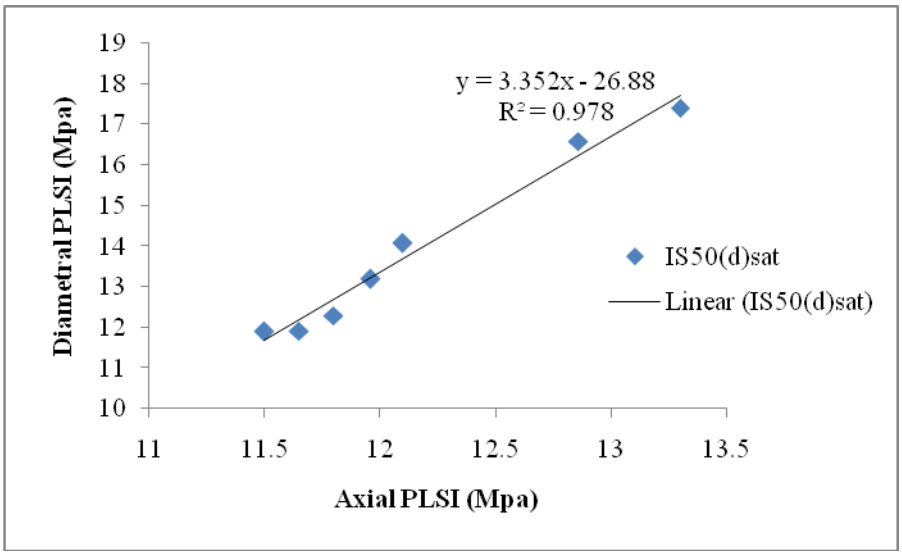


Fig.5 Variation of axial PLSI with diametral PLSI (dry)

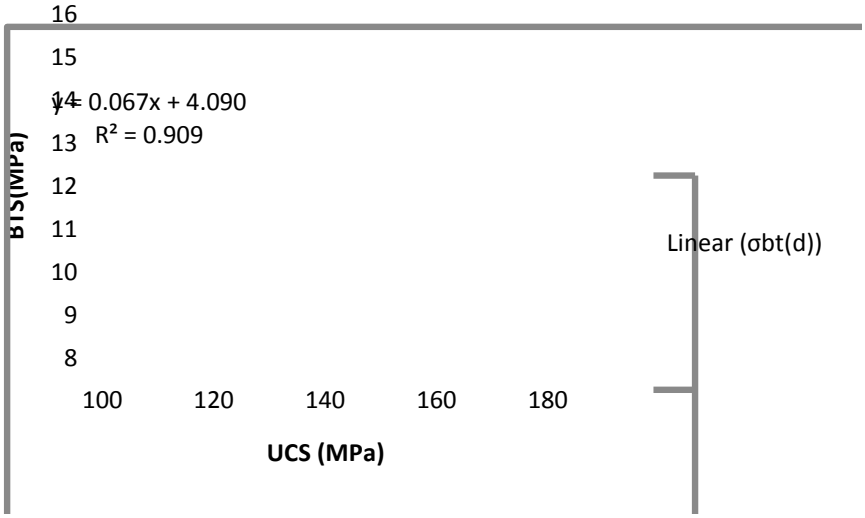


Fig.6 Variation of BTS with UCS (dry)

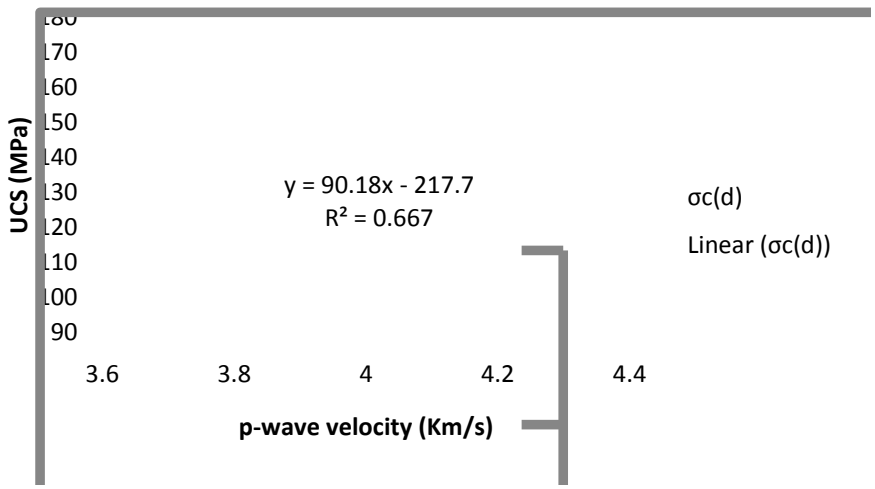


Fig.7 Variation of UCS with P-wave velocity

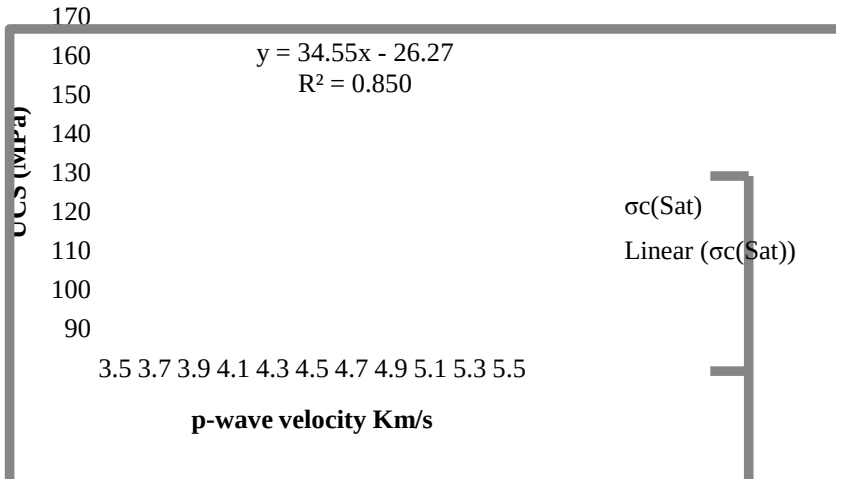


Fig.8 Variation of UCS (sat) with P-wave velocity (sat)

III. CONCLUSION:

- There is significant variation in physical properties and strength characteristics of granite samples obtained from different locations of Mahakaushal and Bundelkhand regions.
- The possible reasons of variation in physical and engineering properties are mineralogical composition, textural variation, alteration and structure.
- Hybridization and assimilation affected the characteristics in mild way.
- There are evidences of two stages of dynamo thermal metamorphism producing twinning, graphic inter growth features. Hybridization of kaolinite with quartz resulted different engineering behaviour of rock samples.
- The correlation among various physical and engineering properties have been developed are shown in Fig.2 to 8.

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