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Physico-Mechanical Properties of Select Granitoid Rocks from a Part of Pandiyan Mobile Belt, India

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Abstract: This study deals with the Physico-mechanical properties of the granites from the Pandiyan mobile belt to identify the suitability of the granite for engineering purposes. The geological characteristics, the mining procedure and mineralogical and engineering properties of the granite samples are estimated through laboratory tests. Based on the results, it is concluded that granitoids of Madurai region is best suited for all the civil engineering works. The granites in Sankarankovil region are more suited as aggregates for road pavements.

Keywords: Granites, Mining, Mineralogy, Engineering properties.

1. Introduction:

Granites are important building materials whose usage very closely depends on their engineering characterization. Some of them are more suitable for road metals, and some are used as aggregates in concrete. Depending upon the strength and other relevant properties, they might also find use as building stones. Hence an attempt is made in this work to characterize the mineralogical and engineering properties of granites available in the southern region of Tamilnadu. Although such studies are reported in the literature [Yaji and Mithanthaya (1996)], there is no recent assessment of granites of southern Tamilnadu.

2. Study Area:

Tamilnadu is enriched with vast resources of granite of different colors and shades. Granites are widely used in constructing compound walls, flooring, Wall cladding, interior and exterior decorations and for monuments. These granites are much in demand in the international market, 'Black of Erode and Salem', 'Peacock Green of Kanyakumari', 'Columbu Juberna ok Karur', 'Raw silk and Kashmir White of Madurai', 'Siva Gold of Sivakasi' and 'Multi colour of Sivagangai' are rocking the International Markets which are exported from Tamilnadu. The major exporters in Tamilnadu are "Tamilnadu minerals" (TAMIN) a Government of Tamilnadu undertaking, "Gem Granites", and "P.R.P Granites" [Reddy (2005)].

Granites from three major districts of southern Tamilnadu are selected for the study viz., Madurai, Virudhunagar and Tirunelveli. Out of a total of 5 samples, 3 are collected from sites in Madurai and 1

each in Virudhunagar and Tirunelveli district as shown in (figure 1). All the samples are not uniform in modal composition even within a single outcrop. And hence the general term "Granitoid" is proposed in the study as the plagioclase composition and the ratio of the alkali to plagioclase feldspars forms the for yardshik granites.

3. Geological Description:

An understanding of geological parameters (such as joints and spacing, dyke, hairline cracks, and color variation) of granites marks the first step before detailed quarrying operations are carried out. Spacing of joints is prevalent in every rock mass, as more the spacing leads to easy and economical quarrying operations (figure 2). Patches of red and brass colors are called "flowers and moles" respectively in stone blocks. Because of the differential hardness of these "flowers and moles", the blocks are liable to be broken at the quarrying stage. They do not take good polish during the final stage. The presence of Dykes affects the quarrying operations particularly in obtaining the big sized blocks. The presence of cracks in the granites do affect quality and commercial value in the market. Further details about geological characteristics are given in Reddy (2010)

A qualitative description of these geological parameters for the different quarries is listed in (Table 2). It can be seen that almost all quarries have sufficient joint spacing. The quarries in Karupaayurani, Thiruthangal and Sankarankovil locations are seen to have color variations. The Dyke is found as a ring pattern in Karupaayurani quarry and as wave in Keelavalavu quarry. The hair line cracks are almost visible in all the

sites visited. The “flowers and moles” are found in Thiruthangal and Karupaayurani quarry.

4. Petrography and Physico-Mechanical Characteristics of Granites:

A Petrographical, mineralogical and engineering properties for the granite samples from different quarries are discussed below:

4.1 Petrography and Mineral Constituents:

Quartz and Feldspar are the essential minerals present in all granites. The percentage of quartz may vary from 20-40. All other minerals, including feldspars may constitute up to 60%. Other accessories include biotite, hornblende, augite, tourmaline, garnet, sphene, zircon etc. The feldspars are more than quartz and generally they are orthoclase, albite and oligoclase. Table 2 gives the mineralogical composition of the samples from different quarries. The sample collected in Karupaayurani quarry has the high Quartz compared to other samples. The Petrographical studies are to determine the colour, structure and texture of the samples collected [Reddy (2005)]. All the samples collected from the sites have an interlocking structure which is desired in granites. Three samples collected in Keeliyur, Sankarankovil and Thiruthangal respectively have a pink base and the sample from Keelavalavu has white base. Brown base is seen for the sample collected in Karupaayurani.

4.3 Engineering properties: Methodology and Results:

The engineering properties of the granitic rocks were determined by a variety of laboratory tests. The specimens were prepared and tested generally in accordance with the procedures given in IS codes (IS 1122-1974, IS 2386-1963, IS 9143-1979). Engineering property studies include specific gravity moisture content, water absorption, porosity, compressive strength and hardness. Three tests trials were carried out for all the tests and for every samples. Standard IS code procedures (Table 1) are followed and their results are presented in Figure 3 and 4. All the samples have water absorption and moisture content less than 0.5% The porosity is also found to be less than 0.25% in all the samples. Thus, all the samples are suited for civil engineering needs. Further, the compressive strength also meets the IS recommendations except sample 4 which is found to have a strength of 89.39 N/mm². For

the same sample, obviously the hardness is also less when compared to granites obtained from other quarries. The quartz percentage is recommended to be within 20 – 40 and all the samples meet the criteria. Moreover, it is also observed that with the increase in percentage of quartz, the compressive strength also increases. Table 3 gives the procedure for determining the engineering properties of granites.

5. Conclusions:

Based on the studies, the following conclusions are arrived at.

1. In all the granite quarries considered in this study, similar procedure is followed for mining operation and polishing. It is seen that Wire saw cutting in huge outcrops enables easy dislodging of rock blocks. The Jockey Machine drilling is found to be essential for developing chunks in mines. Hair line Cracks are found almost in all quarries, whereas dykes occur in Madurai region. Joint spacing is ideal enough in all the quarries.
2. The sample number 4 is collected near Sankarankovil does not meet the IS recommendations on compressive strength for use as building materials. However, this is suitable for construction as road aggregates in pavements.
3. The samples 1, 2 and 3 collected near Madurai and Thiruthangal satisfy the strength and other physical properties as per IS code and are therefore suited for flooring, wall cladding, and in making of monuments.
4. Among all the samples, sample 5 collected in Karupaayurani considered as best for all Civil engineering and architectural purposes.

6. References:

- [1] IS 1122-1974, Methods of tests for Specific Gravity of Natural Building Stones.
- [2] IS 2386-1963, Methods of test for determination Porosity and water absorption IS 9143-1979, procedure for compressive strength.
- [3] Venkat Reddy, D (2005) “Geological aspects in quality assessment and mining of commercial rock deposits of India- a Typical Analysis” Mining Engineers Journal, pp 12-27.
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Figure 1: Map of Study Area

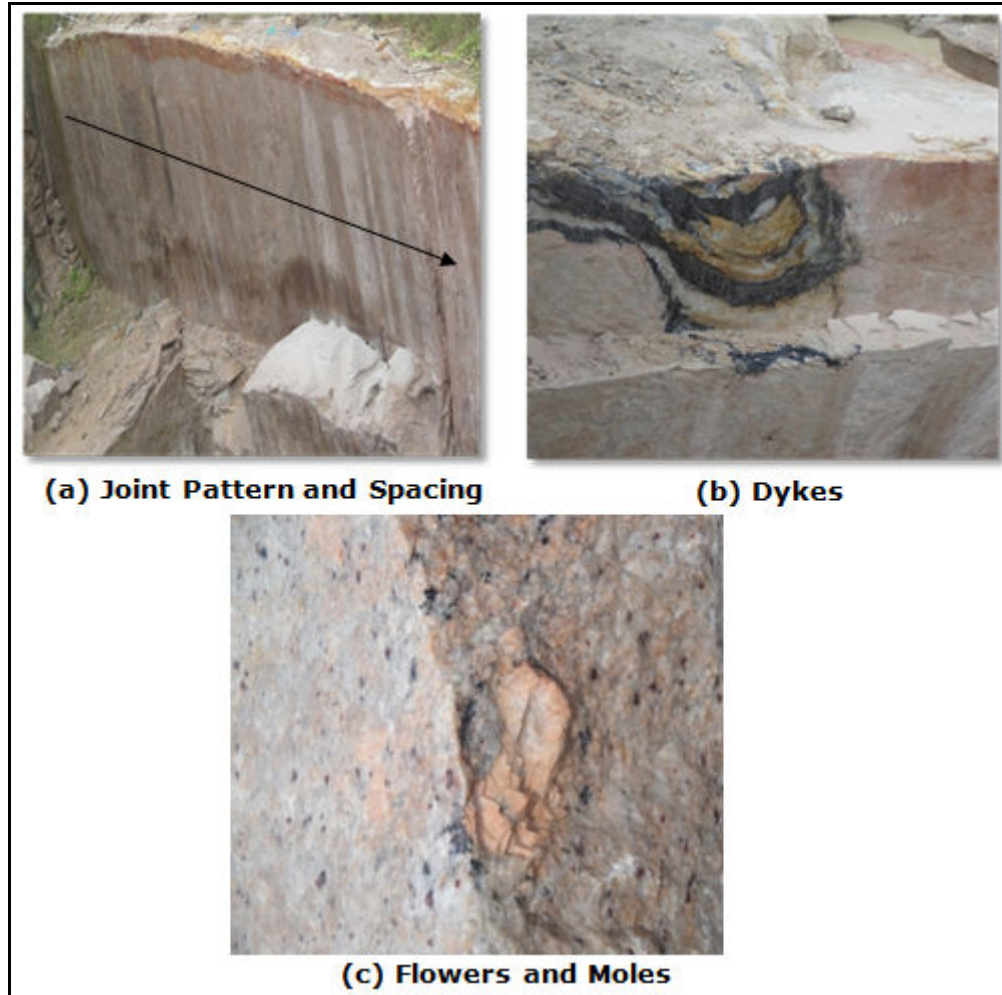


Figure 2: Geological Characteristics of Granites in the Study Area

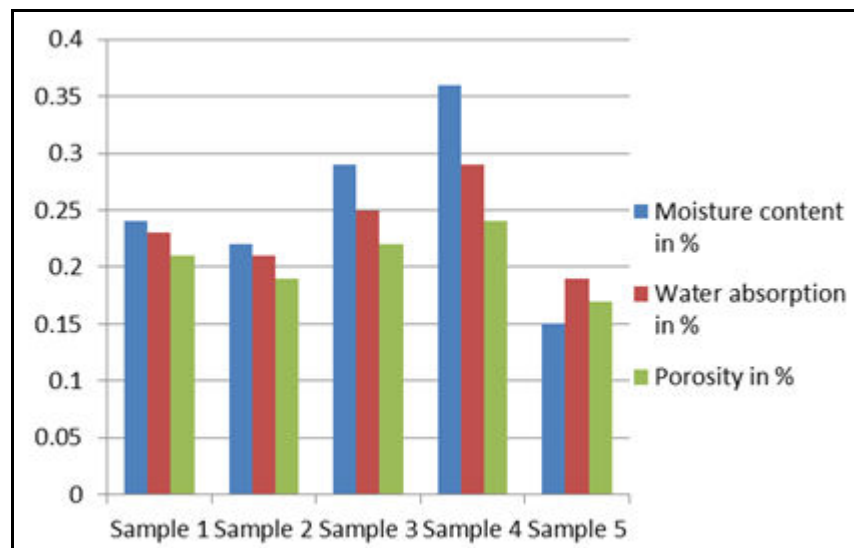


Figure 3: Comparison of Water Absorption, Moisture Content and Porosity

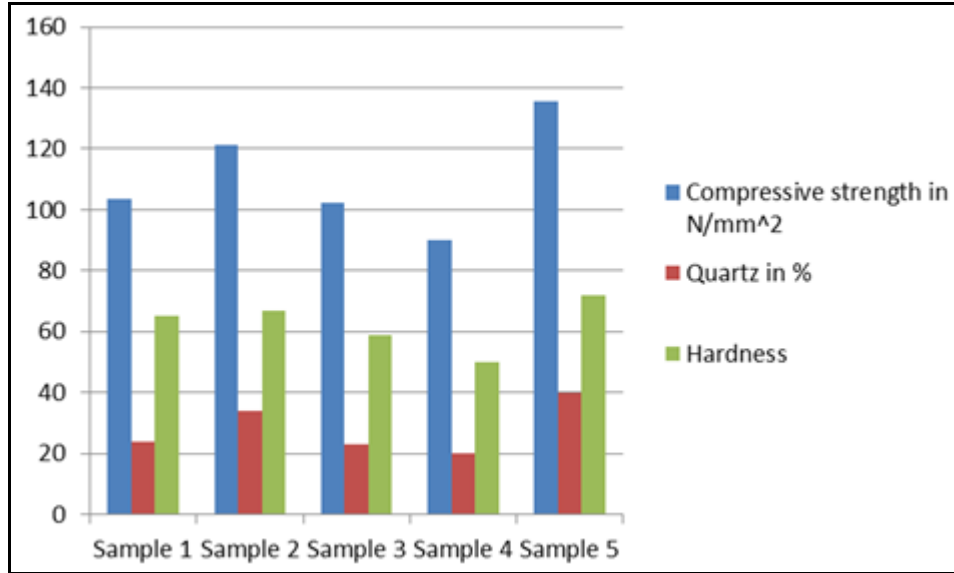


Figure 4: Comparison of Compressive Strength, Hardness and Percentage of Quartz

Table 1: Table for Moisture content, Water Absorption and Porosity

Test / Samples	Moisture content (%)	Water absorption (%)	Porosity (%)
Sample 1	0.24	0.23	0.21
Sample 2	0.22	0.21	0.19
Sample 3	0.29	0.25	0.22
Sample 4	0.36	0.30	0.24
Sample 5	0.15	0.18	0.17

Table 2: Mineral Composition of Granite Samples

Sample No.	Quartz (%)	Feldspar (%)	Biotite (%)	Hornblende (%)	Magnetite (%)	Other Minerals (%)
1	24	60	3	4	3	6
2	34	51	2	4	4	5
3	23	61	2	5	4	5
4	20	61	3	5	5	6
5	40	46	2	4	3	5

Table 3: Procedures Adopted for Determination of Engineering Properties

S.No	Properties	Test Type	Applications
1)	Color and Mineral composition	Visual and microscopic observation	To establish technical name of the rock, to identify micro-fracture and to determine the presence of harmful mineral like pyrite, marcasite etc.
2)	Specific gravity	Laboratory method (IS1122-1974)	To determine the weight of rock for handling.
3)	Porosity and water absorption	Laboratory method (IS2386-1963)	To determine the degree of decomposition of the rock
4)	Hardness	Rockwell Hardness	Useful to assess the quality of various mineral constituents and bond strength that exist between mineral grains of the rock.
5)	Compressive strength	Universal Compressive Testing Machine	This is the strength of the rock under confined conditions. Useful to select rock suitable for various purposes.