Experimental Investigation on the Physio Mechanical Properties of the Rock Samples

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Abstract: In rock mechanics, the major thrust giving by the constructional engineers in the strength properties of the rock mass on which construction is taking place. For instance, in the granite industry, many geological disasters happened due to the misunderstanding of rock mechanical and physical properties. In this research an experimental investigation has been performed to study the rock samples physio mechanical properties. The sample was collected from the granite query and it was found that the samples have high durability and good tensile strength. Further, this paper will help for deigning a safe & secure slope, and for the geological construction in any open cast mines or queries.

Keywords: *Rock mechanics, Physio property, Mechanical property, query.*

I. INTRODUCTION

Rocks are the constitutes of one or more minerals. Minerals are may be pure, solid, inorganic materials which found in Earth's crust. The performance of rock, under the particular conditions depends upon the physical and mechanical properties of the rock samples. The physical properties of the rock are called as the index properties which describe the rock samples and help them in classifying them [1]. The mechanical properties are also called as the strength properties and they gave the information about the performance of rock material when it's subjected to a particular loading system. The knowledge of the Physio mechanical properties of the rock samples is very vital parameter for deigning a safe slope, and for the geological construction in open cast mines [2]. Since, the rock mass is being a structural type material therefore the need of a well-developed method for testing the rock physical and mechanical properties are the prime concern in today's research environment. The lack of homogeneity, presence of inherent, induced micro and mini-fractures and other unaccountable flaws in the rock samples introduce additional problems in the determination of rock properties [3]. In the case, of mining scenario many disasters happen due to the mis-concept of rock mechanical properties [4]. The failure of rock slope is a most popular disaster can be observed in any open cast mines [5]. The slope of an open cast mines primarily depends on the mechanical properties of the rock. The physical properties of rock consist of density, porosity, and permeability, etc. and the mechanical properties mainly include elastic modulus, Poisson's ratio, and rock strength. These parameters can be obtained by lab experiments of core samples or by in-situ tests [6]. In this paper an attempt has been made to investigate the physical and mechanical properties of the collected rock samples under the laboratory condition. Apart from the introduction section in this paper consists of four different sections. The second section of this paper gives the information about the sample preparation, which is followed by the experimental investigation. The last section of this paper deals the conclusions part of the paper.

II. SAMPLE PREPARATION

For conducting the experimental studies on rock samples in the laboratory, a sample preparation is the most important part of this experiment. The samples are prepared as per the recommended of International Standards of Rock Mechanics which is used regular testing of the rock samples. The samples were collected from the site which are situated at the location of 17°39'23.1''N and 79°46'32.28''E in Warangal district of Telangana state. Samples were taken in massive form, but for the experimental simplicity the sample made in a cylindrical form, i.e., NX bore size 54mm dia having the length two times of dia. The samples were crushed and taken as powder or grains form. Afterwards, it is mixed with cement and water for conducting the tests on it. The mixture of sample powder and cement consists of the ratio of 75:25. Thereafter, these mixed sample was filled into hallo cylindrical pipe of 54 mm diameter and length 108mm. The mixed sample material filled into cylindrical pipe with stemming tightly in order to avoid gaps. The sample preparation is presented in the Figure 1.

(a) sample after crushing

(b) Powder form of the crushed sample

(c) Insertion of crushed material in hollow cylinder

(d) Photographic view of the prepared samples

Fig.1 Various stages of sample preparation

III. EXPERIMENTAL INVESTIGATION OF ROCK SAMPLES

The experimental investigation for the field collected sample has been performed in the laboratory. In the laboratory, four types of rock testing method were considered for the determination of its physio mechanical properties. The four tests which are performed in the laboratory are, slake durability, point load index, tensile test and uniaxial compressive test.

Slake Durability Test

For assessing the effect of weathering on rock samples the slake-durability test is treated as simple test. However, after passing of many scientific advancement years still the complete understanding of this test is not clear. Basically, the mechanisms of movements of the rock samples which are placed inside the apparatus are known but its effect on weathering is still unknown. For rocks containing clay materials, the exchange of cautions and anions take place with the adsorption and absorption of water which makes the rock swell in size and slaking occurs. With the duration of the test of only ten minutes, the wetting process may only take for parts of the rock, particularly for the surface part but due to appropriate rotation speed and the level of the water most of the parts of the rocks get wet. Figure 2 represents the photographic view of the slake durability test apparatus on which the test was performed.

Fig. 2 Slake durability testing machine

The slake-durability test was conducted to assess the resistance offered by a rock sample to weakening and disintegration when subjected to two standard cycles of drying and wetting. In this test, the samples were put into the apparatus that comprises two sets of drums having length of 100 mm and the diameter of 140 mm. The two drums rotated in water that had a level of about 20 mm below the drum axis. The rotation was driven by a motor capable of rotating the drums at a speed of 20 rpm, which was held constant for a period of 10 minutes. Ten rock lumps, each had a mass of 40-60 g, were placed in the drums. After slaking for the period of 10 minutes, these rock samples were then dried in an oven at a temperature of 105 degree centigrade for up to 6 hrs. Finally, the mass of dried samples was weighted to obtain the first cycle. The test was conducted over two cycles, in which the weight of particles of 10 rock lumps retained in these wet-dry cycling tests was therefore determined. The results obtained in this test is tabulated in Table 3.1.

Table 3.1: Slake durability test tables for granite sample

Sl .No	Initial Weight (A)	Weight After 1st cycle (B)	Weight After 2nd cycle(C)	%Retained After 1st cycle	%Retained After 2nd cycle
1.	500	497	494	97.2	95.4
2.	502	500	496	98.1	96.5
3.	499	496	494	97.2	96.2

As depicted in Table 3.1. the average of the retention percentages after the first cycle and the second cycle, the values of retention after the first cycle was found to be 98.5%, while the value after second cycle was found to be 96.03%. As per the Gamble's table of classification (which is a standard table for the slake durability test) the tested rock samples were found to be high durable in nature.

Point load Index

The point loading means the load acts in a particular point on both directions. This testing is used to determine rock strength index in geotechnical practice to estimate uni- axial compressive strength index. The point load strength index test was carried out with rock samples. The determination of point load strength index gives the information about the failure strength of the rock samples and also reflects about the compressive strength of the rocks. The four samples were prepared from the field collected samples during test. In these test loads is applied diametrically on the specimen. The load is gradually increased till the specimen fails then the corresponding load at the point of failure is noted and the Point Load Strength Index was calculated. The schematic diagram of the point load test is presented in Figure 3. For point load test, the standard strength average value for each type of rock was calculated. On the Table 3.2 results are presented for cylinder samples for each rock type under study. The graphical representation of the failure load with the diameter of the sample is presented in Figure 4.

Fig. 3 Point load test for rock sample

Table 3.2: Results obtained from the point load test

Si.No	Diameter (m)	Rapture load (P)	P/d^2
1.	0.054	20.1	6.93
2.	0.059	21.2	6.23
3.	0.062	20.8	5.47
4.	0.07	21.6	4.408

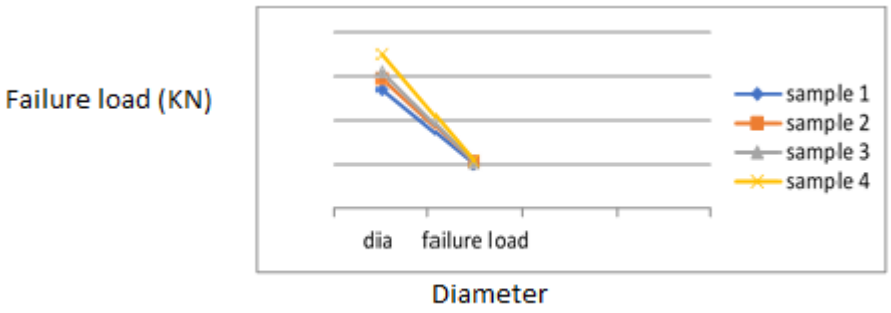

Fig. 4 Graphical representation of rock failure with diameter of samples for point load test

Tensile strength test

The tensile strength of rock can be obtained from Brazilian test loading frame with 100 kN capacity, having a base and a cross head joined together with the two solid pillars with nuts. At the top, the pillars have long threads for height adjustment and on the base, a 100 kN hydraulic jack is centrally fixed between the pillars. This jack has an integral pumping unit and oil reservoir. A 100 kN capacity pressure gauge is fixed to the jack for indicating the load on the specimen and also an operating handle is provided with the jack.

The test was performed by placing the sample specimen in the device so that it is centered on the bottom punch. To make the upper punch contact the loading device carefully adjusted and it was made sure that the deformation indicator should calibrated zero reading. Thereafter, the load is applied slowly to produce axial strain at a rate of 1/2 to 2 per cent per minute and record load and deformation values every 30 seconds. The continue loading until the load values decrease with increasing strain, or until 20 per cent strain is reached. The same procedure was adopted for the other test specimens. The photographic presentation of tensile test is shown in Figure 5. The obtained experimental results of the granite rock samples are tabulated in Table 3.3. The graphical representation of the failure load with the diameter of the sample is presented in Figure 6.

Fig. 5 Testing the rock sample with tensile test

Table 3.3: Results obtained from the tensile test

SI.No	Length (mm)	Diameter (mm)	Load at failure (P) KN	2P/dt
1.	108	54	28.2	9.72
2.	112	56	30	9.67
3.	118	59	31	8.98
4.	124	62	32.5	8.55

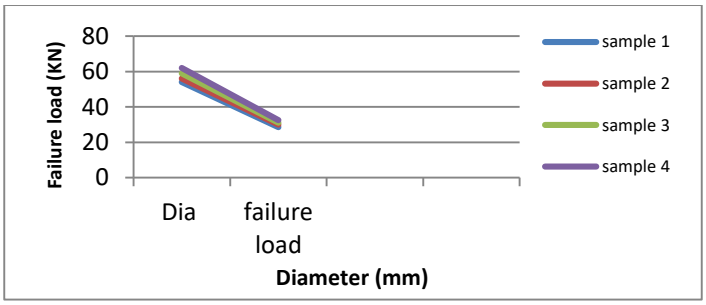

Fig. 6 Graphical representation of rock failure with diameter of samples for tensile test

Uni axial compressive strength test

The cylindrical specimen of rock, which was loaded axially between platens in a testing machine, was used for the determination of compressive strength. In uniaxial compressive strength test, the cylindrical specimens were subjected to major principal stress till the specimen fails due to shearing along a critical plane of failure. In this test the samples were fixed to cylindrical in shape, length 2 times the diameter, ends maintained flat within 0.02mm. The prepared specimens were put in between the two steel plates of the testing machine and load applied at the predetermined rate along the axis of the sample till the sample fails. When a brittle failure occurs, the proving ring dial indicates a definite maximum load which drops rapidly with the further increase of strain. The applied load at the point of failure was noted. The load is divided by the bearing surface of the specimen which gives the Uniaxial compressive strength of the specimen as shown in Figure 7. The obtained experimental results of the UCS test of granite rock samples are depicted in Table 3.4. The graphical representation of the failure load with the diameter of the sample is presented in Figure 8.

Fig 7: A sample under UCS test

Table 3.3: Results obtained from the UCS test

SI.No	Length (mm)	Diameter (mm)	Cross sectional area (A)	Load at failure (P) KN	P/A
1.	100	50	0.0019	949	49.94
2.	104	52	0.0021	950	45.23
3.	98	49	0.0018	954	53.0
4.	108	54	0.0022	956	43.45

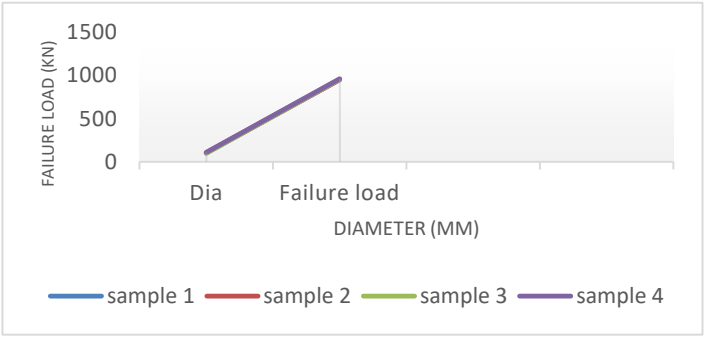

Fig. 8 Graphical representation of rock failure with diameter of samples for UCS test

IV. CONCLUSIONS

When the rock is being used for engineering structures then it may be used as the construction will be made on it and may be used as the material with which construction is made. The knowledge of rock physical and mechanical properties are very much essential in order to design the safe and good construction work. The aim of this research is to investigate the rock physical and mechanical properties by four different laboratories methods, such as slack durability, point load, tensile and uniaxial compressive strength. For each test, the profile of failure load with sample diameter was illustrated and discussed in the paper. The performed test showed that a high durability for the collected granite samples. Based on the tensile, point and uniaxial test, the hardness of the samples were examined which can give the information of using suitable drill machine at the work particular type of granite in the field. This information will also helps in designing any granite mines while its opening phase.

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