Study on the Strength and Deformation Characteristics of Rock Mass

S.Aravindan[1] , DS.Vijayan[2], K.Ilayaraja[3]

Department of Civil Engineering, Bharath University, Selaiyur, Chennai, Tamilnadu, India.

ABSTRACT

This paper deals with the statistical analysis of the compressive strength and of the elastic modulus of jointed rock masses under different confining pressures. Properties of the rock masses with different joint fabric, with and without gouge have been considered in the analysis. A large amount of experimental data of jointed rock masses from the literature has been compiled and used for this statistical analysis. The compressive strength of a rock mass has been represented in a non-dimensional form as the ratio of the compressive strength of the jointed rock to the intact rock. In the elastic modulus, the ratio of elastic modulus of jointed rock to that of intact rock at different confining pressures is used in the analysis. The effect of the joints in the rock mass is taken into account by a joint factor. The joint factor is defined as a function of joint frequency, joint orientation, and joint strength. Several empirical relationships between the strength and deformation properties of jointed rock and the joint factor have been arrived at via statistical analysis of the experimental data.

A comparative study of these relationships is presented. The effect of confining pressure on the elastic modulus of the jointed rock mass is also considered in the analysis. These empirical relationships are incorporated in a nonlinear FEM code to carry out the equivalent continuum analysis of jointed rock masses. The method presented in this paper recognizes that the jointed rock mass will act both as an elastic material and a discontinuous mass. The results obtained by the model with equivalent properties of the rock mass predict fairly well the behavior of
Rock mass

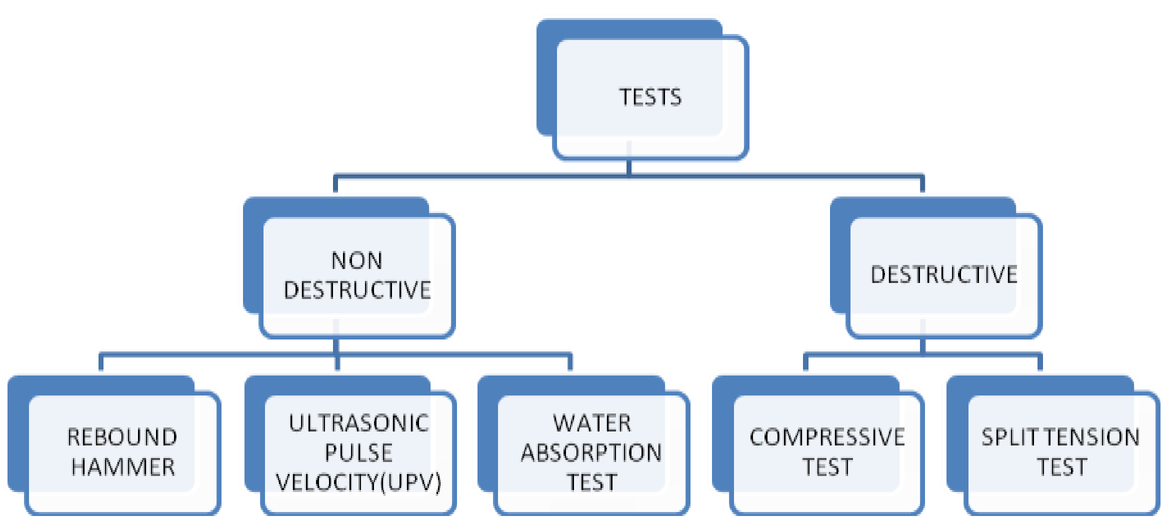
I. Introduction

Rock is a discontinuous medium with fissures, fractures, joints, bedding planes and faults. These discontinuities may exist with or without gouge material. The strength of rock masses depends on the behavior of these discontinuities or planes of weakness. The frequency of joints, their orientation with respect to the engineering structure, and the roughness of the joint have a significant importance from the stability point of the view. Reliable characterizations of the strength and deformation behavior of jointed rocks are very important for safe design of civil structures such as arch dams, bridge piers and tunnels.

II. Materials

The rock mass is collected from Pallavaram, and is found to be a igneous rock. The scientific name of rock is charckonite. The intact rock mass is cored to the shape of cylinder. The dimension of the specimen is 150x75mm (height x diameter). Laboratory test were performed on cylindrical specimens. Ultrasonic measurement of compression pulse velocity(UPV), compressive strength (UCS), dry unit weight(DUW), and saturated unit weight sets of rock specimen is determined

III. METHODOLOGY



IV. Experimental set up

By definition, the ultimate compressive strength of a material is that value of compressive strength reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is the same as that used in a tensile test. However, rather than applying a tensile load, a compressive load is applied. As can be imagined, the specimen (usually cylindrical) is shortened as well as spread laterally.

Fig 1.compression test

Fig 2.split tension test

Tensile testing, also known as tension testing, is a fundamental test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength maximum elongation and reduction in area

Fig 3.ultrasonic pulse velocity

Ultrasonic Pulse Velocity tests are performed to assess the condition of structural Members with two-sided access such as elevated slabs, beams, and columns. Voids, Honeycomb, cracks, delimitation, and other damage in, wood, masonry, Stone, ceramics, and metal materials can be identified and mapped with the method. UPV tests are also performed to predict strength of early age concrete. The UPV test relies on direct arrival of compression waves. Sources and receivers used in the tests have resonant frequencies ranging from 50 to 150 kHz.

This test method covers the testing apparatus, sampling, test specimen preparation, and testing procedures for determining the rebound hardness number of rock material using aspiring driven steel hammer, referred to variously as a rebound hammer, impact test hammer, or concrete test hammer. This test method is best suited for rock material with compressive strengths (see Test Method D 2938) ranging between approximately 1 and 100 MPa.

Fig 4. rebound hammer

Water absorption test gives an idea about the strength of the rock mass. Rocks having more water absorption are more porous in nature and are generally considered unsuitable unless they are found acceptable based on strength impact and hardness test. The specimen is washed thoroughly to remove fines, drained and then placed in a wire basket and immersed in water at a temperature for about 22^0 to 32^0 c and with a cover of at least 5 cm of water above the top of the basket. Immediately after immersion the entrapped air is removed from the sample by lifting the basket containing it above 25 mm above the base of the tank and allowing it to drop 25 times at the rate of above one drop per second. The basket and the sample specimen should remain immersed in water for a period of 24 hours.

Fig 5. oven

S.NO	SPECIMEN SIZE IN mm	SPECIMEN WEIGHT (Kg)	COMPRESSIVE STRENGTH (N/mm^2)	TENSILE STRENGTH (N/mm^2)	REBOUND NO	UPV in mm/sec
1	150 x 75	2.009	36,000	17.217	54	4838
2	150 x75	2.004	45,000	16.663	42	4068
3	150 x75	2.067	42,000	14.441	46	4225
4	150 x75	2.087	32,000	16.107	54	4740
5	150 x75	2.058	26,000	16.663	54	4850
6	150 x75	2.036	38,000	17.773	50	3304
7	150 x75	2.048	35,000	17.217	54	3670
8	150 x75	2.008	40,000	16.107	54	3770
9	150 x75	2.003	34,000	14.996	54	4775
10	150 x75	2.056	39,000	16.107	42	3479
11	150 x75	2.067	29,000	16.663	50	3686
12	150 x75	2.049	30,000	14.441	54	3068
13	150 x75	2.058	44,000	14.996	46	4164
14	150 x75	2.060	34,000	16.663	54	4854
15	150 x75	2.079	37,000	18.329	54	3986

Table 1: Summary of Test Results

V. Results And Discussions

The objective of the study was to determine the dynamic engineering properties as well as the geotechnical and mechanical properties of charnockite rock. Hence rocks can be used for construction in the pavements, parking areas, rock ornaments and in the platforms

VI. Conclusions

The objective of the study was to determine the dynamic engineering properties as well as the geotechnical and mechanical properties of charnockite rock. Hence rocks can be used for construction in the pavements, parking areas, rock ornaments and in the platforms.

References

1. ASTM (2008), ASTM D4543-08, standard practices for preparing rock core as cylindrical test specimen and verifying conformance to dimensional and shape tolerance.
2. ASTM (2010), ASTM D7012-10, standard test method for compressive Strength and elastic modules of intact rock core specimens under varying status of stress and temperatures.
3. ASTM (2008), D5731-08, standard test method for the determination of the point load strength index of rock and application to rock strength classification.
4. ASTM (2002), D3148 standard test method for elastic modules of intact rock core specimen in uniaxial compression.
5. HOEK, E. and BROWN, E.T. (1980), Empirical strength criterion for rock masses, J.Geotech. Eng. Div. 106(GT9), 1013-1035.
6. KAHRAMAN, S. (2001), evaluation for simple method for assessing the uniaxial compressive strength of rock, international journal of rock mechanics and mining sciences, 38, 981-994.