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TO STUDY THE INDIRECT TENSILE STRENGTH OF MARBLE STONE DISC

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Abstract - A study has been made to determine the tensile strength of white marble by ring test. Generally there are several methods to find the tensile strength of rock such as Brazilian test, hoop test, uniaxial tension, bending test, hydraulic extension test and Ring test. Among them, the most commonly used test is Brazilian test and Ring test because of direct measurement of tensile strength are difficult because of gripping system or the use of cement at the test specimen ends can generate unwanted stress concentrations and create premature failure. In the Brazilian test, to measure the tensile strength by developing tension across the diameter of a rock disc, this is subjected to compression through a vertical load. Because the tensile strength of rock is between one quarter and one tenth of the compressive strength, the tensile stress being developed horizontally as a result of vertical compressive stress should be enough to cause tensile failure before failure in compression can occur. For ring test, homogeneous and isotropic white marble stone discs with concentric holes is placed in a compression testing machine and loaded at constant rate. Necessary precautions were observed so that the load on the sample was not eccentric. A series of tests were performed using constant rate of deformation.

The rate of deformation was so chosen that the time for conducting was neither too nor it was less so as to fail the discs suddenly making it difficult to record the reading at failure. A number of tests were performed. For each dia of sample, varying sizes of central hole were used. The effects of inner diameter/ outer diameter ratio (r_1/r_o) on tensile strength from ring test were also studied. It was observed that as the ratio (r_1/r_o) increases, the tensile strength of stone decreases. Some other parameters like as rock type and composition, rock grain size, rock weathering, rock density and porosity, rate of loading, confining stresses σ_1 and σ_3 , geometry, size and shape of the test specimens, water pore pressure and saturation will also affect the tensile strength of rock mass.

Keywords- Stone sample, Brazilian test, Direct tensile test, Ring test

1.INTRODUCTION

The tensile strength is plays a main role in the design of underground openings, optimum roof spans and in the designing of bolting and other roof support systems. Additionally laboratory studies carried out to conclude compressive strength of rock often specify that although the test sample was headed in compression, failure truly followed as a result of tensile stresses, i.e. specimen normally fails when tensile stress predominate and exceed tensile strength. The observations would strongly suggest that the tensile strength also be more meaningful parameter for design than compressive strength. So the tensile strength must be evaluated more carefully.

In the present study attempt was made to study the indirect tensile strength of marble stone ring shaped sample having inner holes of varying diameter and thickness of sample is also varied. The rock mass are also subjected to tensile stresses when located in a slope when it is under the foundation of a dam in an abutment. Rocks have a high compressive strength than other natural substance used for construction.

1.1 PRESENT STATE OF KNOWLEDGE

Tensile strength of rock materials can be obtained from different types of tensile tests: direct tensile test, Brazilian test and flexure test. The most logical method to determine the tensile strength is the direct or straight pull test. But

testing of strength of rock by direct tensile test or any conventional method is trouble-some since the production of test specimen take a large amount time and efforts. Presence of cracks and other discontinuities in rock sample may often make it difficult to prepare the sample of desired geometric shape. So the direct test is not commonly done due to the difficulty in sample preparation.

When a major project likes dam or construction of tunnels is made on rock masses, generally drilling is done to get samples for testing for various properties. In this rock is available in core form which can be converted to different shapes and sizes in laboratory. The tests like Brazilian test and ring tests have been tried. These methods are indirect methods of determining tensile strength of rock. In ring test, a disc is made with central hole and then subjected to diametrical compression. The tensile strength obtained from these tests depending upon various factors like as thickness of sample, diameter of sample, ratio of diameter of central hole to outer diameter of disc specimen etc. For design purpose, a particular value is used. So it is of great use to know about the variations of tensile strength of a particular rock. In this study, an attempt has been made to evaluate the mode of variation of tensile strength of particular homogeneous rock viz. White marble stone.

1.2 PROBLEM AND OBJECTIVE

To achieve the above objectives to study the indirect tensile strength of white marble stone ring shaped sample having inner holes of varying diameter and thickness of sample is also varied

1.3 SCOPE OF WORK

The strength characteristics depend upon temperature, confining pressure and rate of loading. Deformation behavior of ring test specimen can be studied . For design purpose, a particular value is used. So it is of great use to know about the variations of tensile strength of a particular rock.

Table-1: Physical Properties of white marble stone

Hardness	3 to 4 on Mohr's Scale
Density	2.5 to 2.65 Kg/m^3
Compressive Strength	1800 to 2100 Kg/cm^2
Water Absorption	Less than 1%
Porosity	Quite low
Weather Impact	Resistant

2 METHODLOGY

The White marble stone is extracted in large pieces, by methods of large scale blasting and collection will not work. Then large team of workers with a series of large, specialized equipment and products as high capacity extractors, cranes, tamb rock machines and chemicals slowly dig around the slabs of granite to break them free then they are pulled the rock masses in the truck capable of carrying heavy loads or are processed on site depending on the mine..

2.1 Preparation of rock Cubes

The cutting of sample is done slowly because during sampling, there should not form any crack or micro-crack which should affects the test result while testing the sample. Water was admitted freely act as coolant for diamond cut off saw, so that the cutting chips flows away from the job. Water cools help the cut-off saw and smooth cutting is carried out. The length, width and thickness of specimen were kept constant of sample.

2.2 Preparation of rock cores

Water is necessary freely through the swivel in the core barrel to clear the cuttings and act as a coolant for the bit. Care is taken while extracting ring specimen.

2.3 Cutting and Finishing of rock Cores

The core as obtained was given a final finish on circular surface with the diamond cut- off saw. The water was used as coolant. The flat end surfaces of sample were ground. The thickness of samples in general was on inch for ring test. Any irregularities across the thickness of specimen did not exceed 0.1 cm.

2.4 Drilling of central hole

The samples for ring test were drilled using diamond core drill bit (manufacturer named: - P/M tools & Abrasives).. The water was used as a coolant. By this drilling bit varying sizes of central hole varies from 0 cm to 5 cm named P Series, Q series and R series is extracted. Before making a central hole a central point is marked in every test sample so that the position of central hole should not change. This may be affecting the whole sample and test result. Drilling process is slowly carried out for minimizing the error in test specimen. The test samples are shown in appendix.

2.5 Drying of samples

For drying the sample, the samples were kept in a drying oven at standard temperature of 60^{o}c for 48 hours. As the temperature is low, it did not affect properties of rock. Then samples are taken out for testing purpose.

2.6 Testing Procedure

The cylindrical test sample with a central hole was placed horizontally between the steel plates as line loading in a Compression testing machine was loaded at constant rate. The precautions were observed so that the load on the samples was not eccentric so that load was measured with the help of a proving ring. The series of tests were performed using constant rate of deformation. The rate of deformation was so chosen that the time for conducting was neither too nor it was too less so as to fail the discs suddenly making it difficult to record the reading at failure point.

3. RESULTS AND DISCUSSION

Issues related to study of marble stone ring samples have been considered and addressed in preceding chapters. The consideration of these discussions and conclusions require further general discussion, which are vital to assess the present study and envisage the areas for future study. This chapter is divided into different sections based on the issues addressed earlier.

From the table -2 average tensile strength (σ_t) is obtained by conducting ring test by varying inner to outer diameter ratio (R= d/D). A sample of series P having outer diameter of 12cm with a inner diameter of the central holes are 0 cm,1.6 cm, 3.3cm,5cm undergoes failure load from 32.41 KN to 3.41 KN (Compressive Loading).The result of P Series shows that the value of R increases, the tensile strength of the specimen decreases and the obtained results are similar to the results published by Hobbs (1965).

The ring test, it observed that the type of failure of disc is similar to that shown by Hobbs (1965)

TABLE-2: Ring Test Result Of P-Series

	Sample	Dia of 'D' in cm	Dia of hole 'd' in cm	R=d/D	Thickness in cm'	Failure load F in KN	Weight of sample kg	Tensile strength
Q-SERIES	S5	12	0	0	1.5	32.41	0.454	104.9368365
	S6	12	1.6	0.133	1.5	23.81	0.45	77.0918259
	S7	12	3.3	0.27	1.5	11.41	0.422	36.94320594
	S8	12	5	0.41	1.5	3.41	0.372	11.04087049

There is two series of sample P series and Q series.In P series the external diameter is 12cm but in Q series the external diameter is 11cm but P series thickness 1.5cm and Q series thickness 2cm.Four sample in P and Q series and every sample have different radius.The tensile strength decreases as increases the radius of sample. The tensile strength of

sample depend upon internal or external diameter of the sample.

TABLE-3: Ring Test Result Of Q-Series

	Sample	Dia of sample 'D' in cm	Dia of hole 'd' in cm	R= d/D	Thickness of the sample 't in cm'	Failure load F in KN	Weight of sample kg	Tensile strength
Q-SERIES	S9	11	0	0	2	34.6	0.578	158.2744644
	S10	11	1.6	0.145	2	26.41	0.534	120.8100753
	S11	11	3.3	0.3	2	14.6	0.506	66.78633468
	S12	11	5	0.45	2	8.4	0.46	38.42501448

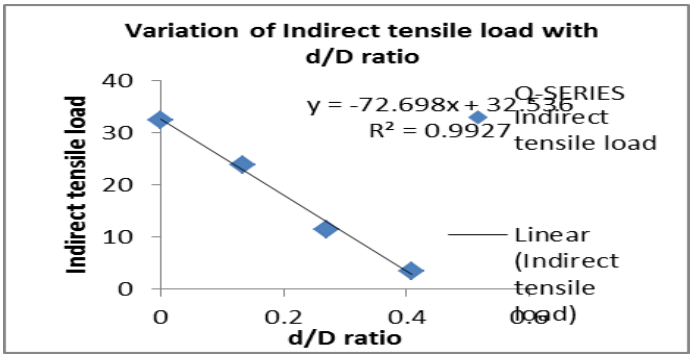


Chart-1: Ring Test graph for P- Series

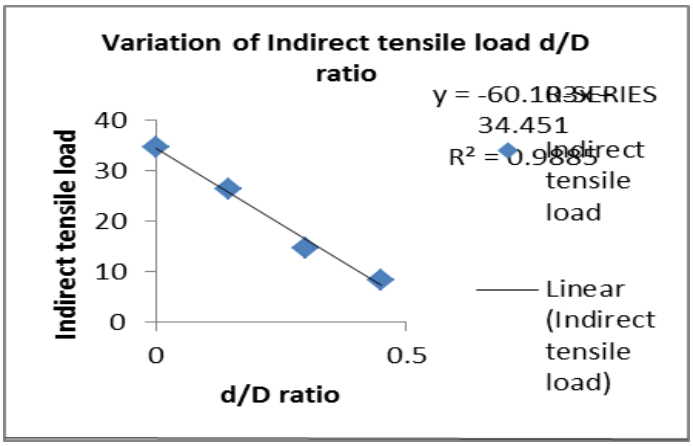
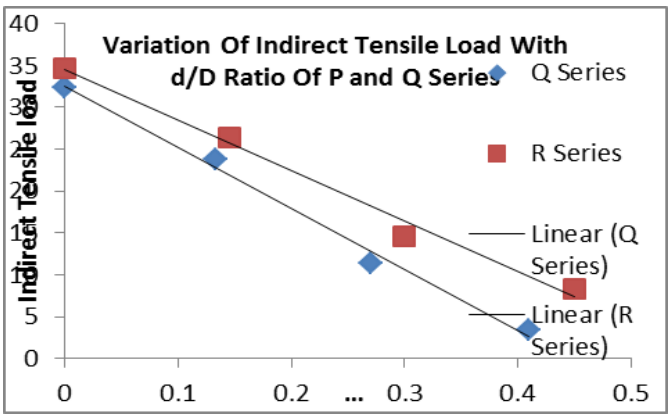


Chart-2: Ring Test graph for Q- Series



Chart–3 Ring Test Combined Graph for P and Q Series

COMPARISON GRAPH

The P series and Q series graph shows the tensile strength of white marble stone. Comparison of graph of P and Q series of tensile strength of marble stone with different thickness. From the table-2,3 shows the tensile strength. The tensile strength of the sample depend upon the thickness of the sample and the internal or external diameter of the sample.

4. CONCLUSIONS

1 The tensile strength of sample decreases when inner diameter of sample increases, due to the decrease of total volume of test specimen; the sample fails at lesser tensile stress.

2 Increase in inner diameter of ring sample causes to decrease in tensile strength of white marble stone specimen.

3 Ratio R (inner dia/outer dia) versus tensile strength plots indicates that the ratio 'R' increases, tensile strength of samples decreases.

4 Here is some deviation in the sample to sample tensile strength depending upon the test method and sample size. Larger size sample tend to give lesser value of tensile strength as compare to smaller size of sample because of micro-cracks and fractures are increases with increase in diameter of test sample. In the ring test, the outer diameter of ring should not be more than 13 cm. Because micro-cracks and other properties like void ratio, water pore pressure and other factors may affects the tensile strength of rock sample. However, the lowest value is more conservative and may be a better measure of tensile strength of rocks.

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