International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June-2017 www.irjet.net p-ISSN: 2395-0072

STUDY OF TENSILE STRENGTH OF MARBLE STONE DISC BY RING TEST

Pankaj Kumar[1], Umesh Dhiman[2], Rubel Sharma[3]

[1]M.tech student, Dept. of Civil Engineering, GGGI College of Engg. & Technology, AMBALA, Haryana, India
[2,3]Assistant Professor, Dept. of Civil Engg. GGGI College of Engg. & Technology, AMBALA, Haryana, India

---

Abstract - Civil engineering projects that involve rock materials as a prime material either as a construction or foundation materials the combination of initial stresses induced by the construction and function of engineering structure produce rock failure and the extent of the failure zone has to be analysed. So it is necessary to know how the stresses are redistributed due to the rock structure interaction and what the rock mass strength is.

Basically rock mass strength depends on the strength of integral rock and the strength of rock discontinuities. A rock mass has reduced tensile strength and reduced shear strength depends upon micro-cracks presence on the plane of rock mass. Rock mass strength dependent and varies with the volume of rock. So the knowledge of engineering properties of rock is an necessary requirement for designing of civil engineering structures on rock masses. A various types of rock material are used as a constructional material in different forms of construction, which will have a higher compressive strength and lower tensile strength. Low tensile strength is due to the subsistence of micro cracks presents in the rock, these micro-cracks may causes of rock failing suddenly in tension with a small strain. Tensile failure of rock material plays an vital role in drilling, cutting and blasting of rock stones, hydraulic fracturing of tunnels or borehole, design of underground openings, optimum roof span and in the designing of bolting and other roof support systems.

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

1. INTRODUCTION

Information of engineering properties of rock is an essential condition for designing various types of civil engineering structures on rock stacks. A design engineer has to know different rock properties such as compressive strength, tensile strength, modulus of elasticity, unit weight and porosity etc.

Various rocks are used as a constructional material in diverse forms. It is well known that rocks have a high compressive strength than any other natural substance used for construction. But on the other hand it is weaker to large extend in tension. Low tensile strength is due to the subsistence of micro cracks in the rock. The existence of micro cracks may also be the cause of rock failing suddenly in tension with a small strain. Tensile failure of rock masses also plays an important role in many engineering activities like as drilling, cutting and blasting of rock stones, hydraulic fracturing of a borehole or a tunnel, exploitation of rock slopes, and excavation of horizontally bedded roof strata. The rock mass are also subjected to tensile stresses when located in a slope or even when it is under the foundation of a dam in an abutment.

The tensile strength 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 the compressive strength of rock often specify that although the test sample was headed in compression, failure truly occurred as a result of tensile stresses, i.e. specimen normally fails when tensile stress predominate and exceed tensile strength. The fore-going 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.

1.1 PROBLEM AND OBJECTIVE

To achieve and meet the above objectives 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

1.2 SCOPE OF WORK

The effect of temperature, confining pressure and rate of loading on the strength characteristics can be studied. 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, typically methods of large scale blasting and collection will not work. Then large team of workers with a series of large, specialized equipment and products such 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 into 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 so that 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 the cut-off saw and smooth cutting is carried out. The length, width and thickness of specimen were kept constant

2.2 Preparation of rock cores

Water was admitted 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 Drying of samples

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

2.4 Testing Procedure

The cylindrical test sample with a central hole was placed horizontally between the steel plates ensuring line loading in a Compression testing machine was loaded at constant rate. Necessary precautions were observed so that the load on the samples was not eccentric; the load was measured with the help of a proving ring. 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 too less so as to fail the discs suddenly making it difficult to record the reading at failure

3. RESULTS AND DISCUSSION

Determine the indirect tensile strength of white marble stone of different diameter. Ring test determine the tensile strength of sample From the table - 1, 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 11cm with a inner diameter of the central holes are 0 cm,1.6 cm, 3.3cm,5cm undergoes failure load from 27.2 KN to 4.41 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 result shows that increase in inner diameter of ring sample causes to decrease in tensile strength of white marble stone specimen. From the ring test, it have been observed that the type of failure of disc is similar to that shown by Hobbs (1965)

TABLE-1: Ring Test Result Of P series

	Sample	Dia of sample 'D' in cm	Dia. of central hole 'd' in cm	R= d/D	Thickness of the sample 't in cm'	Failure load F in KN	Weight of sample 'W' in kg	Tensile strength
P-SERIES	S1	11	0	0	1.5	27.2	0.41	96.07411697
	S2	11	1.6	0.145	1.5	17.6	0.386	62.1656051
	S3	11	3.3	0.3	1.5	13.2	0.366	46.62420382
	S4	11	5	0.45	1.5	4.41	0.32	15.57672264

There is two series of sample P series and Q series.In P series the external diameter is 11cm but in Q series the external diameter is 12cm.Four sample in each series and every sample different radius.The tensile strength decreases when increases the radius of sample.the tensile strength of sample depend upon external or internal diameter of the sample

TABLE-2: Ring Test Result Of Q-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	36.943205 94
	S8	12	5	0.41	1.5	3.41	0.372	11.04087049

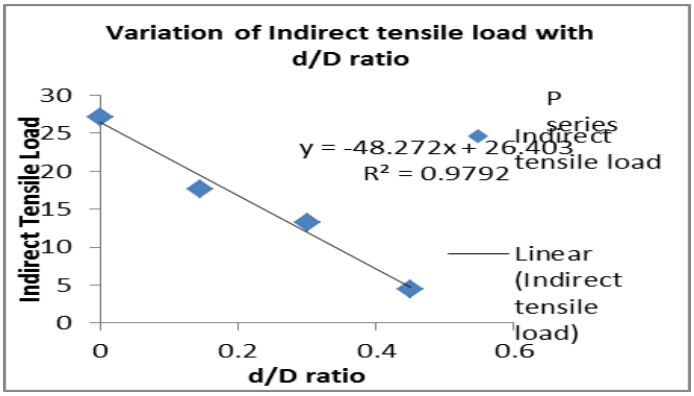
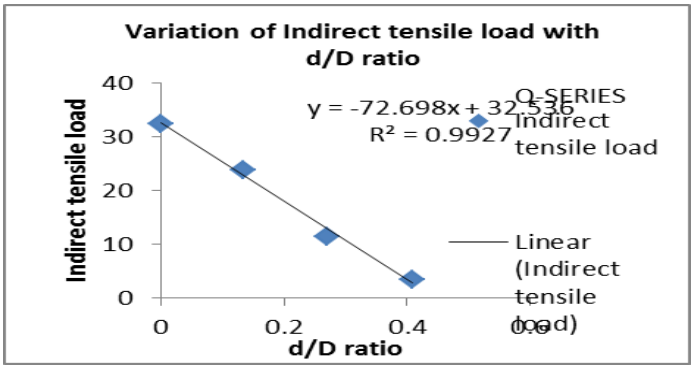


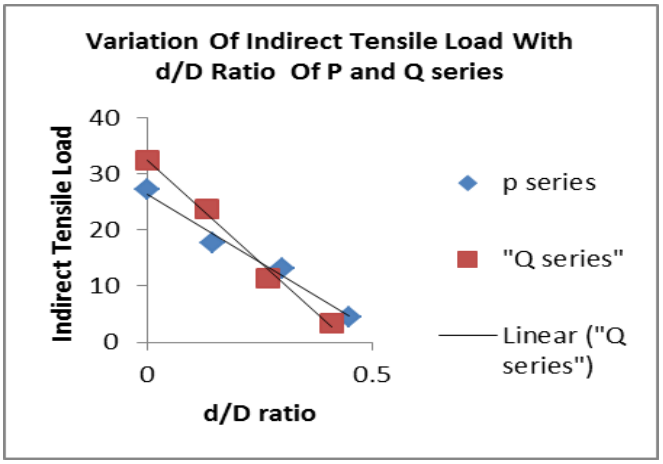
Chart-1: Ring Test graph for P- Series



Chart–2 Ring Test graph for Q – Series

COMPARISON GRAPH

Comparison of graph of P and Q series of tensile strength of marble stone.



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

4. CONCLUSIONS

1 The tensile strength of sample decreases as inner diameter of sample increases, because of 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 The ratio R (inner dia/outer dia) versus tensile strength plots indicates that as the ratio 'R' increases, tensile strength of samples decreases.

4 The tensile strength of rock is an experimental property and not a material property. Because of real tensile strength is only obtained by the direct tensile method and there are many problems to make test specimen for direct tensile strength test.

REFRENCES

[1] Addinall, E., Hackett, P. (1964) "Tensile failure in rock like materials" In: Proc., 6th Symp. on Rock Mechanics, University of Missouri at Rolla, Rolla,pp.515-538.

[2] Bienewaki, Z.T. and Mewkes, I. (1978) "Suggested methods for determining tensile strength of rock material", International Journal of Rock Mechanics and Mining sci., vol. 15, 1978, pp. 99-104.

3) Barla, G., Goffi, l. (1974) "Direct tensile testing of anisotropic rocks", In Proc., 3rd Int. Congr. Rock Mechanics, Denver, 2(A), pp.93-98

4) Berenbaum, R., Brodie, I. (1959) "The tensile strength of coal" J. Inst. Fuel.No.32, pp.320-327.

5) Colback, P.S.B, (1956) "An analysis of brittle fracture initiation and propagation in Brazilian test", Proceedings of I Congress Int.soc. Of Rock Mech., Liabon vol. 1, pp. 385-391.

6) Chun' An Tang, John A. Hudson(2010), "Rock failure mechanisms, illustrated and explained by Chun" Edition 3rd pp.42-60".

7) Fairhurst, C. (1964) "On the validity of the Brazilian test for brittle materials", International Journal of Rock Mechanics and Mining Sci., vol. 1, 1964, pp. 555-556.

8) Hobbs. (1964) "The tensile strength of rocks", International Journal of Rock Mechanics and Mining sci., vol. 1, 1964, pp. 385-395.

9) Grosvenor, N.E. (1961) "New method for determining the tensile strength of a rock" Trans. Soc. Min. Eng. AIME220, pp.447-449.

10) Hudson, J.A (1959) "Tensile strength and ring test", Int. Jr. Rock Mech. Min. Sci, vol. 5, No.1, pp.91-97.

11) Hudson, J.A (1958) "Tensile strength and ring test", Bit. School of Mineral and Metallurgical Engg. University Minnesota..

12) Hobbs, D.W. (1965) "An assessment of a technique for determining the tensile strength of rock." Br. J. Applied Physics, No. 16, pp.259-268.

[13] Kahraman, S., 2003. Performance analysis of drilling machines using rock modulus ratio. Journal of the South African Institute of Mining and Metallurgy, 103(8), pp.515-522.

[14] Z. A. Erguler and R. Ulusay (2009) "Water-induced variations in mechanical properties of clay-bearing rocks,"International Journal of Rock Mechanics and Mining Sciences, vol. 46, no. 2, pp. 355–370.

[15] Perras, M.A. and Diederichs, M.S., 2014. A review of the tensile strength of rock: concepts and testing. Geotechnical and geological engineering, 32(2), pp.525-546.

[16] W. Li and J. Bai (2015), "Numerical modeling for yield pillar design: a case study,"Rock Mechanics and Rock Engineering, vol. 48, no. 1, pp. 305–318.

BIOGRAPHIES

Pankaj Kumar [1]M.tech student, Dept. of Civil Engineering, GGGI College of Engg. & Technology, AMBALA, Haryana, India