International Journal of Research in Engineering, Science and Management
Volume-1, Issue-11, November-2018
www.ijresm.com | ISSN (Online): 2581-5792

Relation between Weathering and Index Properties of Basalt near Mhow (Indore)

Gunjan Shrivastava
Assistant Professor, Dept. of Civil Engineering, Sushila Devi Bansal College of Engineering, Indore, India

***Abstract*: This study is oriented towards studying the physical and engineering properties of some selected basalt rocks around the Indore. For that purpose, about 48 rock specimens were extracted from six different locations at different depth along vertical wall of open cast stone quarrying mines around Indore. These locations are identified as: Gawli Palasia, Donger Goan, Mhow Gaon, Kodriya, Jamli and Simrol area. Several experimental tests were conducted on these specimens. The results were analyzed, compared, and classified according to several internationally known classification systems.**

***Keywords*: Basalt Rock, Weathering, Engineering Properties, Rock Classification**

1. Introduction

Basalt is a dark-colored, fine grained heavy extrusive volcanic igneous rock which was derived from magma and spread over different localities in Indore, Western Madhya Pradesh. It is the most abundant lava formed rock, and is composed mainly of pyroxene, plagioclase, with or without olivine. Basalt may be quite dense, or filled with many gas bubbles, depending upon the conditions prevailing at the time of extrusion.

Weathering is an essential process that affects the mechanical properties of rock material and mass at shallow depths and on the surface through chemical and physical weathering. Physical weathering leads to the opening of discontinuities by rock fractures, progressively breaking down the original rock to a soil-like material representing advanced stages of weathering. Chemical weathering results in chemical changes in minerals and both physical and chemical weathering greatly affects the engineering structures found at or near the Earth's surface. The composition of basalt is strongly influenced by the nature of weathering in the source area of the sediment. Chemical and physical weathering is also responsible for the formation of soils that supply nutrients to enable plant growth and control the Earth's surface morphology. In the field, the samples were described in terms of their weathering grade based on visual descriptions and a number of simple index tests. Extensive surface and subsurface investigations were carried out to determine the characteristics and depth of weathering profiles developed in the rock.

2. Cope of study

Scopes of this study are to establish various engineering and physical parameters of weathered rock with different degree of weathering. Weathered rocks possess most problematic condition for any engineering works. Since this research is regarding the weathered rock material properties, thus it is useful to understand about the rock material weathering processes. Rock weathering process is a dynamic process and multi is factors involve in the physical and chemical reactions to weathering agents and conditions. Chemical weathering is defined as a decaying process of rocks cause by reactions to water, carbon dioxide and humidity of rock composition mineralogy. Whereas, physical weathering is a slaking and fragmentation process cause by force from water, air movements and the changes of inner stress. Continuous weathering process that occurred during this geologic period has caused the decreasing in rock physical nature.

3. Weathering grade classification

This classification of the rock mass is proposed on the basis of the recommendations by the Engineering Geology working partly of the Geological Society of London (1995). The degree of weathering in a rock mass is arrived on the basis of the change in its strength, extent of alteration on its surface and also along the fractures or discontinuities. Alteration is noted in

Table 1
Weathering grade classification

Grade	Description	Basis of Grading
I	Unweathered (UW)	The rock mass is fresh, no change is noticed. There is no decolouration or alteration is observed.
II	Slightly Weathered (SW)	Not significant weathered, decolouration present only along cracks or discountunities
III	Moderately Weathered (MW)	Rock mass altered significantly and is partly modified into soil. Decolouration of the material noticed along the cracks. Increase in the extent of fracturing and disintegration evidenced.
IV	Highly Weathered (HW)	Material is discoloured and considerable loss of strength is observed. More than half of the material is convert to soil. Decomposition penetrates deeply inside the rock material.
V	Completely Weathered (CW)	Original strength is completely lost. The rock mass is changed to soil.
VI	Residual Weathered (RW)	Original fabric destroyed on total conversion to soil.

terms of discolouration or formation of altered product including soil. In this simplified classification, the rock mass is categorized into six grades ranging from grade I (unaltered fresh rock) through grade VI (totally altered in to soil).

4. Field sampling

A total of about 48 rock specimens were extracted from the field samples. These specimens were subjected to various tests including air dry and wet cases. Various laboratory tests were carried out on rock specimens extracted from various mines, which were collected from six locations around Indore.

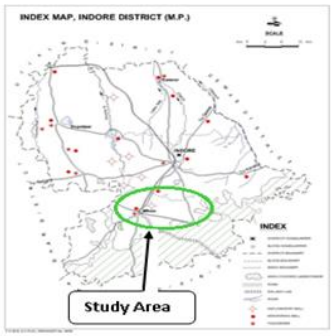

Fig. 1. Index map

5. Laboratory testing

After the collection of samples, it will be brought to the laboratory to be tested. In order to analyze rock mass character and its behavior an extensive laboratory test has been performed throughout the work. The test programme included the follows: - Unconfined Compressive Strength Test, Toughness Test (Impact Test), Water Absorption Test and Density Test.

To measure or evaluate any property of basalt, suitable specimens needed to be prepared. The suggested test procedure by many authorities worldwide, such as the American Society for Testing and Materials (ASTM) or the International Society of Rock Mechanics (ISRM), call for cylindrical or cubic specimens extracted either in-situ or in the laboratory. For this study, rock specimens were prepared by means of laboratory equipment, such as the laboratory rock coring drill, the commercial diamond impregnated rock saw, a universal specimen grinding machine, and other necessary accessories. Laboratory methods and results tests to measure the index properties are normally conducted for classification purposes.

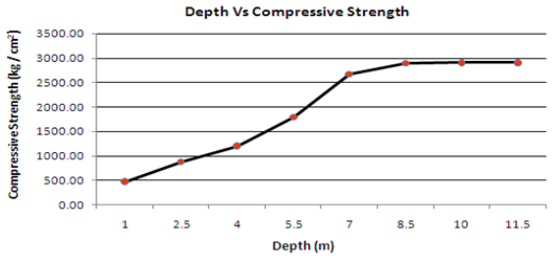

Fig. 2. Depth vs. Compressive strength

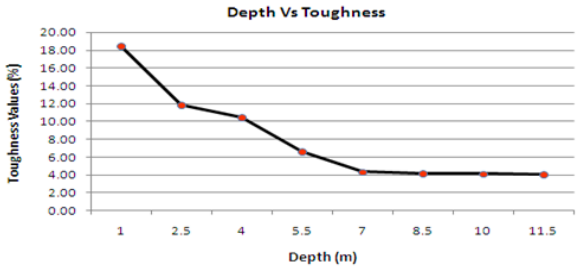

Fig. 3. Depth vs. Toughness

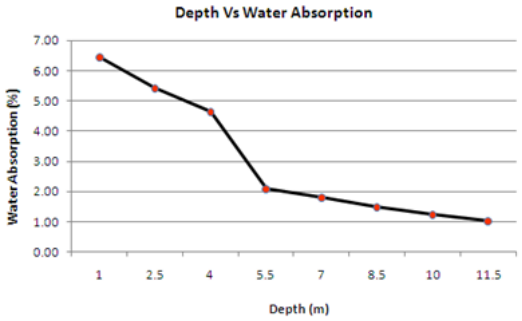

Fig. 4. Depth vs. Water absorption

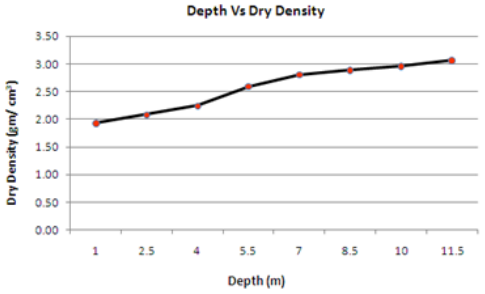

Fig. 5. Depth vs. Dry density

Table 2
Compressive strength test results

Sample Nos	Depth (m)	Compressive Strength (kg/ cm^2)						
		Location: 01 Gawli Palasia	Location: 02 Donger Goan	Location: 03 Mhow Gaon	Location: 04 Kodriya	Location: 05 Jamli	Location: 06 Simrol	Average
1	1	469.32	471.23	470.32	468.92	470.67	471.32	470.29
2	2.5	876.63	875.61	875	877	876.07	874.92	875.87
3	4	1201.93	1200.27	1198.39	1202.13	1200.9	1198.62	1200.37
4	5.5	1795.88	1794.99	1798.32	1794.2	1795.71	1796.39	1795.92
5	7	2668	2669.04	2671.06	2669.49	2670.72	2671.96	2670.05
6	8.5	2900.42	2899.21	2901.87	2896.33	2901.46	2902.23	2900.25
7	10	2903.96	2904.01	2905.94	2904.67	2905.77	2904.98	2904.89
8	11.5	2910.47	2908.91	2909.69	2910.39	2911.03	2910.31	2910.13

Table 3
Toughness test results

Sample Nos	Depth (m)	Toughness Test Values (%)						
		Location: 01 Gawli Palasia	Location: 02 Donger Goan	Location: 03 Mhow Gaon	Location: 04 Kodriya	Location: 05 Jamli	Location: 06 Simrol	Average
1	1	19.06	19	18.69	18.02	18	18.06	18.47
2	2.5	12.63	11.9	11.29	11.22	11.96	12.06	11.84
3	4	10.69	10.12	10.44	10.39	10.44	10.69	10.46
4	5.5	7.22	6.99	6.05	6.11	6.91	6.49	6.63
5	7	4.25	4.19	4.17	4.12	4.72	4.66	4.35
6	8.5	4.22	4.12	4.11	4.08	4.19	4.32	4.17
7	10	4.23	4.09	4.1	4.03	4.11	4.24	4.13
8	11.5	4.19	4	4.01	4	3.99	4.13	4.05

Table 4
Water absorption test

Sample Nos	Depth (m)	Water Absorption Test Values (%)						
		Location: 01 Gawli Palasia	Location: 02 Donger Goan	Location: 03 Mhow Gaon	Location: 04 Kodriya	Location: 05 Jamli	Location: 06 Simrol	Average
1	1	6.63	6.59	6	6.79	6.23	6.55	6.47
2	2.5	5.44	4.97	5.12	5.99	5.47	5.63	5.44
3	4	4.39	4.21	4.99	4.89	4.72	4.67	4.65
4	5.5	2.01	2.12	2.1	2.09	2.13	2.1	2.09
5	7	1.9	1.47	1.96	1.93	1.94	1.67	1.81
6	8.5	1.78	1.33	1.48	1.57	1.29	1.47	1.49
7	10	1.21	1.04	1.2	1.4	1.16	1.38	1.23
8	11.5	0.96	0.9	1.01	1.11	1.02	1.12	1.02

Table 5
Dry density test result

Sample Nos	Depth (m)	Dry DensityTest Values(gm / cm^3)						
		Location: 01 Gawli Palasia	Location: 02 Donger Goan	Location: 03 Mhow Gaon	Location: 04 Kodriya	Location: 05 Jamli	Location: 06 Simrol	Average
1	1	1.93	1.9	1.96	1.99	1.9	1.89	1.93
2	2.5	1.99	2.01	2	2.11	2.19	2.19	2.08
3	4	2.12	2.15	2.21	2.29	2.31	2.36	2.24
4	5.5	2.59	2.66	2.58	2.5	2.69	2.54	2.59
5	7	2.78	2.79	2.77	2.82	2.88	2.81	2.81
6	8.5	2.89	2.91	2.88	2.84	2.91	2.9	2.89
7	10	2.94	2.99	2.97	2.93	2.98	2.96	2.96
8	11.5	2.98	3.02	2.99	3.12	3.18	3.11	3.07

Table 6
Discussion of test results

Sample No	**Depth (m)**	**Proposed Weathering Grade (I to VI)**	**Average Engineering Properties**			
			Compressive Strength (kg/ cm^2)	**Toughness Value (%)**	**Abrasion Value (%)**	**Dry Density (gm/ cm^3)**
1	1	V	470.29	18.47	6.47	1.93
2	2.5	VI to V	875.87	11.84	5.44	2.08
3	4	VI	1200.37	10.46	4.65	2.24
4	5.5	VI	1795.92	6.63	2.09	2.59
5	7	III	2670.05	4.35	1.81	2.81
6	8.5	III	2900.25	4.17	1.49	2.89
7	10	II to III	2904.89	4.13	1.23	2.96
8	11.5	II	2910.13	4.05	1.02	3.07

6. Conclusion

Open cast mining of road metals (basalt mining) near provided an excellent opportunity to examine the sub surface rock profile of the collected rock samples at same location. During the work, it has been observed that their physical as well as engineering properties that are directly or indirectly related to the depth. The test result and analytical discussion suggest the fact that physical and chemical weathering is significant in the basaltic area especially up to the depth of 7 to 8 meter. Below this depth the effect of physical weathering is less, although there is slight decrease in weathering index with increase in depth. In the study area on the surface or near the surface, basalts are highly disintegrated and eventually have significant low bulk density. Chemical weathering might also be significant as a result of chemical and mineralogical alteration through the action of surface and ground water. The effects of the chemical weathering on the engineering properties of rocks are subjected to further research. However

present studies shows that physical weathering on rocks (basalt) decrease the engineering behaviors of the rocks and the degree of engineering properties of rocks increase with depth. Increases of engineering properties of rocks provide stability of foundation.

References

[1] Bieniawski, Z.T. (1976): Rock mass classification in Rock Engineering, Proc. Symp. On Rock Exploration, Cape Town, 1, 97-106.
[2] Broch, E. & Franklin, J.A. 1972. Point-load strength test. Int. Journal Rock Mech. Mining Science. 9: 669-697. Caterpillar Performance Handbook (2001).
[3] Chigira, M., Sone, K. 1991. Chemical weathering mechanisms and their effects on engineering properties of soft sandstone and conglomerate cemented by zeolite in a mountanious area. Quarterly Intel. Journal Engineering Geology. 30:195-219.
[4] Chigira, M. 1990. A mechanism of chemical weathering of mudstone in a mountainous area. Quarterly Intel.Journal Engineering Geology 29: 119-139.
[5] Dearman, W.B. (1974): Weathering classification in the rock characterization of rock for engineering Purposes in British Practice. Bull .Int. Assoc. Engg. Geology, No. 9, 33-42.
[6] Deere, D.U., Miller, R.P. 1966. Engineering clssification and index properties for intact rock. Tech. Rep. AFWL-TR-65-116, Air Force Weapons Lab., Kirtland Air Force Base: 308.
[7] Deere, D.U. and Deere, D.W. (1988): the Rock Quality (RQD) index in practice. In rock classification system for engineering purposes. L.Kirkaldie (ed.), ASTM, Spl Publ, 984, 91-101, Philadelphia.
[8] Hassani, F.P., Scoble, M.J. & Whittaker, B.N. 1980. Application of the point load index test to strength determination of rock and proposals for new size-correction chart. Proc. 21st U.S. Symp. Rock Mechanics, Rolla, Md. 543-564.
[9] Hencher S.R. and Martin R.P. (1982) The description and classification of weathered rocks in Hong Kong for Engineering Purposes, Proceedings of the seventh Southeast Asian Geotechnical Conference/22-26 November 1982, Hong Kong.
[10] Iliev, I.G.(1967): An attempt to estimate the degree of weathering of intrusive rocks from the physio- mechanical properties, Proc. 1st Cong of Intl. Soc. of Rock Mechanics, Lisbon, 109-114. Komoo, I. 1995. Weathering as an important factor in assessing engineering properties of rock materials. Forum on Soil and Rock Properties, Geological Society Malaysia. Universiti Malaya, Kuala Lumpur.
[11] Weaver, J.M., 1975, Geological factors significant in the assessment of rippability, Civil Eng. In South Africa, Vol. 17.