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Influence of Weathering on the Engineering Properties of Basalt near Indore, Madhya Pradesh

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ABSTRACT: *The purpose of this study is to investigate various engineering properties of rocks with different degree of weathering. Weathering is a process involving disintegration and decomposition of rocks in nature. The different kinds of rocks which are formed under different conditions undergo disintegration and decay when exposed to the earth surface. The disintegrated and the altered products stay at the site of formation. Weathering occurs in situ, or "with no movement", and thus should not be confused with erosion, which involves the movement of rocks and minerals by agents such as water, ice, wind, and gravity.*

I. INTRODUCTION

Most civil engineering works occur close to the surface and the process of 'weathering' has affected most groundmasses at shallow depth. Because of this, weathering of both engineering soils and rocks is one of the most important problems with which the engineering geologist has to contend. Weathering implies decay and change in state from an original condition to a new condition as a result of external processes. Weathering takes place in all environments but is most intense in hot, wet climates where weathering may be expected to extend to great depths. While weathering may reach great depths in limestone, and rocks containing halite and gypsum, it is slow to do so and the style of weathering may change if climatic conditions change.

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. This study has been carried out near the Indore on the Deccan Trap Basalt.

II. 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.

Primary weathering process is when the rock mass undergoes chemical and physical weathering process which the effect will change its color, fabrics, mineralogy, texture, sizes and decompose to residual soil. The chemical and physical weathering may happen at the same time, or otherwise. Chemical and, or physical weathering rate is determine through the factors of lithology, climate, topography, and groundwater. Tropical weathering on rock minerals is far more aggressive but it is less effective in cool climate. High humidity in air causes chemical weathering process can be more aggressive in decreasing physical behavior than crushing and erosion.

Weathering profiles are graded from top surface to the unaltered fresh rocks at depth, in to six grades (I to VI) with the highly altered top horizon designated as grade VI and the unaltered rock mass at the bottom as grade I. Change in strength, permeability, and deformability are also taken in to consideration. This approach is very useful for the preparation of weathering maps for project sites in Civil Engineering practices.

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 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).

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.

III. METHODOLOGY

The physical and engineering properties of weathered rocks will be studied to quantify the weathering impact to these materials. The standard testing procedures will become more difficult as rock material become weaker. This research focused on the basic physical and engineering properties of weathered rock, which can be the basic to compare the behavior of fresh or unweathered rock. One of the main scopes in this research is focused on field study. Field study concentrates field recognition on nature of different type of rock to problems in various engineering behavior. Some samples were collected from the field in accordance to the field study and classification. Samples representing particular group of weathering classification had been brought back to the laboratory for further study.

IV. LABORATORY TEST

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 research project. The test programme included the follows: -

Unconfined Compressive Strength Test
Crushing Strength Test
Toughness Test (Impact Test)
Water Absorption Test
Density Test
Abrasion Test

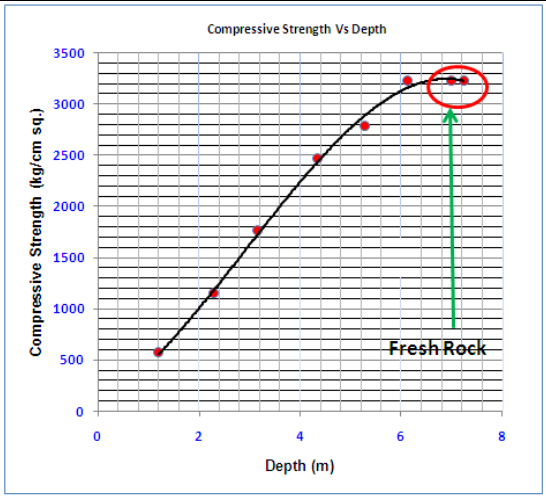
Figure- Collection of samples from various depths

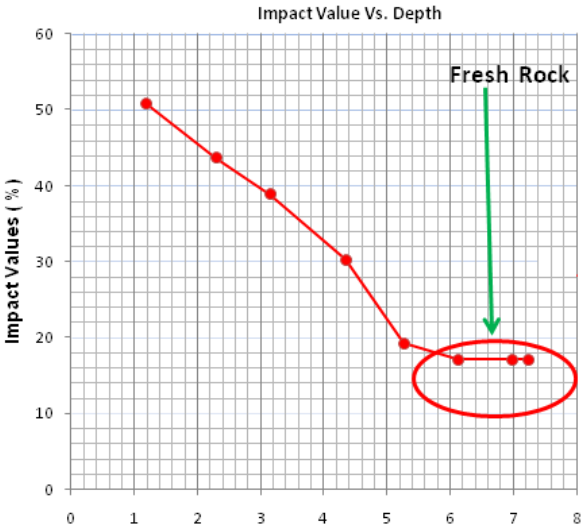

Figure- Rock samples for laboratory testing

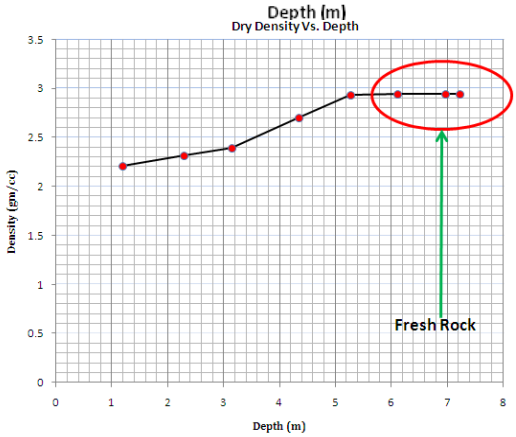
V. DISCUSSION OF TEST RESULTS

Sample No.	Depth (m)	Proposed Weathering Grade (I to VI)	Engineering Properties					
			Compressive Strength (kg/ cm^2)	Water Absorption (%)	Dry Density (gm/ cm^3)	Abrasion Value (%)	Toughness Value (%)	Crushing Strength (%)
01	1.20	V	572.67	6.15	2.21	59.67	50.78	1.98
02	2.30	IV	1149.00	3.63	2.32	51.00	43.66	2.01
03	3.15	III or IV	1762.82	2.85	2.39	43.09	38.91	2.17
04	4.35	III	2471.98	1.51	2.70	36.78	30.28	2.24
05	6.12	III	3225.12	0.28	2.93	22.56	19.18	2.55
06	6.98	II	3226.12	0.25	2.94	19.97	17.13	2.67
07	7.23	I or II	3226.14	0.25	2.94	19.97	17.13	2.68

GRAPHICAL REPRESENTATION OF TEST RESULT







VI. CONCLUSION

Construction of the 3.5m diameter dig well at super corridor Indore provided an excellent opportunity to examine the sub surface rock profile of the collected rock samples at same location at the time of drilling and from dig. 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.

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