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ROCK CLASSIFICATION AND ROCK PROPERTY INDEX

Warren W. Krech

Bureau of Mines

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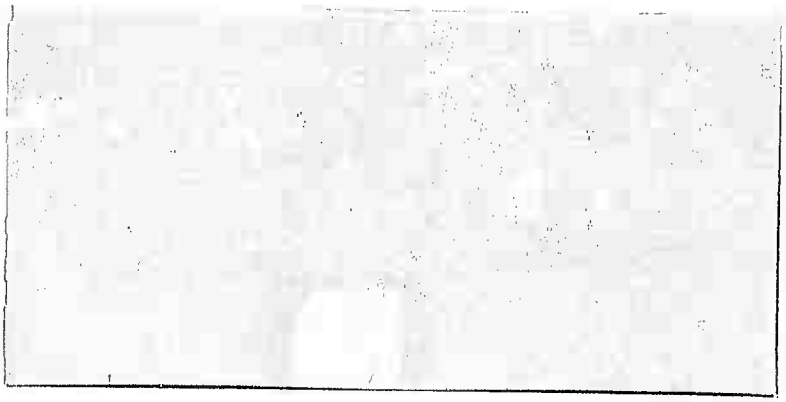

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13. ABSTRACT

A suite of eight rock types commonly used in rock mechanics research has been obtained from quarries in oriented lots, and are being distributed as one-cubic foot blocks to ARPA participants at their request. Mechanical property testing is underway on all eight ARPA rock types. A manuscript for reporting the test results is underway. A comprehensive listing of rock property data obtained from Bureau of Mines and outside literature sources is being compiled. A literature review on rock classification for engineering purposes has been completed, and development of a qualitative rock classification system is underway.

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ANNUAL REPORT

Rock Classification and Rock Property
Index Report Summary

by

Warren W. Krech

The objectives of this project are twofold: to establish a standard rock suite, and to advance knowledge of rock classification.

In more detail, the objectives are as follows:

1) Acquire a suite of standard homogeneous rock materials.
2) Test for the mechanical properties of the standard suite.
3) Distribute standard rock blocks and test data to participants in the Bureau program for ARPA.
4) Compile a comprehensive list of standard physical properties for a large number of rock types.
5) Provide a general engineering classification that relates qualitative geologic conditions to excavation performance.
6) Develop a scheme that delineates the information necessary to build quantitative classifications of rock masses based on the functional response of a given excavation system operating within a rock mass.

A suite of eight rock types commonly used in rock mechanics research has been obtained from quarries in oriented lots, and are being distributed as one-cubic foot blocks to ARPA participants at their request (see Table 1). Mechanical property testing is underway on all eight ARPA

TABLE 1. - Present rock suite for ARPA contractors

Rock Type	Geologic Name	Quarry Operator
Granodiorite	St. Cloud Gray Granodiorite (Charcoal Granite)	Cold Spring Granite Co. Cold Spring, Minnesota 56320
Granite	Westerly Granite (blue)	Bonner Monument Co. Box 407 Westerly, Rhode Island 02891
Granite	Barre Granite	Rock of Ages Corp. P. O. Box 482 Barre, Vermont 05641
Basalt	Dresser Basalt	Bryan Dresser Trap Rock, Inc. Box 215 Shakopee, Minnesota 55379
Quartzite	Sioux (Jasper) Quartzite	Jasper Stone Co. P. O. Box 206 Sioux City, Iowa 51102
Sandstone	Berea Sandstone	Cleveland Quarries Amhurst, Ohio 44001
Limestone	Holston Limestone (Tennessee Pink Marble)	John J. Craig Co. P. O. Box 631 Knoxville, Tennessee 37091
Limestone	Salem (Indiana or Bedford) Limestone	Indiana Limestone Co. P. O. Box 72 Bedford, Indiana 47421

rock types. A manuscript for reporting the test results is underway. A comprehensive listing of rock property data obtained from Bureau of Mines and outside literature sources is being compiled. A literature review on rock classification for engineering purposes has been completed, and development of a qualitative rock classification system is underway.

Introduction

Since the early 1900's there have been numerous attempts to classify rocks. Most of the classifications that were developed were based on support criteria for completed excavations, minimizing their importance for pre-excavation considerations. Although a few of the more recent classification attempts have utilized observations that can be made prior to an excavation, they do not include enough of the important geologic conditions to be effectively used in developing the preliminary plans for an excavation.

The direction taken by this project is based on two general objectives which will be elaborated upon in the following section. First, a short-range objective is to develop a better qualitative classification of rock based on geologic conditions present at an excavation site. Second, a long-range goal is to develop a quantitative classification of rock mass based on a functional response of a given excavation system operating within the rock mass.

Qualitative Classification

This portion of the project has been established to improve the prediction of certain geologic conditions that can severely affect an excavation operation. Typical important conditions are rock competency, discontinuities, stress conditions, and ground water. Studies to improve geologic prediction may be separated into the following aspects:

1) Definition of geologic conditions that are of paramont importance.

2) Improvement of geologic and geophysical techniques for detecting those conditions defined in 1.

3) Improvement of communications for reporting the geologic conditions which characterize a particular excavation site so that information may be utilized to establish preliminary excavating plans.

Efforts are underway to establish a qualitative classification of rock masses as relates to an excavation operation that is based on geologic conditions. A literature survey yielded information on prior attempts at qualitative classification directed at opening stability prediction, but only a minimal amount related to rock boreability. The most serious handicap in all classification efforts is the lack of sufficient and/or proper data.

This project has as a secondary purpose the establishment of a standard suite of rock for use by various researchers, such that test results can be more readily correlated between researchers. Table 1 shows the rock types available upon request. A series of standard properties tests are being conducted on rock blocks from the suite, and results will be available to interested researchers. A comprehensive listing of previously published rock property data useful for preliminary evaluation of excavation sites is underway. Eleven standard properties have been chosen for the listing, with as many properties shown

for each rock type listed as can be located. All literature search references and all property listings are being placed on computer cards for maximum flexibility and usefulness.

Quantitative Classifications

The long-range objective of rock classification research is to obtain a quantitative classification of rocks according to the response of a particular excavation system operating within the rock. This type of classification requires sound mathematically definable knowledge of the effects of rock mass properties (including geologic conditions) on each facet of the overall excavation system. With this knowledge, a contractor would be able to develop accurate estimates of the various operations and equipment necessary to complete an excavation.

Development of the classification will follow these general guidelines:

1) Select the excavation system(s) (for example, horizontal boring) for which knowledge of response characteristics in different rocks is desired
2) Acquire large amounts of accurate, controlled data on intrinsic rock properties and the behavior of various elements of the total excavation system. This in turn requires better rock mass property testing techniques.
3) Develop a response function for the total excavation system based on the interaction between the components of the excavation system and the geologic environment characterized by the measured properties.

4) Separate the total spread of responses for different rocks into nominal ranges that provide meaningful classifications for contractors.

5) Repeat steps 1-4 for other excavation systems (conventional drill and blast).

Digressing briefly to a description of the mechanism for collecting the desired data mentioned in item 2, it appears that full or near full scale model excavation systems will be required. This could be as a mobile unit dispatched to many test locations and/or a fixed unit operating at one site at which various in situ conditions can be realistically duplicated. The input required in item 2 above is particularly expensive and time consuming to acquire. Furthermore, it is contingent on developments in other research topics of the Rock Properties and State of Stress Measurements study areas. As new excavation techniques are developed under auspices of ARPA and others, new classifications will likewise be required, each necessitating the acquisition of reams of new data relating significant properties to that particular excavation system. Strict coordination and extensive information exchange between various committees (and investigators) within the Rock Properties and State of Stress Measurements groups will be required.

As a foundation for the eventual development of such a program, effort within this project is being directed toward establishing a scheme delineating the information necessary to build quantitative

classifications. Such a scheme is necessary in view of the large amounts of costly data that must be acquired in order to ultimately build function classifications useful to systems analysis of excavation processes.