

# Rock Classification Systems for Engineering Purposes

**Louis Kirkaldie** EDITOR



**STP 984**

**STP 984**

# ***Rock Classification Systems for Engineering Purposes***

*Louis Kirkaldie, editor*



ASTM  
1916 Race Street  
Philadelphia, PA 19103

**LIBRARY OF CONGRESS**  
**Library of Congress Cataloging-in-Publication Data**

Rock classification systems for engineering purposes / Louis Kirkaldie, editor.  
(Special technical publication; (STP) 984)

Papers from the Symposium on Rock Classification Systems for Engineering Purposes, held in Cincinnati, Ohio, June 25, 1987, and sponsored by ASTM Committee D-18 on Soil and Rock.

Includes bibliographies and index.

"ASTM publication code number (PCN) 04-984000-38."

ISBN 0-8031-0988-1

1. Engineering geology—Congresses. 2. Rocks—Classification—Congresses. I. Kirkaldie, Louis. II. Symposium on Rock Classification Systems for Engineering Purposes (1987: Cincinnati, Ohio) III. ASTM Committee D-18 on Soil and Rock. IV. Series: ASTM special technical publication; 984.

TA703.5.R63 1988

624.1'51—dc19

88-5091  
CIP

Copyright © by AMERICAN SOCIETY FOR TESTING AND MATERIALS 1988

**NOTE**

The Society is not responsible, as a body,  
for the statements and opinions  
advanced in this publication.

**Peer Review Policy**

Each paper published in this volume was evaluated by three peer reviewers. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM.

# Foreword

The Symposium on Rock Classification Systems for Engineering Purposes was held in Cincinnati, Ohio, on 25 June 1987. ASTM Committee D-18 on Soil and Rock served as sponsor of the event. The symposium chairman was Louis Kirkaldie, USDA Soil Conservation Service, who has also edited this publication.

# Contents

<b>Overview—LOUIS KIRKALDIE</b>	vii
<b>Opening Remarks—H. J. PINCUS</b>	1
<b>ROCK CLASSIFICATION SYSTEMS</b>	
<b>The Unified Rock Classification System—D. A. WILLIAMSON AND C. R. KUHN</b>	7
<b>The Rock Mass Rating (RMR) System (Geomechanics Classification) in Engineering Practice—Z. T. BIENIAWSKI</b>	17
Discussion	32
<b>A Ground Support Prediction Concept: The Rock Structure Rating (RSR) Model—E. H. SKINNER</b>	35
Discussion	50
<b>Critique of the Rock Material Field Classification Procedure—J. S. MOORE</b>	52
Discussion	55
<b>Rock Mass Classification and Tunnel Reinforcement Selection Using the <i>Q</i>-System—N. BARTON</b>	59
Discussion	85
<b>CASE HISTORIES</b>	
<b>The Rock Quality Designation (RQD) Index in Practice—D. U. DEERE AND D. W. DEERE</b>	91
<b>Case Histories of Groundmass Characterization for Excavatability—H.A.D. KIRSTEN</b>	102
<b>A Case History Review from a Perspective of Design by Rock Mass Classification Systems—G. A. NICHOLSON</b>	121
<b>APPENDIX</b>	
<b>Rock Material Field Classification Procedure</b>	133

## Overview

---

The Symposium on Rock Classification Systems for Engineering Purposes was organized to develop standards for rock classification. In the initial discussions, it was recognized that standards for rock classification for engineering purposes must be based on the rock use; that is, the rock would need to be classified for specific engineering purposes.

In organizing the symposium, many individuals, agencies, and organizations were contacted in an effort to solicit papers on rock classification. That effort resulted in the first five papers presented at the symposium (all included in this publication). The authors were asked to present a rationale for the classification system or procedures with which they were involved. The papers discussed the pros and cons of the classification system, including its strengths and weaknesses. (Because it is so often cited, the Rock Material Field Classification Procedure is given *in toto* in the Appendix.)

This volume meets the purposes for which the symposium was organized. It presents papers on each classification system or procedure and gives the strong points and weaknesses as seen by the person most familiar with the classification. It is important to note that within the five papers on classification there are at least seven classifications for specific engineering uses.

The papers in this volume follow the same order as presented at the symposium. The classifications are followed by the case histories in which rock classification is a critical factor. This information is very valuable to those practicing in the fields of engineering geology and geotechnical engineering, because it brings together in one source five of the major classification systems and procedures used in the field today. Some of the classifications are very specific, some are slightly more generalized, but all can be used directly to classify rock for engineering purposes.

Although future standards may not follow any of the classifications included, the systems and procedures presented in this volume demonstrate that rock is being classified for specific engineering purposes; these classifications can be a guide in the future development of standards. Also, the papers on case histories are useful examples for the development of standards.

In the past, problems arose with classification systems because most were generic (not tailored to a specific engineering use) and rock was classified by traditional mineralogic and petrologic characteristics. These classifications then had to be interpreted as to the rock behavior for different engineering uses. The papers in this volume attack the problem from the other direction by specifying a use the rock will serve, then classifying the rock according to its most important characteristics for particular engineering purposes.

The authors have all contributed importantly to rock classification for engineering purposes. Although work needs to be done to develop ASTM standards, the papers in this volume show that standards can and will be developed in the near future.

<sup>1</sup> Soil Conservation Service, U.S. Department of Agriculture, Washington, DC 20013.

ISBN 0-8031-0988-1