


# Rock



FOR

# Erosion Control

McElroy/Lienhart, editors



STP 1177

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# ***Rock for Erosion Control***

*Charles H. McElroy and David A. Lienhart, editors*

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# Foreword

This publication, *Rock for Erosion Control*, contains papers presented at the symposium, Durability and Specification Conformance Testing of Rock Used for Erosion Control, held in Louisville, KY on 18 June, 1992. The symposium was sponsored by ASTM Committee D-18 on Soil and Rock and its Subcommittee D18.17 on Rock for Erosion Control. Charles H. McElroy of the Soil Conservation Service in Forth Worth, TX and David A. Lienhart of the U.S. Army Corps of Engineers in Cincinnati, OH presided as symposium co-chairmen and are the editors of the resulting publication.

# Contents

**Overview**—C. H. MCELROY AND D. A. LIENHART

vii

## DURABILITY TESTING

<b>Bureau of Reclamation Experience in Testing of Riprap for Erosion Control of Embankment Dams</b> —J. A. FARRAR	3
<b>The Influence of Fabric and Composition on the Durability of Appalachian Shales</b> —L. E. VALLEJO, R. A. WELSH, JR., C. W. LOVELL, AND M. K. ROBINSON	15
<b>Verification of Rock Durability Evaluation Procedures Using Petroglyphs and Indian Rock Art</b> —T. L. JOHNSON, S. R. ABT, AND M. FLIEGEL	29
<b>Fractals, Pore Potential, and Sphinx Limestone Durability</b> —S. S. YERRAPRAGADA, S. S. TAMBE, AND K. L. GAURI	38
<b>A Mill Abrasion Test for Wear Resistance of Armour Stone</b> —J.-P. LATHAM	46
<b>Insoluble Residue of Carbonate Rock and Its Applications to the Durability Assessment of Rock Riprap</b> —H. H. FISHER	62
<b>Environmental Testing of Rock Used as Erosion Protection in Arid Environments</b> —D. M. DUFFY AND H. H. HATZELL	69
<b>The Mechanism of Freeze-Thaw Deterioration of Rock in the Great Lakes Region</b> —D. A. LIENHART	77
<b>Evaluation of Limestone and Dolomite Armor Stone Durability From Observations in the Great Lakes Region</b> —R. L. ERICKSON	88
<b>Petrographic Examination of Large Stone Durability</b> —G. S. WONG AND R. J. LUTTON	94

SPECIFICATION CONFORMANCE TESTING

<b>Production of Erosion Control Stone—</b> H. SCHAUBERGER, C. O. D. ARRAND, AND J. D. MAJOR	113
<b>Proposed Standard for Sizes of Stone for Erosion Control—</b> C. R. MAREK	122
<b>Riprap Quality Criteria in Standard Specifications and Engineering Guidance—</b> R. J. LUTTON AND C. S. WONG	131

# Overview

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Rock (stone) has been widely used for many years as a means to combat erosion, especially that caused by hydraulic forces. Millions of tons of quarried stone are used each year in the United States and throughout the world. Because a wide variety of rock types and sources are available, a multitude of uses are involved, and exposure to climatic conditions vary widely, no consensus on criteria exists among those who must evaluate the durability of the rock for the proposed design life of the associated structures.

This Special Technical Publication (STP) has been published as a result of the June 1992 symposium on Durability and Specification Conformance Testing of Rock Used for Erosion Control held in Louisville, Kentucky. The symposium was an outgrowth of work within ASTM Subcommittee D18.17 on Rock for Erosion Control, a subcommittee of ASTM Committee D18 on Soil and Rock.

ASTM Subcommittee D18.17 was formed in 1878 as a result of expressed needs by those in attendance at a special Task Group meeting held in Boston, Massachusetts. The approved scope of D18.17 is as follows:

It shall be the responsibility of Subcommittee D18.17 to develop methods of tests and engineering specifications for rock (variously known as riprap, breakwater stone, armor stone, filter stone, and bedding material) for erosion control.

Several needs were identified by Subcommittee D18.17. Generally these needs fall into one of three categories: (1) rock durability testing, (2) rock gradations (specifications), and (3) acceptance testing.

An informal survey of some of the major users of rock for erosion control in the United States indicated that the most common laboratory tests used for evaluating durability of rock were petrographic examination, wet-dry, freeze-thaw, sodium or magnesium sulfate soundness, specific gravity, absorption, Los Angeles Abrasion, and the splitting tensile strength. The test procedures used varied from user to user, but were generally very similar to existing ASTM standard test methods for coarse aggregates. As a result, very small test specimens were and still are generally used. Considerable variation exists among the users on the acceptable criteria for each test. In most cases the criteria are based on the intended use of the rock being tested.

Many designers consider the use of small specimens to be a major limitation to the present state-of-the-art for rock durability testing. Their contention is that the breaking of a large piece of stone into smaller test specimens results in breakage along planes of weakness in the stone. This may, in some cases, indicate a false evaluation of the rock's durability.

Testing of small specimens has evolved to its present state for several reasons:

1. Standard test procedures are already available, and some performance data are documented.
2. Equipment to test larger specimens is expensive and cumbersome to operate.
3. Large scale testing is labor intensive.
4. Documented performance data that can be correlated back to large scale durability testing are lacking.

The second major category of problems identified concerns design specifications. Because a wide variety of uses and many different users exist, designers often have their own unique

design procedure to size the rock for their particular application. Complicated, and in many cases very confusing, specifications often result. Some specifications are based on mass and some on size. Generally, a range is given. Often, quarry operations, including equipment, must be changed to meet the specifications, resulting in a much higher unit cost. Some quarries simply refuse to produce a limited tonnage of rock if a change in operations or equipment is required. In addition, many designers do not understand quarry operations, and their specifications are often vague and impractical to meet.

A third problem area concerns the methodologies used to check for conformance to design specifications. Gradations or sizes can be specified to be checked at the quarry, as delivered to the project site, or after placement. The rock may meet the specifications at the quarry, but hauling and placement can alter the in-place gradations.

Not only is “when” to check gradation a problem, but “how” is perhaps a bigger one. Some inspectors have a truck dump a load of rock on a concrete pad and weigh or measure each stone. Some may just measure the stone, and others use a visual inspection only.

ASTM Committee D18, through the activities of its Subcommittee D18.17, has been developing standards to address the identified problems. ASTM D4992, Standard Practice for Evaluation of Rock to be Used for Erosion Control, was the first standard developed. Others include ASTM D5121, Standard Practice for Preparation of Rock Slabs for Durability Testing, and D5240, Standard Test Method for Testing Rock Slabs to Evaluate Soundness of Rock Riprap by Use of Sodium and Magnesium Sulfate. Standard test methods for wet-dry and freeze-thaw testing of rock slabs are in the ASTM ballot process.

Subcommittee D18.17 has also been developing a proposed specification for sizes of rock used for erosion control. The proposed standard has undergone several drafts and is also in the balloting process.

Members of Subcommittee D18.17 received approval to plan and sponsor a symposium. The goals of this symposium were:

1. To provide an opportunity to examine the current technology used by scientists, geologists, engineers, and others to measure and evaluate the durability and performance of rock used for riprap, gabions, canal and channel linings, and other erosion control applications.
2. To provide a forum for presenting state-of-the-art procedures used by construction and quarry personnel for specification conformance and compliance testing.
3. To identify areas where new standards are needed. The organizers also hoped that the symposium would publicize the work being done in the subcommittee and generate additional assistance in the development of standards already in progress and others that are needed.

The symposium was organized into two sessions: (I) Durability Testing, and (II) Specification Conformance Testing. It featured invited authors and selected authors who responded to the Call for Papers.

The organizers invited a larger user (U.S. Bureau of Reclamation) to present an overview of the procedures their agency uses to evaluate the durability of rock. They also invited a representative from a large quarry operation to present a paper on the equipment, procedures, and problems involved in producing stone for erosion control projects. The third invited participant presented a paper that contained background information and a draft of the proposed standard specification for sizes of rock used for erosion control that was developed in Subcommittee D18.17.



This STP will serve as an excellent reference on both durability and conformance testing of rock for those actively engaged in production, testing, design, and Quality Assurance/Quality Control (QA/QC) activities. Many interesting topics for research have been identified that will challenge and direct our future work in these areas. In part I of the STP, new test methods, such as the mill abrasion test for wear resistance, were introduced. Refinements, improvements, and additional data are also presented for older test methods, such as the jar slake test, insoluble residue test, wet-dry test, and the freeze-thaw test. Another paper introduced the use of petroglyphs and Indian Rock Art age dating as indicators of durability. A mathematical analysis of fractals and pore potential to explain, predict, and document durability was also presented.

Relying on a single laboratory test to evaluate the durability of rock is impossible. One paper presents an excellent summary of the importance of visual inspection and observation and historical performance documentation in evaluating rock for a specific use.

In Part II an invited paper outlines the processes used at a major quarry to produce different size stones to meet specifications. Another invited paper gives the details on a proposed standard specification for sizes of rock. ASTM Subcommittee D18.17 is very interested in any feedback concerning these proposed specifications. The results of a survey of the specifications used by State highway departments and two federal agencies are presented in another paper. In addition, criteria for several different quantitative tests are shown along with generic qualitative requirements listed by some users. Another paper focuses on the improvements needed in present QC/QA methods and verification along with three case histories as examples. Discussions of correlation data based on field performance further enhance the value of the symposium and this publication.

Although each paper presents specific conclusions, some generalized conclusions common to several of the papers are:

- The size of the rock pores is important if rock is subjected to extremes in temperature. Rocks that have small pores are generally more susceptible to damage from climatic changes.
- Although accelerated weathering tests are difficult to model in the laboratory, good correlation to performance has been achieved, especially with the freeze-thaw test.
- Petrographic analysis is a vital element in evaluating durability of rock.
- In addition to laboratory evaluation, visual observations and historical performance data are valuable tools for evaluating rock sources.

Perhaps a more important result of the symposium is that many issues were identified and additional research and work are urgently needed. Some of these are being worked on by ASTM Subcommittee D18.17 and others. However, many of the issues are not being addressed. Readers of the STP will discover several different avenues of research and study that are needed to advance the state-of-the-art technology. Some of the more pressing issues are:

- Consensus standard specifications for sizes of rock used for erosion control.
- Better and easier methods for modeling accelerated weathering in the laboratory.
- An evaluation of the size and type of rock test specimens and how well the test specimens represent actual rock masses (cube vs. slab vs. rock cores vs. broken pieces).
- Improved standard test methods for QA/QC at the source and at the project.

The editors express their appreciation to all those who attended the symposium, the authors whose papers appear in this volume, the reviewers of the submitted papers, the ASTM Committee D18 for sponsoring the symposium through its Subcommittee D18.17, and to the ASTM Staff. Without their combined efforts, this STP would not have reached the high quality level that is associated with ASTM publications.

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