

Guide to Shotcrete

Reported by ACI Committee 506

John H. Pye
Chair

Dudley R. Morgan
Secretary

Jon B. Ardahl
Hugo Armelin
Lars F. Balck, Jr.[†]
Michael Ballou
Nemkumar Banthia
Denis Beaupre
Chris Breeds
Jean-Francois Dufour
Steven Gebler

I. Leon Glassgold*
Jill E. Glassgold
Warren Harrison
Merlyn Isaak
Marc Jolin
Pierre Lacombe
Albert Litvin
Kristian Loevlie

H. Celik Ozyildirim
Harvey Parker
Jeffrey Pool
James A. Ragland
Venkataswamy Ramakrishnan
Paul E. Reinhart
Raymond J. Schutz
Philip T. Seabrook

W. L. Snow, Sr.
Randy South
Peter C. Tatnall
Lawrence J. Totten
Ransom C. White, Jr.
Peter T. Yen
George Yoggy
Christopher M. Zynda

*Deceased

[†]Subcommittee chair who produced this report.

This guide provides information on materials and properties of both dry-mix and wet-mix shotcrete. Most facets of the shotcrete process are covered, including application procedures, equipment requirements, and responsibilities of the shotcrete crew. Other aspects, such as preconstruction trials, craftsman qualification tests, materials tests, and finished shotcrete acceptance tests, are also discussed.

Keywords: dry-mix shotcrete; mixture proportion; placing; quality control; shotcrete; wet-mix shotcrete.

CONTENTS

Chapter 1—General, p. 506R-2

- 1.1—Introduction
- 1.2—Scope
- 1.3—History
- 1.4—Definitions
- 1.5—Shotcreting processes
- 1.6—Properties
- 1.7—Shotcrete applications
- 1.8—New developments and potential future uses

ACI Committee Reports, Guides, Standard Practices, and Commentaries are intended for guidance in planning, designing, executing, and inspecting construction. This document is intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. The American Concrete Institute disclaims any and all responsibility for the stated principles. The Institute shall not be liable for any loss or damage arising therefrom.

Reference to this document shall not be made in contract documents. If items found in this document are desired by the Architect/Engineer to be a part of the contract documents, they shall be restated in mandatory language for incorporation by the Architect/Engineer.

Chapter 2—Materials, p. 506R-9

- 2.1—Introduction
- 2.2—Delivery, handling, and storage
- 2.3—Cement
- 2.4—Aggregate
- 2.5—Water
- 2.6—Bonding compounds
- 2.7—Admixtures
- 2.8—Reinforcement
- 2.9—Curing and form coating compounds

Chapter 3—Equipment, p. 506R-11

- 3.1—Introduction
- 3.2—Dry-mix equipment
- 3.3—Wet-mix equipment
- 3.4—Air requirements
- 3.5—Mixing equipment
- 3.6—Hoses
- 3.7—Nozzles
- 3.8—Auxiliary equipment
- 3.9—Plant layout and operation
- 3.10—Other uses of shotcrete equipment
- 3.11—Safety

Chapter 4—Crew organization, p. 506R-18

- 4.1—Introduction
- 4.2—Composition and duties

ACI 506R-05 supersedes ACI 506R-90 (Reapproved 1995) and became effective October 7, 2005.

Copyright © 2005, American Concrete Institute.

All rights reserved including rights of reproduction and use in any form or by any means, including the making of copies by any photo process, or by electronic or mechanical device, printed, written, or oral, or recording for sound or visual reproduction or for use in any knowledge or retrieval system or device, unless permission in writing is obtained from the copyright proprietors.

- 4.3—Crew qualifications
- 4.4—Communications

Chapter 5—Preliminary procedures, p. 506R-20

- 5.1—Introduction
- 5.2—Surface preparation
- 5.3—Formwork
- 5.4—Reinforcement
- 5.5—Anchors
- 5.6—Alignment control
- 5.7—Joints
- 5.8—Protection of adjacent surfaces

Chapter 6—Proportioning and preconstruction testing, p. 506R-24

- 6.1—Introduction
- 6.2—Performance versus prescription specification
- 6.3—Proportioning of shotcrete mixture
- 6.4—Preconstruction testing

Chapter 7—Batching and mixing, p. 506R-26

- 7.1—Introduction
- 7.2—Batching
- 7.3—Mixing

Chapter 8—Shotcrete placement, p. 506R-27

- 8.1—Introduction
- 8.2—Special applications and mixtures
- 8.3—Preliminary procedures
- 8.4—Shotcrete equipment procedures
- 8.5—Application of shotcrete
- 8.6—Finishing
- 8.7—Tolerances
- 8.8—Curing
- 8.9—Hot-weather shotcreting
- 8.10—Cold-weather shotcreting
- 8.11—Hazards

Chapter 9—Quality control, p. 506R-35

- 9.1—Introduction
- 9.2—Design and quality control
- 9.3—Materials
- 9.4—Application equipment
- 9.5—Craftsmanship
- 9.6—Placement techniques
- 9.7—Inspection
- 9.8—Testing procedures

Chapter 10—References, p. 506R-36

- 10.1—Referenced standards and reports
- 10.2—Cited references

Appendix—Payment for shotcrete work, p. 506R-38

- A.1—Introduction
- A.2—Payment methods
- A.3—Factors affecting payment
- A.4—Supplementary items
- A.5—Methods of measurement
- A.6—Pay items

CHAPTER 1—GENERAL

1.1—Introduction

Shotcrete has grown into an important and widely used construction technique. Because of continuing research and development in materials, equipment, and construction procedures, this guide is revised periodically to reflect current industry practice. The guide was originally prepared to replace “Recommended Practice for Shotcreting” (ACI 506-66, Revised 1983).

1.2—Scope

This guide, based on many years of practice and experience, covers aspects of shotcrete construction including materials, equipment, crew organization, preliminary preparation, proportioning, shotcrete placement, and quality control. New construction, repair, linings, coatings, refractories, underground support, and other special applications are also discussed. An appendix on suggested methods of payment is included. Procedures vary from one region to another, and adjustments may be required to meet the needs of a particular project. No attempt is made to provide guidelines for the design of shotcrete installations.

1.3—History

In 1910, a double-chambered cement gun, based on a design developed by Carl Akeley, was introduced to the construction industry. The sand-cement product produced by this device was given the proprietary name Gunite. In the ensuing years, trademarks such as Guncrete, Pneucrete, Blastcrete, Blocrete, Jetcrete, and the terms “pneumatically applied mortar or concrete” and “sprayed concrete” were introduced to describe similar processes. The early 1930s saw the generic term “shotcrete” introduced by the American Railway Engineering Association to describe the Gunite process. In 1951, the American Concrete Institute adopted the term “shotcrete” to describe the dry-mix process. It is now also applied to the wet-mix process and has gained widespread acceptance in the United States and around the world (ACI Committee 506 1966).

The 1950s saw the introduction of dry-mix guns, which applied mixtures containing coarse aggregate; wet-mix shotcrete equipment; and the rotary gun, a continuous feed device. Many improvements were made to wet-mix equipment and materials in the 1970s and 1980s. These improvements allowed pumping low-slump concrete longer distances at greater volumes. These innovations enhanced the utility, flexibility, and general effectiveness of the process. The development of centrifugally applied concrete and low-pressure, low-velocity wet-process mortar and concrete are not considered shotcrete in this guide because they do not comply with the current definition of shotcrete or they do not achieve sufficient compaction (ACI Compilation No. 6 1987).

1.4—Definitions

The following definitions cover terms used in shotcreting:

air ring—a perforated manifold in the nozzle of wet-mix shotcrete equipment through which high-pressure air is introduced into the material flow.