

ACI 515.2R-13

**Guide to Selecting Protective
Treatments for Concrete**

Reported by ACI Committee 515



American Concrete Institute®



American Concrete Institute®
Advancing concrete knowledge

First Printing
July 2013

Guide to Selecting Protective Treatments for Concrete

Copyright by the American Concrete Institute, Farmington Hills, MI. All rights reserved. This material may not be reproduced or copied, in whole or part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of ACI.

The technical committees responsible for ACI committee reports and standards strive to avoid ambiguities, omissions, and errors in these documents. In spite of these efforts, the users of ACI documents occasionally find information or requirements that may be subject to more than one interpretation or may be incomplete or incorrect. Users who have suggestions for the improvement of ACI documents are requested to contact ACI via the errata website at www.concrete.org/committees/errata.asp. Proper use of this document includes periodically checking for errata for the most up-to-date revisions.

ACI committee documents are 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. Individuals who use this publication in any way assume all risk and accept total responsibility for the application and use of this information.

All information in this publication is provided “as is” without warranty of any kind, either express or implied, including but not limited to, the implied warranties of merchantability, fitness for a particular purpose or non-infringement.

ACI and its members disclaim liability for damages of any kind, including any special, indirect, incidental, or consequential damages, including without limitation, lost revenues or lost profits, which may result from the use of this publication.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. ACI does not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations, including but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.

Participation by governmental representatives in the work of the American Concrete Institute and in the development of Institute standards does not constitute governmental endorsement of ACI or the standards that it develops.

Order information: ACI documents are available in print, by download, on CD-ROM, through electronic subscription, or reprint and may be obtained by contacting ACI.

Most ACI standards and committee reports are gathered together in the annually revised *ACI Manual of Concrete Practice* (MCP).

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
U.S.A.
Phone: 248-848-3700
Fax: 248-848-3701

www.concrete.org

ISBN-13: 978-0-87031-825-2
ISBN: 0-87031-825-X

Guide to Selecting Protective Treatments for Concrete

Reported by ACI Committee 515

Fred R. Goodwin, Chair

Terry J. Willems, Secretary

Ralph T. Brown
Dianne Carey
Stephen D. Disch
H. Peter Golter

Edward P. McGettigan
Oon-Soo Ooi
Keith A. Pashina
Arthur T. Weiss Jr.

Consulting members
Jon B. Ardahl
Charles O. Pratt
Ronald R. Stankie

Concrete structures can be subjected to physical or chemical attacks by various substances, including water, acids, alkalis, salt solutions, and organic chemicals. Damage may vary in intensity from surface discoloration or roughening to catastrophic loss of structural integrity due to acid attack. This guide addresses the effects of various substances on untreated concrete and provides recommendations for protective treatments.

Keywords: acids; alkali; chemical attack; coal tar distillates; coatings; deicer; distress; durability; exposure condition; fatty acids; hardener; membrane; petroleum oils; protective treatment; resin; salt solution; sealer; solvents; topping; vegetable oils.

CONTENTS

CHAPTER 1—INTRODUCTION AND SCOPE, p. 2

- 1.1—Introduction, p. 2
- 1.2—Scope, p. 2

CHAPTER 2—NOTATION AND DEFINITIONS, p. 2

- 2.1—Notation, p. 2
- 2.2—Definitions, p. 3

ACI Committee Reports, Guides, 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 3—TABLES OF CHEMICALS, THEIR EFFECTS ON CONCRETE, AND PROTECTIVE TREATMENTS, p. 3

- 3.1—Aggressive substances, p. 3
- 3.2—Treatment methods, p. 3

CHAPTER 4—PROTECTIVE TREATMENTS AND SYSTEMS DESCRIPTIONS, p. 13

- 4.1—Magnesium fluosilicate or zinc fluosilicate, p. 13
- 4.2—Alkali silicates, sodium silicate (water glass), potassium silicate, lithium silicate, p. 13
- 4.3—Drying oils, p. 13
- 4.4—Coumarone-indene resin, p. 14
- 4.5—Styrene-butadiene (SBR) copolymer resin, p. 14
- 4.6—Chlorinated rubber, p. 14
- 4.7—Chlorosulfonated polyethylene (hypalon), p. 14
- 4.8—Vinyls and latex-based materials, p. 14
- 4.9—Bituminous paints, mastics, and enamels, p. 15
- 4.10—Polyester and vinyl ester materials, p. 15
- 4.11—Polyurethane/urethane, p. 16
- 4.12—Epoxy, p. 16
- 4.13—Neoprene, p. 17
- 4.14—Polysulfide, p. 17
- 4.15—Coal tar and coal-tar epoxy, p. 17
- 4.16—Chemical-resistant masonry units, mortars, grouts, and concretes, p. 18
- 4.17—Sheet rubber, p. 20
- 4.18—Resin sheets, p. 20
- 4.19—Lead sheet, p. 20
- 4.20—Glass, p. 20

ACI 515.2R-13 was adopted and published July 2013.

Copyright © 2013, 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.

- 4.21—Acrylics, methyl methacrylate (MMA), and high-molecular-weight methacrylate (HMWM), p. 20
- 4.22—Silane, siloxane, and siliconates (organosilicon compounds), p. 20
- 4.23—Metalizing, p. 22
- 4.24—Crystalline coatings and admixtures, p. 22
- 4.25—Polyurea, p. 22
- 4.26—Adjunct additives, p. 23

CHAPTER 5—REFERENCES, p. 23

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

The rate of attack on concrete is directly related to the activity of aggressive chemicals. Solutions of high concentration are generally more corrosive than those of low concentration and produce more rapid disintegration of concrete, although, in some cases, the reverse is true. The rate of attack might be altered by the solubility of the reaction products based on concrete type. A lower hydroxide ion concentration generally causes more rapid attack on concrete surfaces. Also, because high temperatures usually accelerate chemical attack as compared to normal temperatures, better protection is required for concrete as temperature increases. Rapid disintegration in the context used refers to immediate and very aggressive attack. Slow disintegration refers to attack over a time period of months to years, depending on the factors previously described as well as interactions with other substances.

Generally there are three methods for mitigating chemical attack: 1) choosing the optimized concrete mixture to make it less permeable (ACI 201.2R); 2) isolating it from the agents causing chemical attack by using a suitable coating, overlay, lining, or barrier; or 3) modifying the composition, temperature, or other factors affecting the rate of chemical attack to make it less aggressive to the concrete (Addis 1994). Isolation materials include coatings, sheet membranes, chemical-resistant grouted masonry (brick and tile), as well as combinations of these materials; it is not uncommon to use a membrane between the substrate concrete and chemical-resistant masonry for a redundant protective system. The focus of this document is selection of materials to isolate the concrete from aggressive chemical substances. When protective material is bonded to concrete, bond strength should be evaluated and should be in compliance with the producer's and specifier's requirements.

Kuenning (1966) studied the nature of aggressive chemicals, modes of attack, and reaction products for mortars exposed to acids, alcohols, aluminates, amino acids, ammonium salts, benzene, borates, carbonates, chlorates, chlorides, chromates, esters, ferrocyanides, fluosilicates, linseed oils, magnesium salts, manganates, molybdates, nitrates, nitrites, phosphates, seawater, stannates, sulfates, and sugars. Type I and Type V cements were studied at varying water-cement ratios (w/c). The study found resistance of mortar to chemical attack was increased by a longer period of curing and a decrease in w/c . Type V cement mortar was more resis-

tant to sulfate attack than the other mortars, but not to acidic sulfates or those that contained ammonium or magnesium. The zero- C_3A cement mortar generally had lower resistance to chemical attack than Type V.

Basson (1989) created an aggressiveness index taken from a chemical analysis of a water sample adjusted by factors such as prevailing temperature, flow conditions, or wet and dry cycles of the exposed concrete (National Association of Corrosion Engineers 1991). Guidelines with protective treatments are given in Chapter 4.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. ACI does not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations, including but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.

This information, based both on literature sources and experience, must be considered a guide to assist in designing a test program using the concrete mixtures and chemicals for a specific application. Many of the recommended treatments were taken from Kerkhoff (2001).

Unless otherwise specified, percentage concentration of dissolved substance is the mass concentration of solute in solvent (assumed to be water unless otherwise described).

1.2—Scope

This guide refers to common protective treatments for the chemicals classified in Tables 3.1a through 3.1h. More exotic treatments, such as lead sheet, glass, or metalizing are included, but not usually called for except in extreme or unusual circumstances. Because various treatments provide different degrees of protection, product producers should be consulted for each application.

In all cases, specific recommendations from material producers should be followed instead of the general guidance given in this guide, as individual treatment types vary widely within a specific product type. Specific product recommendations are beyond the scope or intent of this guide.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

Special notation characters are referenced in Tables 3.1a through 3.1h to provide further clarification of specific chemicals and are shown as letters in the column headed "Notes."

- a = sometimes used in food processing or as food or beverage ingredient; ask for advisory opinion of Food and Drug Administration (FDA) regarding coatings for use with food ingredients.
- b = water with a pH higher than 6.5 may be aggressive if it also contains bicarbonates; natural water is usually of pH higher than 7.0 and seldom lower than 6.0, though pH values as low as 0.4 have been