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Guide to Selecting Protective Treatments for Concrete

Reported by ACI Committee 515

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Guide to Selecting Protective Treatments for Concrete

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Guide to Selecting Protective Treatments for Concrete

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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.

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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 resistant 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.

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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