# Guide to External Curing of Concrete

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# Guide to External Curing of Concrete

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# Guide to External Curing of Concrete

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*This guide reviews and describes practices, procedures, materials, and monitoring methods for the external curing of concrete and provides guidance for specifying curing procedures. Current curing techniques are presented and commonly accepted methods, procedures, and materials are described. Methods are given for [illegible] structures and buildings, pavements and other slabs-on-ground, and for mass concrete. Curing methods for several specific categories of cement-based products are discussed in the document.*

*The materials, processes, quality control measures, and inspections described in this document should be [illegible], monitored, or performed as applicable only by individuals holding the appropriate ACI certifications or equivalent.*



**Keywords:** cold weather construction; curing compound; hot weather construction; mass concrete; [illegible]forced concrete; sealer; shotcrete; slabs-on-ground.



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## CONTENTS




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## CHAPTER 1—INTRODUCTION

### 1.1—Introduction

The principles and practices of external curing are applicable to all types of concrete construction. This document does not fully address curing for specialty concrete and special construction techniques (refer to 4.5), nor does it fully address internally cured concrete. For additional information on internally cured concrete using preconditioned absorptive lightweight aggregates, refer to ACI (308-13). Curing measures, in general, are specified in ACI 308.1. Curing measures directed toward the maintenance of satisfactory concrete temperature under specific environmental conditions are addressed in greater detail in ACI 305R, ACI 306R, ACI 301, and ACI 318.

The fundamental principles of external curing remain the same as in the past; however, new research and methods of curing are presented herein. Topics such as internal curing, curing at elevated temperatures, sustainability, curing of moisture-sensitive flooring, sensors for mass concrete curing, and new curing monitoring techniques have been added or enhanced in this document.

### 1.2—Curing

Curing is an action taken to maintain moisture and temperature conditions in a freshly placed cementitious mixture to allow hydraulic cement hydration and, if pozzolans are used, pozzolanic reactions to occur so that the potential properties of the mixture may develop. A mixture is properly proportioned and adequately cured when the properties of the in-place concrete equal or exceed the design properties of the concrete. The curing period begins at placing and continues until the desired concrete properties have developed. The objectives of curing are to prevent the loss of moisture from concrete and maintain a favorable concrete temperature for a sufficient period of time. Proper curing allows the cementitious material within the concrete to properly hydrate. Hydration is the chemical reaction that leads to changes that take place when portland cement reacts with water. Both at depth and near the surface, curing has a significant influence on the properties of hardened concrete, such as strength, permeability, abrasion resistance, volume stability, propensity for early-age cracking, and resistance to freezing and thawing and deicing chemicals.

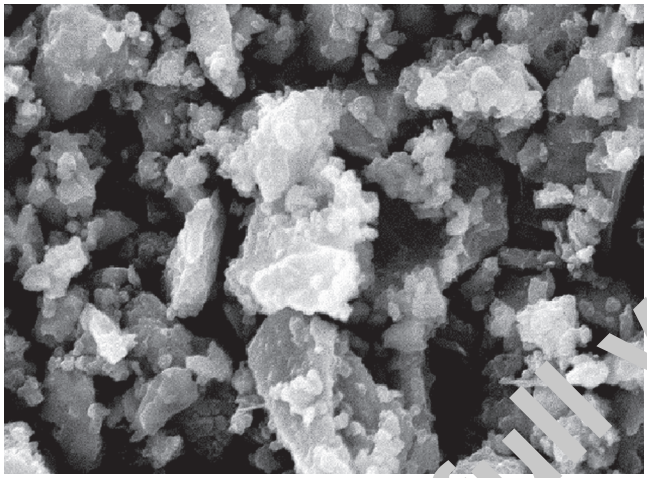

*Fig. 1.3.1a—Unhydrated particles of portland cement—magnification 2000× (Soroos 1994).*

The term "curing" has also been used in a more general sense to describe the process by which hydraulic cementitious concrete matures and develops hardened properties over time as a result of the continued hydration of the cementitious materials in the presence of sufficient water and heat. While all concrete hydrates to varying levels of maturity with time, the rate and extent to which this development takes place depends on the natural environment surrounding the concrete and on the measures taken to modify this environment by limiting the loss of water, heat, or both, from the concrete; externally providing moisture and heat; or incorporating special materials in the mixture design.

### 1.3—Curing and hydration of portland cement

**1.3.1** *Hydration of portland cement*—Portland-cement concrete is a composite material in which aggregates are bound in a porous matrix of hardened cement paste. At the microscale, the hardened paste is held together by bonds that develop between the products of the reaction of cement with water and mechanically interlocks the aggregate. Similar products are formed from the reactions between cement, other cementitious materials, and water.

The cement-water reaction includes both chemical and physical processes that are collectively known as the hydration of the cement (Taylor 1997). As the hydration process continues, the strength of the interparticle bonding increases,

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