IN-LB	Inch-Pound Units
SI	International System of Units

Shrinkage-Compensating Concrete—Guide

Reported by ACI Committee 223

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
Phone: +1.248.848.3700
Fax: +1.248.848.3701

www.concrete.org

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Shrinkage-compensating concrete is used in construction to minimize drying-shrinkage cracking. Its characteristics are similar to those of portland-cement concrete. The materials, proportions, placement, and curing should ensure that expansion compensates for subsequent drying shrinkage.

This guide sets forth criteria and practices to ensure the development of expansive strain in concrete. In addition to a discussion of basic principles, methods and details are given covering structural design details and applications, concrete mixture proportioning, placement, finishing, and curing.

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

Keywords: calcium cement; drying shrinkage; expansion cement; mixture proportions; restraints; shrinkage-compensating concrete; shrinkage cracking; slab-on-ground; structural design.

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CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Shrinkage-compensating concrete is made with an expansive cement or expansive component system in which initial expansion, if properly restrained, offsets strains caused by drying shrinkage. Since the mid-1960s, shrinkage-compensating concrete has been used in many applications. These applications include highway and airport pavements (McLean et al. 2016; Ramseyer and Roswurm 2019), bridge decks (Gruner and Plain 1993; Ramey et al. 1999; Gagné et al. 2008), hydraulic structures (Ramseyer et al. 2016), wastewater treatment plants, containment structures (Valentine 1994), post-tensioned structures (Hoffman 1980; Eskildsen et al. 2009), parking structures (Bondy 2010, 2011), and slabs-on-ground (Keith et al. 1996, 2006; Bailey et al. 2001; Shadravan et al. 2016; Ramseyer and Roswurm 2016).

Shrinkage-compensating concrete is used to minimize cracking and structural movement caused by drying shrinkage in concrete. Drying shrinkage is the contraction in the concrete caused by moisture loss from drying concrete. It does not include plastic volume changes that occur before setting when surface evaporation exceeds concrete bleeding rate or length and volume changes induced by temperature, structural loads, or chemical reactions.

The amount of drying shrinkage that occurs in concrete structures depends on the constituent materials, mixture proportions, curing, drying environment, and restraint. Tensile stresses caused by restraint to drying shrinkage can occur before concrete tensile strength is fully developed. When concrete is restrained by reinforcement, subgrade friction, or other means, drying shrinkage causes tensile stresses to develop. When drying shrinkage stresses exceed the tensile strength of the concrete, it cracks. The spacing and size of cracks that develop in structures depend on the amount of shrinkage, degree of restraint, and amount of reinforcement.

Shrinkage-compensating concrete is proportioned so concrete volume increases after setting and during early-age hardening. When restrained by reinforcement, concrete expansion results in tension in reinforcement and compression in concrete. Upon drying, the shrinkage, instead of causing tensile stress that results in cracking, relieves compressive stresses caused by initial expansion of the shrinkage-compensating concrete.

1.2—Scope

Recommendations of this guide include proportioning, mixing, placing, finishing, curing, and testing. Shrinkage-compensating concrete is produced using expansive cements or expansive component systems.

There have been significant changes and advances in the use of shrinkage-compensating concrete since it was first introduced into the market but, in some areas, the original practices remain the best current practice. Although many references used in this guide are over 10 years old, they remain a valid reference to today's practice.

CHAPTER 2—DEFINITIONS

2.1—Definitions

Please refer to the latest version of ACI Concrete Terminology for a comprehensive list of definitions. Definitions provided herein complement that resource.

expansive component system—combination of portland cement and expansive component that, when mixed with water, forms a paste that, after setting, increases in volume to a significantly greater degree than portland cement paste.

1. expansive component Type K—blend of calcium sulfoaluminate and calcium sulfate that produces ettringite when mixed with portland cement and water.
2. expansive component Type M—blend of calcium-aluminate cement and calcium sulfate that produces ettringite when mixed with portland cement and water.
3. expansive component Type S—blend of tricalcium aluminate (C_3A) cement and calcium sulfate that produces ettringite when mixed with portland cement and water.
4. expansive component Type G—blend of calcium oxide (CaO) (SiO_2 and Al_2O_3) that produces calcium hydroxide platelet crystals when mixed with portland cement and water.

CHAPTER 3—GENERAL CONSIDERATIONS

Drying shrinkage of concrete is affected mainly by water content, aggregate composition and size, drying environment, mixture proportions, paste content, and binder characteristics. Lower water content, aggregate with a higher modulus of elasticity, larger aggregate size, longer moist curing, and leaner mixtures reduce drying shrinkage.