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Report on Controlled Low-Strength Materials

Reported by ACI Committee 229

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Report on Controlled Low-Strength Materials

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CONTENTS

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CHAPTER 1—INTRODUCTION

Controlled low-strength material (CLSM) is a self-consolidating cementitious material used primarily as a backfill as an alternative to compacted fill. Terms used to describe this material include flowable fill, controlled density fill, flowable mortar, plastic soil-cement, and soil-cement slurry.

CLSM is a mixture intended to result in a compressive strength of 1200 psi (8.3 MPa) or less. Most CLSM applications require unconfined compressive strengths of 300 psi (2.1 MPa) or less. Long-term strengths (90 to 180 days) should be targeted to be less than 100 psi (0.7 MPa) for excavation with hand tools. Lower-strength requirements are necessary to allow for future excavation of CLSM.

The term "CLSM" is used to describe a family of mixtures for various applications. CLSM mixtures can also be developed as anticorrosion fills, electrically conductive materials, low-permeability fills, thermal fills, and durable pavement bases. For example, the upper limit of 1200 psi (8.3 MPa) allows use of this material for applications where future excavation is unlikely, such as structural fill under buildings. CLSM is a self-consolidated backfill or fill material that is used in place of compacted earth fill and should not be considered as a type of low-strength concrete. Generally, CLSM mixtures are not designed to resist freezing and thawing, abrasive or erosive forces, or aggressive chemicals. Using recycled materials can maximize recycled material content for sustainable construction. Nonstandard materials that have been tested and found to satisfy the intended application can be used to produce CLSM. Chapter 9 describes low-density (LD) CLSM produced using preformed foam as part of the mixture proportioning. Using preformed foam in LD-CLSM mixtures allows these materials to be produced having unit weights lower than those of typical CLSM. The distinctive properties of LD-CLSM and procedures for mixing it are discussed in Chapter 9.

CLSM typically requires no consolidation or special curing procedures to achieve desired strength and should not be confused with compacted soil-cement, as reported in ACI 230.1R. Long-term compressive strengths for compacted soil-cement often exceed the 1200 psi (8.3 MPa) maximum limit established for CLSM.

Long-term compressive strengths of 50 to 300 psi (0.3 to 2.1 MPa) are low when compared with conventional concrete. In terms of allowable bearing pressure, however—which is a common criterion for measuring the capacity of a soil to support a load—50 to 100 psi (0.3 to 0.7 MPa) strength is equivalent to a well-compacted fill.

Although CLSM generally costs more per cubic yard (cubic meter) than most soil or granular backfill materials, its many advantages often result in lower in-place costs. In fact, for some applications, CLSM is the only reasonable backfill method available (Adaska 1994, 1997; Ramme 1997). Table 1 lists a number of advantages to using CLSM (Smith 1991).

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

E = modulus of elasticity, psi (MPa)
f_c' = 28-day specified compressive strength of concrete, psi (kPa)
k = coefficient of permeability, in./s (mm/s)
RE = removability modulus
W = dry mass density, lb/ft^3 (kg/m^3)

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology," http://terminology.concrete.org.

CHAPTER 3—APPLICATIONS

3.1—General

The primary application of CLSM is as a structural fill or backfill in place of compacted soil. Because CLSM needs minimal consolidation and can be designed to be fluid, it is useful in areas where placing and compacting fill is difficult. If future excavation is anticipated, the maximum long-term compressive strength should generally not exceed 100 psi (0.7 MPa). The following applications present a range of uses for CLSM (Sullivan 1997).

3.2—Backfills

CLSM can be readily placed into a trench, hole, or other cavity (Fig. 3.2a and 3.2b). Compaction or consolidation equipment is not required; hence, trench width or excavation size can be reduced. Granular or site-excavated backfill, even if compacted or consolidated in the required layer thickness, cannot achieve the uniformity and density of CLSM (Sullivan 1997).

When backfilling against retaining walls, consideration should be given to lateral pressures exerted on the wall by flowable CLSM. Where lateral fluid pressure is a concern,

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