Guide for Cast-in-Place Low-Density Cellular Concrete

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This guide provides information on the materials, properties, design, proper handling, and applications of cast-in-place low-density cellular concretes having oven-dry densities of 50 lb/ft^3 (800 kg/m^3) or less. Roof deck systems and geotechnical applications often incorporate these low-density cellular concretes.

Keywords: cellular concrete; engineered fill; foaming agent; geotechnical fill; insulating concrete; insulating concrete roof decks; low-density cellular concrete; low-density controlled low-strength material (LD-CLSM); preformed foam.

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CHAPTER 1—GENERAL

1.1—Definition of cellular concrete

Low-density cellular concrete (Fig. 1.1) is defined as concrete made with hydraulic cement, water, and preformed foam to form a hardened material having an oven-dry density of 50 lb/ft^3 (800 kg/m^3) or less. These mixtures may include aggregate and other material components including, but not limited to, fly ash and chemical admixtures.

This guide provides data and techniques pertaining to the properties and applications of cast-in-place low-density cellular concrete. Common applications of cast-in-place low-density cellular concrete are on roof decks and geotechnical applications. On roof decks, the material provides roofing base, thermal insulation, and drainage slope for flat-roofed industrial and commercial buildings (Fig. 1.2).

In geotechnical applications, the material is applied in thick sections of cellular concrete with low compressive strengths (Fig. 1.3) for the replacement of poor soils, fills for abandoned structures (pipelines), and cellular concrete fills designed, mixed, and placed to meet specific job conditions and functional requirements.

1.2—Definition of low-density, controlled low-strength material (LD-CLSM)

Controlled low-strength material (CLSM) is a cementitious material that is in a flowable state at the time of placement, and that has a specified compressive strength of 1200 psi (8.3 MPa) or less at the age of 28 days. This material is discussed further in ACI 229R. Low-density CLSM (LD-CLSM) meets this definition, and has a cast density that is controllable from 20 to 50 lb/ft^3 (320 to 800 kg/m^3). The quantity of preformed foam in the mixture determines the mixture's final density.

CHAPTER 2—MATERIALS

The basic materials in low-density cellular concrete are cement, water, and preformed foam. Because the main ingredient by volume of a low-density cellular concrete mixture is preformed foam, it is critical that all admixtures be compatible with the preformed foam within the specific mixture. Trial mixture tests are needed to determine compatibility and the resulting physical properties. Low-density cellular concrete mixtures may also include supplementary cementitious materials.

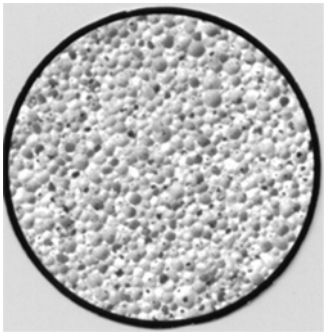

Fig. 1.1—Typical cell structure of cellular concrete.

Fig. 1.2—Roof deck application (click on picture to view video).

Fig. 1.3—Geotechnical application (click on picture to view video).

2.1—Cement

The cement should meet the requirements of ASTM C 150 (portland cement), C 595 (blended cement), or C 1157 (hydraulic cement). Blended cements include cement containing combinations of portland cement, pozzolans, slag, other hydraulic cement, or some combination of these. Blended cement may result in lower rates of early strength

development and should be tested for specific applications. High-early-strength (Type III or HE) cement produces cellular concrete with higher rates of early strength development.

2.2—Water

Mixing water for concrete should be clean and free from detrimental amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or reinforcement. Any nonpotable water should be tested for hardness, pH, suspended solids, total salt content, and other characteristics that might affect the preformed foam, the setting time, and the strength of the low-density cellular concrete.

2.3—Preformed foam

Preformed foam is created by diluting a liquid foam concentrate with water in predetermined proportions (Fig. 2.1) and passing this mixture through a foam generator. Meter the preformed foam directly into the cement-water slurry at the job site (Fig. 2.2). The density of the preformed foam is typically between 2.5 and 4.0 lb/ft^3 (40 and 65 kg/m^3).

The foam concentrate should have a chemical composition capable of producing and maintaining stable air cells within the concrete mixture. The air cells should be able to resist the physical and chemical forces imposed during mixing, pumping, placing, and setting of the cellular concrete. If the cellular (air-cell) structure is not stable, it may break down under these forces, resulting in an increased concrete density. Most common proprietary formulations of foam concentrates contain protein hydrozylates or synthetic surfactants. ASTM C 796 provides a standard method for laboratory measurement of the performance of a foaming chemical to be used in producing foam (air cells) for making cellular concrete. ASTM C 869 is a standard specification that covers foaming agents specifically formulated for making preformed foam for use in the production of cellular concrete. This specification provides the means for evaluating the performance of a specific foaming agent. Further information concerning these formulations and the procedures for using them is available from foam manufacturers.

2.4—Aggregates

Low-density cellular concrete may include lightweight aggregates such as vermiculite or perlite meeting the requirements of ASTM C 332 Group 1 to lower the slump to achieve steeper roof slopes, and to maintain moisture in dry climates. Wilson (1981) provides additional information on the use of lightweight aggregates used in cellular concrete. Any proposed aggregates should be tested for physical properties, pumpability, and compatibility in trial mixtures.

2.5—Admixtures

2.5.1 *Chemical admixtures*—Chemical admixtures, such as water-reducing admixtures and set accelerators, are used with cellular concretes. Water-reducing admixtures can improve compressive strength for special mixtures or applications. Hot water, high-early-strength (Type III or HE) cement, and chemical accelerators can be used singly or in combination

Fig. 2.1—Diluting foam concentrate in water (click on picture to view video).

Fig. 2.2—Metering preformed foam into cement-water slurry (click on picture to view video).

to accelerate setting. Accelerators containing chloride ions should not be used in cellular concrete placed in contact with steel. Chemical admixtures should conform to ASTM C 494 and be used at dosages recommended by the manufacturer or determined by trial mixtures.

Not all chemical admixtures are compatible for use in foamed cellular concrete. Individual manufacturers of foam concentrate should be contacted for information about the compatibility of specific admixtures with their foam concentrates, and trial batches should be used to determine the resulting mixture characteristics.

2.5.2 *Supplementary cementitious materials*—In the production of cellular concrete, supplementary cementitious materials such as fly ash, silica fume, high reactivity metakaolin, or ground-granulated blast-furnace slag (slag cement) are included to reduce bleeding and segregation and to increase strength. Trial batches should be used to confirm the compatibility of the selected foam concentrate with other admixtures, and to help determine the proper admixture dosages and resulting physical properties. Various mineral admixtures may differ considerably in composition, fineness, and other properties. The user should review major fly ash properties—loss on ignition (LOI), cementing activity, and