Guide for Cellular Concretes Above 50 pcf, and for Aggregate Concretes Above 50 pcf with Compressive Strengths Less Than 2500 psi

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This guide presents information on materials, fabrication, properties, design, and handling of cellular concretes with oven-dry densities greater than 50 pcf (800 kg/m^3) and aggregate concretes with oven-dry densities above 50 pcf (800 kg/m^3) but whose compressive strengths are less than 2500 psi (17.24 MPa). The usual density range of the concrete considered is 50 to 120 pcf. Those concretes in the lower portion of this range are generally used for thermal and sound insulation fills for roofs, walls, and floors. At the higher densities they are used in cast-in-place walls, floors, and roofs, and also for precast elements such as wall and floor panels.

Keywords: cellular concretes; compressive strength; concrete construction; fire resistance; formwork (construction); insulating concretes; lightweight aggregate concretes; lightweight concretes; mixture proportioning; modulus of elasticity; precast concrete; shear properties; splitting tensile strength; structural design; thermal conductivity.

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ACI 523.3R-93 supersedes ACI 523.3R-75 (Revised 1982) and became effective November 1, 1993.

INTRODUCTION

The concretes that are the subject of this guide have applications ranging from insulating fills to structural elements. This is made possible mainly by the control of density which in turn affects other properties such as strength, modulus of elasticity, and thermal conductivity. Some of the present commercial uses of these concretes are:

1. Fills for thermal and sound insulation of floors, walls, and roofs
2. Cast-in-place walls, floors, and roofs
3. Precast elements such as wall and floor panels.

The steadily increasing use of these concretes and the fact that they are specifically not covered in other ACI guides and standards have led to the preparation of this guide.

CHAPTER 1—GENERAL

1.1—Scope

This guide applies to all cellular concretes that weigh more than 50 pcf (800 kg/m^3) oven-dry and also to aggregate concretes that weigh more than 50 pcf (800 kg/m^3) oven-dry but have a compressive strength less than 2500 psi (175 kgf/cm^2). Lightweight aggregate concretes of higher strength are, by definition, within the scope of ACI Committee 213, Lightweight Aggregates and Lightweight Aggregate Concrete.

Both precast and cast-in-place concretes are within the scope of this guide.

1.2—Objective

The objective is to assemble, in this guide, the presently available information relating to the properties and use of the subject concretes. It is intended that such information will be an aid in the selection, proportioning, production, and use of these concretes.

1.3—Definitions

The terms "cellular concrete" and "aggregate concrete" are used throughout this guide. These terms have many meanings throughout the various areas of concrete technology but are defined as follows for use in this guide:

1.3.1 *Cellular concretes*—The cellular concretes referred to in this guide are lightweight concretes that contain stable air or gas cells uniformly distributed in the mixture. In the density range covered by this guide, cellular concretes commonly include natural or manufactured sand aggregate. Other types of aggregates may be added; for example, manufactured lightweight aggregates such as expanded clay, shale, slate, sintered fly ash, perlite, and vermiculite as well as natural lightweight aggregates such as pumice, scoria, or tuff. The air cells are usually added at the mixer as a stable preformed foam metered from a calibrated nozzle and thoroughly blended into the mixture. The air cells may also be formed mechanically by entrapping air during high-speed mixing of the concrete materials containing a foaming agent. It is likewise possible to form gas cells in the mixture as the product of a chemical reaction. This guide does not cover products or processes that use gas-evolving chemical reactions. The air cells in cellular concrete are predominantly macroscopic bubbles as contrasted with the predominantly microscopic bubbles in air-entrained concrete.

1.3.2 *Aggregate concretes*—The aggregate concretes referred to in this guide are made with lightweight aggregates such as expanded clay, shale, slate, slag, sintered fly ash, perlite, and vermiculite or natural aggregates such as pumice, scoria, or tuff. These aggregates are used with or without the addition of sand. By definition, these concretes contain no air cells in the paste other than that entrapped by normal mixing and from conventional air-entraining agents.

1.4—Standards and ACI documents cited in this report

The standards of the various standards-producing organizations and ACI documents referred to in this document are listed below with their serial designation.

1.4.1 *ACI documents*

211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete
212.3R Chemical Admixtures for Concrete
213R Guide for Structural Lightweight Aggregate Concrete
318 Building Code Requirements for Reinforced Concrete
347R Guide to Formwork for Concrete
408.1R Suggested Development Splice and Standard Hook Provisions for Deformed Bars in Tension
426R Shear Strength of Reinforced Concrete Members
517.2R Accelerated Curing of Concrete at Atmospheric Pressure
544.1R Report on Fiber-Reinforced Concrete

1.4.2 *ASTM standards*

C33 Standard Specification for Concrete Aggregates