

ACI 213R-03

Guide for Structural Lightweight- Aggregate Concrete

Reported by ACI Committee 213



american concrete institute

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The guide summarizes the present state of technology. It presents and interprets the data on lightweight-aggregate concrete from many laboratory studies, accumulated experience resulting from successful use, and the performance of structural lightweight-aggregate concrete in service.

This guide includes a definition of lightweight-aggregate concrete for structural purposes, and discusses, in condensed fashion, the production methods for and inherent properties of structural lightweight aggregates. Other chapters follow on current practices for proportioning, mixing, transporting, and placing; properties of hardened concrete; and the design of structural concrete with reference to ACI 318.

Keywords: abrasion resistance; aggregate; bond; contact zone; durability;

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fire resistance; internal curing; lightweight aggregate; lightweight concrete; mixture proportion; shear; shrinkage; specified density concrete; strength; thermal conductivity.

FOREWORD

This guide covers the unique characteristics and performance of structural lightweight-aggregate concrete. General historical information is provided along with detailed information on lightweight aggregates and proportioning, mixing, and placing of concrete containing these aggregates. The physical properties of the structural lightweight aggregate along with design information and applications are also included.

Structural lightweight concrete has many and varied applications, including multistory building frames and floors, curtain walls, shell roofs, folded plates, bridges, prestressed or precast elements of all types, marine structures, and others. In many cases, the architectural expression of form combined with functional design can be achieved more readily with structural lightweight concrete than with any other medium. Many architects, engineers, and contractors recognize the inherent economies and advantages offered by this material, as evidenced by the many impressive lightweight concrete structures found today throughout the world.

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CHAPTER 1—INTRODUCTION

1.1—Objectives

The objectives of this guide are to provide information and guidelines for designing and using lightweight concrete. By using such guidelines and construction practices, the structures can be designed and performance predicted with the same confidence and reliability as normalweight concrete and other building materials.

1.2—Historical background

The first known use of lightweight concrete dates back over 2000 years. There are several lightweight concrete structures in the Mediterranean region, but the three most notable structures were built during the early Roman Empire and include the Port of Cosa, the Pantheon Dome, and the Coliseum.

The Port of Cosa, built in about 273 B.C., used lightweight concrete made from natural volcanic materials. These early builders learned that expanded aggregates were better suited for marine facilities than the locally available beach sand and gravel. They went 25 mi. (40 km) to the northeast to quarry volcanic aggregates at the Volcine complex for use in the harbor at Cosa (Bremner, Holm, and Stepanova 1994). This harbor is on the west coast of Italy and consists of a series of four piers (~ 13 ft [4 m] cubes) extending out into the sea. For two millennia they have withstood the forces of nature with only surface abrasion. They became obsolete only because of siltation of the harbor.

The Pantheon, finished in 27 B.C., incorporates concrete varying in density from the bottom to the top of the dome. Roman engineers had sufficient confidence in lightweight concrete to build a dome whose diameter of 142 ft (43.3 m) was not exceeded for almost two millennia. The structure is in excellent condition and is still being used to this day for spiritual purposes (Bremner, Holm, and Stepanova 1994).

The dome contains intricate recesses formed with wooden formwork to reduce the dead load, and the imprint of the grain of the wood can still be seen. The excellent cast surfaces that are visible to the observer show clearly that these early builders had successfully mastered the art of casting concrete made with lightweight aggregates. Vitruvius took special interest in building construction and commented on what was unusual. The fact that he did not single out lightweight concrete for comment might simply imply that these early builders were fully familiar with this material (Morgan 1960).

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