Guide for Design and Construction with Autoclaved Aerated Concrete Panels

Reported by ACI Committee 526

ACI 526R-19

American Concrete Institute
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First Printing
July 2019
ISBN: 978-1-64195-065-7

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Special acknowledgments to Alaa Abd Ali and Greg Mueller for their contributions to this guide.

This guide is intended for use by architects, engineers, contractors, building officials, and manufacturers. Its purpose is to present, in a single source, information that can help those individuals design, specify, and construct with factory-reinforced panels of autoclaved aerated concrete (AAC). In this guide, introductory information on AAC is first presented, followed by a description of its manufacture, guidance on structural design using reinforced panels, and guidance on construction with such panels. The body of this guide ends with an extensive background chapter on the material characteristics of AAC and the structural behavior and design of AAC elements.

Keywords: autoclaved aerated concrete; design; sustainability; shear wall.

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ACI 526R-19 was adopted and published July 2019.

CHAPTER 1—INTRODUCTION

1.1—Introduction

Autoclaved aerated concrete (AAC) is produced as masonry type units where it can be reinforced in the field similar to conventional concrete masonry or as factory-produced panels with reinforcement installed in the factory. Reinforcement for factory-installed panels can be supplemented with reinforcing steel as the panels are assembled in the field. Because design and construction provisions already exist for AAC masonry made from masonry-type units without factory-installed reinforcement, this guide touches only briefly on AAC masonry. Provisions for the design and construction of AAC masonry can be found in TMS 402/602. This guide addresses design, specification, and construction needs for factory-reinforced panels, for which comparable design and construction provisions do not yet exist.

This guide is also intended to be used as a starting point for the development of mandatory-language design provisions, under the mandate of ACI Committee 318 or other committee so designated by ACI. To facilitate that process, the design provisions proposed in this guide, though written in nonmandatory language as required by ACI, are arranged to follow the format of ACI 318.

Fig. 1.3—Macroscopic cellular (void) structure of AAC.

1.2—Historical background of AAC

AAC was first produced commercially in Sweden in 1923. Since that time, its production and use have spread to more than 40 countries in North America, Central and South America, Europe, the Middle East, Asia, and Australia. This wide experience has produced many case studies of use in different climates and under different building codes.

In the United States, modern uses of AAC began in 1990, for residential and commercial projects in the southeastern states. United States production of plain and reinforced AAC started in 1995 in the Southeast and has since spread to other parts of the country.

1.3—Scope and objectives of this guide

AAC, a form of cellular concrete, is a low-density cementitious product of calcium silicate hydrates in which the low density is obtained by the formation of macroscopic air bubbles, mainly by chemical reactions within the mass during the liquid or plastic phase. The air bubbles are uniformly distributed and are retained in the matrix on setting, hardening, and subsequent curing with high-pressure steam in an autoclave, to produce a homogeneous structure of macroscopic voids, or cells (Fig. 1.3). AAC is broken down into classes defined by the unit weight and compressive strength. Material specifications for this product are prescribed in ASTM C1693.

This guide is limited to AAC with a density of 50 lb/ft^3 (800 kg/m^3) or less.

The specific objectives of this guide are to:

a) Review the basic characteristics of AAC
b) Provide a brief history of structural applications of AAC
c) Review the fabrication of AAC panels
d) Recommend structural design procedures for factory-reinforced AAC panels
e) Recommend construction details for use with factory-reinforced AAC panels

The structural design procedures and construction details recommended herein are intended to result in AAC panels with reliable structural capacity, durability, appearance, and overall serviceability.

This guide is limited to AAC with a density of 50 lb/ft^3 (800 kg/m^3) or less. It is written for structural designers and addresses design using factory-reinforced AAC panels. Design of AAC masonry is also addressed in ACI 530/530.1.

The specific objectives of this guide are to:

a) Review the basic characteristics of AAC

b) Provide a brief history of structural applications of AAC

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d) Recommend structural design procedures for factory-reinforced AAC panels

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The structural design procedures and construction details recommended herein are intended to result in AAC panels with reliable structural capacity, durability, appearance, and overall serviceability.

Chapter 2 presents standard notation and definitions. Material and thermal characteristics and an introduction to manufacturing are presented in Chapter 3. A general design overview is presented in Chapter 4. In Chapter 5, handling and erection of panels are addressed. Chapter 6 presents the detailed technical justification for the proposed design provisions. References are presented in Chapter 7. Appendix A provides design examples. In Appendix B, typical design details are used to introduce the reader to specific configurations of the AAC structural elements whose design and construction are addressed by this document.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

A = area of wall, in.^{2} (mm^2)
A_s = effective cross-sectional area of horizontal reinforcement in AAC panel, in.^{2} (mm^2)
d = distance from centroid of tension steel to fiber at maximum compressive strain (taken as $0.8\ell_w$ for a shear wall), in. (mm)
d_{cross} = diameter of cross wire in reinforced AAC panel, in. (mm)
d_{long} = diameter of longitudinal wire in reinforced AAC panel, in. (mm)
E_{AAC} = modulus of elasticity of AAC, psi (MPa)
f_{AAC} = tested compressive strength of AAC, psi (MPa)
f'_{AAC} = specified compressive strength of AAC, psi (MPa)
f_{bond} = tensile bond strength of AAC, psi (kPa)
f_c = tested compressive strength of concrete, psi (MPa)
f_g' = specified compressive strength of grout, psi (MPa)
f_r = modulus of rupture of concrete, psi (kPa)
f_{rAAC} = modulus of rupture of AAC, psi (kPa)
f_s = stress developed in horizontal reinforcement of reinforced AAC panel, psi (MPa)
f_t = splitting tensile strength of concrete, psi (MPa)
f_{tAAC} = splitting tensile strength of AAC, psi (MPa)
f_y = specified yield strength of steel reinforcement, psi (MPa)
h_{crack} = height of flexural crack in a shear wall at flexure-shear cracking, in. (mm)
h_{wall} = height of shear wall, in. (mm)
L = length of a beam or floor slab including the support width, in. (mm)
ℓ_{cross} = length of transverse steel in AAC panel, in. (mm)
ℓ_n = clear span of a beam or floor slab, in. (mm)
ℓ_w = plan length of shear wall, in. (mm)
M = moment at the base of shear wall, kip-in. (kN-m)
n_{cross} = number of cross wires
n_{long} = number of longitudinal wires
P = axial force acting on wall, kip (kN)
R-value = thermal resistance of a wall system, h-ft^2°F/Btu (m^{2}K/W)
S = section modulus, in.3 (mm3)
S_{cross} = center-to-center spacing of cross wires (transverse steel) in reinforced AAC panel, in. (mm)
s_h = spacing of longitudinal wires in reinforced AAC panel, in. (mm)
t = specified thickness of shear wall, in. (mm)
U-value = thermal conductivity of a wall system, Btu/h-ft^2°F (W/m^{2}K)
V = shear at the base of shear wall, kip (kN)
V_{AAC} = shear strength provided by autoclaved aerated concrete, kip (kN)
V_c = shear strength provided by concrete, kip (kN)
V_{cr} = base shear at flexural cracking capacity, kip (kN)
V_{ds} = strength of an AAC shear wall as governed by crushing of diagonal strut, kip (kN)
V_n = nominal shear strength of a reinforced concrete section, kip (kN)
V_s = shear strength provided by the shear reinforcement, kip (kN)
V_{ss} = sliding shear capacity of AAC shear wall, kip (kN)
w = horizontal projection of the width of the diagonal strut, in. (mm)
ε_{cs} = drying shrinkage of AAC
μ = coefficient of friction
ρ_{1693} = density of AAC as defined by ASTM C1693

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource. Definitions provided herein complement that source.

autoclaved aerated concrete—cementitious product based on calcium silicate hydrates in which low density is attained by the inclusion of an agent resulting in macroscopic voids and is subjected to high-pressure steam curing.

corrosion-inhibiting coating—acrylic synthetic resin material manufactured specifically for coating smooth wire reinforcement embedded in factory-produced AAC panels; embedded wire cages are generally coated by dipping in the liquid coating after the cages are welded.