

ACI 301-10

Specifications for Structural Concrete

An ACI Standard

Reported by ACI Committee 301



American Concrete Institute®



First Printing
December 2010

American Concrete Institute®
Advancing concrete knowledge

Specifications for Structural Concrete

Copyright by the American Concrete Institute, Farmington Hills, MI. All rights reserved. This material may not be reproduced or copied, in whole or part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of ACI.

The technical committees responsible for ACI committee reports and standards strive to avoid ambiguities, omissions, and errors in these documents. In spite of these efforts, the users of ACI documents occasionally find information or requirements that may be subject to more than one interpretation or may be incomplete or incorrect. Users who have suggestions for the improvement of ACI documents are requested to contact ACI. Proper use of this document includes periodically checking for errata at www.concrete.org/committees/errata.asp for the most up-to-date revisions.

ACI committee documents are intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. Individuals who use this publication in any way assume all risk and accept total responsibility for the application and use of this information.

All information in this publication is provided “as is” without warranty of any kind, either express or implied, including but not limited to, the implied warranties of merchantability, fitness for a particular purpose or non-infringement.

ACI and its members disclaim liability for damages of any kind, including any special, indirect, incidental, or consequential damages, including without limitation, lost revenues or lost profits, which may result from the use of this publication.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. ACI does not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations, including but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.

Order information: ACI documents are available in print, by download, on CD-ROM, through electronic subscription, or reprint and may be obtained by contacting ACI.

Most ACI standards and committee reports are gathered together in the annually revised *ACI Manual of Concrete Practice* (MCP).

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
U.S.A.

Phone: 248-848-3700
Fax: 248-848-3701

www.concrete.org

ISBN 978-0-87031-403-2

Specifications for Structural Concrete

An ACI Standard

Reported by ACI Committee 301

W. Calvin McCall*
Chair

Colin L. Lobo
Secretary

James Edward Anderson
Jon B. Ardahl
Nicholas J. Carino*
Ramon J. Carrasquillo
Domingo J. Carreira
Mark F. Chrzanowski
Steven R. Close
James N. Cornell II*
Juan Pablo Covarrubias

Marwan A. Daye
Mario R. Diaz
Daniel P. Dorfmueller
Barry E. Foreman
Sidney Freedman*
John W. Gajda
David P. Gustafson
Charles S. Hanskat
Jerry S. Haught

Kenneth C. Hover*
Steven C. Jaycox
Larry B. Krauser
James A. Lee
Frank Stephen Malits
Theodore L. Neff*
Jerry Parnes
Aimee Pergalsky*
Henry B. Prenger

G. Michael Robinson
Bruce A. Suprenant
Wahid A. Tadros
Scott M. Tarr*
Arthur T. Weiss, Jr.
Michael A. Whisonant
Michelle L. Wilson*
Dennis M. Wittry
Bryan T. Wood

*Subcommittee Chairs.

Voting Subcommittee Members

Scott Michael Anderson
Roger J. Becker
Julie K. Buffenbarger
Anthony R. DeCarlo, Jr.
Darryl E. Dixon
Greg K. Fricks
Thomas M. Greene
Gardner P. Horst

Robert S. Jenkins
Larry P. Jorn
Alfred L. Kaufman, Jr.
Roy H. Keck
Donald P. Kline
Jason J. Krohn
Lionel A. Lemay

Kevin A. MacDonald
Thomas O. Malerk
Arthur W. McKinney
Andrew S. McPherson
Donald F. Meinheit
Dennis W. Phillips
Robert C. Richardson†

John R. Ries
Edward D. Russell
Gregory M. Scurto
Larbi M. Sennour
William C. Sherman
Joseph J. Steinbicker
Gregory R. Wagner

†Deceased.

ACI 301-10 supersedes ACI 301-05, was adopted June 22, 2010, and published December 2010.

Copyright © 2010, American Concrete Institute.

All rights reserved including rights of reproduction and use in any form or by any means, including the making of copies by any photo process, or by electronic or mechanical device, printed, written, or oral, or recording for sound or visual reproduction or for use in any knowledge or retrieval system or device, unless permission in writing is obtained from the copyright proprietors.

This is a Reference Specification that the Architect/Engineer can apply to any construction project involving structural concrete by citing it in the Project Specifications. Checklists are provided to assist the Architect/Engineer in supplementing the provisions of this Reference Specification as needed by designating or specifying individual project requirements.

The first five sections of this document cover general construction requirements for cast-in-place structural concrete and slabs-on-ground. These sections cover materials and proportioning of concrete; reinforcement and prestressing steel; production, placing, finishing, and curing of concrete; formwork performance criteria and construction; treatment of joints; embedded items; repair of surface defects; and finishing of formed and unformed surfaces. Provisions governing testing, evaluation, and acceptance of concrete as well as acceptance of the structures are included. The remaining sections are devoted to architectural concrete, lightweight concrete, mass concrete, post-tensioned concrete, shrinkage-compensating concrete, industrial floor slabs, tilt-up construction, precast structural concrete, and precast architectural concrete.

Keywords: architectural; cold weather; compressive strength; durability; concrete slab; consolidation; curing; finish; formwork; grouting; hot weather; industrial floors; inspection; joints; lightweight concrete; mass concrete; mixture proportions; placing; precast; post-tensioned; prestressing steel; repair; reshoring; shoring; shrinkage-compensating; slabs-on-ground; steel reinforcement; testing; tilt-up; tolerance; welded wire.

CONTENTS

(mandatory portion follows)

Section 1—General requirements, p. 5

- 1.1—Scope
 - 1.1.1—Work specified
 - 1.1.2—Work not specified
 - 1.1.3—Units
- 1.2—Definitions
- 1.3—Referenced standards and cited publications
 - 1.3.1—Referenced standards
 - 1.3.2—Cited publications
 - 1.3.3—Field references
- 1.4—Standards-producing organizations
- 1.5—Submittals
 - 1.5.1—General
 - 1.5.2—Contractor's quality control
- 1.6—Quality assurance and quality control
 - 1.6.1—General
 - 1.6.2—Responsibilities of Contractor
 - 1.6.3—Responsibilities of Owner's testing agency
 - 1.6.4—Tests on hardened concrete in place
 - 1.6.5—Evaluation of concrete strength tests
 - 1.6.6—Acceptance of concrete strength
 - 1.6.7—Field acceptance of concrete
- 1.7—Acceptance of structure
 - 1.7.1—General
 - 1.7.2—Dimensional tolerances
 - 1.7.3—Appearance
 - 1.7.4—Strength of structure
 - 1.7.5—Durability
- 1.8—Protection of in-place concrete
 - 1.8.1—Loading and support of concrete
 - 1.8.2—Protection from mechanical injury

Section 2—Formwork and formwork accessories, p. 13

- 2.1—General

- 2.1.1—Description
- 2.1.2—Submittals
- 2.2—Products
 - 2.2.1—Materials
 - 2.2.2—Performance and design requirements
 - 2.2.3—Fabrication and manufacture
- 2.3—Execution
 - 2.3.1—Construction and erection of formwork
 - 2.3.2—Removal of formwork
 - 2.3.3—Reshoring and backshoring
 - 2.3.4—Strength of concrete required for removal of formwork
 - 2.3.5—Field quality control

Section 3—Reinforcement and reinforcement supports, p. 16

- 3.1—General
 - 3.1.1—Submittals
 - 3.1.2—Material storage and handling
- 3.2—Products
 - 3.2.1—Materials
 - 3.2.2—Fabrication
- 3.3—Execution
 - 3.3.1—Preparation
 - 3.3.2—Placing

Section 4—Concrete mixtures, p. 20

- 4.1—General
 - 4.1.1—Description
 - 4.1.2—Submittals
 - 4.1.3—Quality control
 - 4.1.4—Material storage and handling
- 4.2—Products
 - 4.2.1—Materials
 - 4.2.2—Performance and design requirements
 - 4.2.3—Proportioning
- 4.3—Execution
 - 4.3.1—Measuring, batching, and mixing
 - 4.3.2—Delivery

Section 5—Handling, placing, and constructing, p. 25

- 5.1—General
 - 5.1.1—Description
 - 5.1.2—Submittals
 - 5.1.3—Delivery, storage, and handling
- 5.2—Products
 - 5.2.1—Materials
 - 5.2.2—Performance and design requirements
- 5.3—Execution
 - 5.3.1—Preparation
 - 5.3.2—Placement of concrete
 - 5.3.3—Finishing formed surfaces
 - 5.3.4—Finishing unformed surfaces
 - 5.3.5—Sawed joints
 - 5.3.6—Curing and protection
 - 5.3.7—Repair of surface defects

Section 6—Architectural concrete, p. 30

- 6.1—General

- 6.1.1—Description
- 6.1.2—Submittals
- 6.1.3—Quality control
- 6.1.4—Product delivery, storage, and handling
- 6.2—Products
 - 6.2.1—Materials
 - 6.2.2—Performance and design requirements
 - 6.2.3—Proportioning concrete mixtures
- 6.3—Execution
 - 6.3.1—Preparation
 - 6.3.2—Placement of reinforcement
 - 6.3.3—Batching, mixing, and transporting
 - 6.3.4—Conveying and placement
 - 6.3.5—Consolidation
 - 6.3.6—Formwork
 - 6.3.7—Formwork monitoring
 - 6.3.8—Formwork removal
 - 6.3.9—Repair of tie holes and surface defects
 - 6.3.10—Finishing
 - 6.3.11—Curing architectural concrete
 - 6.3.12—Final cleanup
 - 6.3.13—Final acceptance of architectural concrete

Section 7—Lightweight concrete, p. 33

- 7.1—General
 - 7.1.1—Description
 - 7.1.2—Submittals
 - 7.1.3—Aggregate storage and handling
- 7.2—Products
 - 7.2.1—Aggregates
 - 7.2.2—Performance and design requirements
 - 7.2.3—Mixtures
 - 7.2.4—Batching and mixing
- 7.3—Execution
 - 7.3.1—Consolidation
 - 7.3.2—Finishing
 - 7.3.3—Field quality control

Section 8—Mass concrete, p. 34

- 8.1—General
 - 8.1.1—Description
 - 8.1.2—General requirements
 - 8.1.3—Submittals
- 8.2—Products
 - 8.2.1—Materials
- 8.3—Execution
 - 8.3.1—Curing and protection

Section 9—Post-tensioned concrete, p. 35

- 9.1—General
 - 9.1.1—Description
 - 9.1.2—Submittals
 - 9.1.3—Quality control
 - 9.1.4—Product delivery, handling, and storage
- 9.2—Products
 - 9.2.1—Materials
 - 9.2.2—Proportioning grout mixtures
- 9.3—Execution

- 9.3.1—Installer certification
- 9.3.2—Inspection
- 9.3.3—Bonded tendon installation
- 9.3.4—Grouting
- 9.3.5—Unbonded tendon installation
- 9.3.6—Tendon tolerances
- 9.3.7—Concrete placement
- 9.3.8—Tensioning
- 9.3.9—Tendon finishing

Section 10—Shrinkage-compensating concrete, p. 42

- 10.1—General
 - 10.1.1—Description
 - 10.1.2—General requirements
 - 10.1.3—Submittals
- 10.2—Products
 - 10.2.1—Materials
 - 10.2.2—Performance and design requirements
 - 10.2.3—Proportioning
 - 10.2.4—Reinforcement
 - 10.2.5—Isolation-joint filler materials
- 10.3—Execution
 - 10.3.1—Reinforcement
 - 10.3.2—Placing
 - 10.3.3—Isolation joints
 - 10.3.4—Curing

Section 11—Industrial floor slabs, p. 43

- 11.1—General
 - 11.1.1—Description
 - 11.1.2—General requirements
 - 11.1.3—Submittals
- 11.2—Products
 - 11.2.1—Materials
 - 11.2.2—Concrete mixture
 - 11.2.3—Proportioning
 - 11.2.4—Vapor retarder
 - 11.2.5—Reinforcement
 - 11.2.6—Load-transfer devices
 - 11.2.7—Joint filler materials
 - 11.2.8—Isolation-joint filler materials
 - 11.2.9—Curing materials
 - 11.2.10—Liquid surface densifier
 - 11.2.11—Mineral or metallic shake surface hardeners
- 11.3—Execution
 - 11.3.1—Preparation
 - 11.3.2—Measuring, batching, and mixing
 - 11.3.3—Delivery
 - 11.3.4—Concrete placement
 - 11.3.5—Finishing slab surface
 - 11.3.6—Joints
 - 11.3.7—Curing and protection
 - 11.3.8—Liquid surface densifier
 - 11.3.9—Joint filling

Section 12—Tilt-up construction, p. 45

- 12.1—General

- 12.1.1—Description
- 12.1.2—Coordination
- 12.1.3—General requirements
- 12.1.4—Submittals
- 12.1.5—Tilt-up contractor qualifications
- 12.2—Products
 - 12.2.1—Aggregates
 - 12.2.2—Bearing shims
 - 12.2.3—Bond breaker
 - 12.2.4—Cast-in anchors and connections
 - 12.2.5—Coloring agent
 - 12.2.6—Curing compound
 - 12.2.7—Face mixture
 - 12.2.8—Grout
 - 12.2.9—Sandwich insulation systems
- 12.3—Execution
 - 12.3.1—Casting bed
 - 12.3.2—Bond breaker
 - 12.3.3—Reveals
 - 12.3.4—Panel identification
 - 12.3.5—Side forms
 - 12.3.6—Placing concrete
 - 12.3.7—Finishes
 - 12.3.8—Smooth finishes
 - 12.3.9—Smooth textured finishes
 - 12.3.10—Treated textured finishes
 - 12.3.11—Retarded exposed aggregate finishes
 - 12.3.12—Bush-hammered exposed aggregate finish
 - 12.3.13—Hand placed aggregate for exposed aggregate finish
 - 12.3.14—Sandblasted finish
 - 12.3.15—Veneer faced finish
 - 12.3.16—Curing of panels
 - 12.3.17—Handling and erection of panels
 - 12.3.18—Tolerances
 - 12.3.19—Testing for panel erection

Section 13—Precast structural concrete, p. 46

- 13.1—General
 - 13.1.1—Description
 - 13.1.2—Submittals
 - 13.1.3—Quality assurance
 - 13.1.4—Product delivery, storage, and handling
- 13.2—Products
 - 13.2.1—Performance requirements
 - 13.2.2—Form materials and accessories
 - 13.2.3—Prestressing steel
 - 13.2.4—Concrete materials
 - 13.2.5—Steel connection materials
 - 13.2.6—Bearing pads and other accessories
 - 13.2.7—Grout materials
 - 13.2.8—Insulated panel components and accessories

- 13.2.9—Concrete mixtures
- 13.2.10—Form fabrication
- 13.2.11—Hardware
- 13.2.12—Fabrication
- 13.2.13—Fabrication tolerances
- 13.2.14—Finishes
- 13.2.15—Source quality control
- 13.2.16—Acceptance of precast elements
- 13.2.17—Defective Work
- 13.3—Execution
 - 13.3.1—Preparation
 - 13.3.2—Examination
 - 13.3.3—Erection
 - 13.3.4—Erection tolerances
 - 13.3.5—Field quality assurance
 - 13.3.6—Repairs
 - 13.3.7—Cleaning

Section 14—Precast architectural concrete, p. 52

- 14.1—General
 - 14.1.1—Description
 - 14.1.2—Submittals
 - 14.1.3—Sample panels and mockup
- 14.2—Products
 - 14.2.1—Window washing system
 - 14.2.2—Stone to precast concrete anchorages
 - 14.2.3—Form liners
 - 14.2.4—Surface retarder
 - 14.2.5—Thin and half-brick units and accessories
 - 14.2.6—Glazed and unglazed ceramic tile units
 - 14.2.7—Architectural terra cotta units
 - 14.2.8—Setting mortar
 - 14.2.9—Latex portland cement pointing grout
 - 14.2.10—Setting systems for brick and ceramic tile
 - 14.2.11—Stone facing
 - 14.2.12—Form fabrication
 - 14.2.13—Stone facing installation
 - 14.2.14—Face and backup concrete mixtures
 - 14.2.15—Precast architectural concrete unit finishes
- 14.3—Execution
 - 14.3.1—Erection

(nonmandatory portion follows)

Notes to Specifier, p. 56

- General notes
- Foreword to checklists
- Mandatory Requirements Checklist
- Optional Requirements Checklist
- Submittals Checklist

(mandatory portion follows)

SECTION 1—GENERAL REQUIREMENTS

1.1—Scope

1.1.1 Work specified—This Specification governs the construction of cast-in-place and precast structural concrete and industrial floor slabs cast on ground.

Provisions of this Specification shall govern except where other provisions are specified in Contract Documents.

1.1.2 Work not specified—The following subjects are not in the scope of this Specification:

- Precast concrete products covered by ASTM specifications;
- Heavyweight shielding concrete;
- Slipformed paving concrete;
- Terrazzo;
- Insulating concrete;
- Refractory concrete;
- Shotcrete; and
- Slipformed concrete walls.

1.1.3 Units—Values in this Specification are stated in inch-pound units. A companion specification in SI units is also available.

1.2—Definitions

acceptable or accepted—determined to be satisfactory by Architect/Engineer.

acceptance—acknowledgment by Architect/Engineer that submittal or completed Work is acceptable.

ACI Concrete Field Testing Technician Grade I—a person who has demonstrated knowledge and ability to perform and record the results of ASTM standard tests on freshly mixed concrete and to make and cure test specimens. Such knowledge and ability shall be demonstrated by passing prescribed written and performance examinations and having credentials that are current with the American Concrete Institute.

Architect/Engineer or Engineer/Architect—Architect, Engineer, architectural firm, engineering firm, or architectural and engineering firm issuing Contract Documents or administering the Work under Contract Documents, or both.

architectural concrete—concrete that is typically exposed to view, is indicated as architectural concrete in Contract Documents, and therefore requires special care in selection of the concrete materials, forming, placing, and finishing to obtain the desired architectural appearance.

backshores—shores placed snugly under a concrete slab or structural member after the original formwork and shores have been removed from a small area at a time, without allowing the slab or member to deflect, or support its own weight or existing construction loads.

cast-in-place concrete—concrete that is deposited and allowed to harden in the place where it is required to be in the completed structure, as opposed to precast concrete.

check test—test performed to verify a previous test result of freshly-mixed concrete.

Contract Documents—a set of documents supplied by Owner to Contractor as the basis for construction; these documents contain contract forms, contract conditions, specifications, drawings, addenda, and contract changes.

Contractor—the person, firm, or entity under contract for construction of the Work.

design reference sample—sample of precast concrete color, finish, and texture that is submitted for initial verification of design intent.

duct—the material creating a conduit in a concrete member to accommodate the prestressing steel of a post-tensioning tendon.

equivalent diameter of bundle—the diameter of a circle having an area equal to the sum of the bar areas in a bundle of reinforcing bars.

expansive cement—a cement that, when mixed with water, produces a paste that, after setting, tends to increase in volume and is used to compensate for volume decrease due to shrinkage or to induce tensile stress in reinforcement.

exposed to view—portion of structure that can be observed by the public during normal use.

high-early-strength concrete—concrete that, through the use of additional cement, high-early-strength cement, or admixtures, has accelerated early-age strength development.

jack clearance—minimum space required to safely install, operate, and remove a hydraulic jack through its full range of movement in stressing of a tendon.

licensed design engineer—an individual representing the Contractor who is licensed to practice engineering as defined by the statutory requirements of the professional licensing laws of the state or jurisdiction in which the project is to be constructed.

lightweight concrete—structural concrete containing lightweight aggregate conforming to ASTM C330 and having an equilibrium density, as determined by ASTM C567, between 90 and 115 lb/ft³.

mass concrete—any volume of structural concrete in which a combination of dimensions of the member being cast, the boundary conditions, the characteristics of the concrete mixture, and the ambient conditions can lead to undesirable thermal stresses, cracking, deleterious chemical reactions, or reduction in the long-term strength as a result of elevated concrete temperature due to heat from hydration.

normalweight concrete—structural concrete containing aggregate that conforms to ASTM C33 and that typically has a density between 135 and 160 lb/ft³.

Owner—the corporation, association, partnership, individual, public body, or authority for whom the Work is constructed.

permitted—accepted by or acceptable to Architect/Engineer; usually pertains to a request by Contractor, or when specified in Contract Documents.

post-tensioning—a method of prestressing reinforced concrete in which tendons are tensioned after the concrete has attained a specified minimum in-place strength or a specified minimum age.

precast concrete—concrete cast elsewhere than its final position.

prestressed concrete—structural concrete in which internal stresses have been introduced to reduce potential tensile stresses in concrete resulting from loads (see **post-tensioning** and **pretensioning**).