An ACI Standard and Report

Building Code Requirements for Structural Concrete (ACI 318-14)

Commentary on Building Code Requirements for Structural Concrete (ACI 318R-14)

Reported by ACI Committee 318

ACI 318-14

American Concrete Institute
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Building Code Requirements for Structural Concrete and Commentary

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PREFACE TO ACI 318-14

The "Building Code Requirements for Structural Concrete" ("Code") provides minimum requirements for the materials, design, and detailing of structural concrete buildings and, where applicable, nonbuilding structures. This Code addresses structural systems, members, and connections, including cast-in-place, precast, plain, nonprestressed, prestressed, and composite construction. Among the subjects covered are: design and construction for strength, serviceability, and durability; load combinations, load factors, and strength reduction factors; structural analysis methods; deflection limits; mechanical and adhesive anchoring to concrete; development and splicing of reinforcement; construction document information; field inspection and testing; and methods to evaluate the strength of existing structures. "Building Code Requirements for Concrete Thin Shells" (ACI 318.2) is adopted by reference in this Code.

The Code user will find that ACI 318-14 has been substantially reorganized and reformatted from previous editions. The principal objectives of this reorganization are to present all design and detailing requirements for structural systems or for individual members in chapters devoted to those individual subjects, and to arrange the chapters in a manner that generally follows the process and chronology of design and construction. Information and procedures that are common to the design of members are located in utility chapters.

The quality and testing of materials used in construction are covered by reference to the appropriate ASTM standard specifications. Welding of reinforcement is covered by reference to the appropriate American Welding Society (AWS) standard.

Uses of the Code include adoption by reference in a general building code, and earlier editions have been widely used in this manner. The Code is written in a format that allows such reference without change to its language. Therefore, background details or suggestions for carrying out the requirements or intent of the Code provisions cannot be included within the Code itself. The Commentary is provided for this purpose.

Some of the considerations of the committee in developing the Code are discussed within the Commentary, with emphasis given to the explanation of new or revised provisions. Much of the research data referenced in preparing the Code is cited for the user desiring to study individual questions in greater detail. Other documents that provide suggestions for carrying out the requirements of the Code are also cited.

Technical changes from ACI 318-11 to ACI 318-14 are outlined in the May 2014 issue of *Concrete International*.

Transition keys showing how the code was reorganized are provided on the ACI website on the 318 Resource Page under Topics in Concrete.

KEYWORDS

admixtures; aggregates; anchorage (structural); beam-column frame; beams (supports); building codes; cements; cold weather construction; columns (supports); combined stress; composite construction (concrete and steel); composite construction (concrete to concrete); compressive strength; concrete construction; concrete slabs; concretes; construction joints; continuity (structural); contract documents; contraction joints; cover; curing; deep beams; deflections; earthquake-resistant structures; embedded service ducts; flexural strength; floors; folded plates; footings; formwork (construction); frames; hot weather construction; inspection; isolation joints; joints (junctions); joists; lightweight concretes; load tests (structural); loads (forces); materials; mixing; mixture proportioning; modulus of elasticity; moments; pipe columns; pipes (tubing); placing; plain concrete; precast concrete; prestressed concrete; prestressing steels; quality control; reinforced concrete; reinforcing steels; roofs; serviceability; shear strength; shear walls; shells (structural forms); spans; splicing; strength; strength analysis; stresses; structural analysis; structural concrete; structural design; structural integrity; T-beams; torsion; walls; water; welded wire reinforcement.

NOTES FROM THE PUBLISHER

ACI Committee Reports, Guides, and Commentaries are intended for guidance in planning, designing, executing, and inspecting construction. This commentary (318R-14) is 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 information it contains. ACI disclaims any and all responsibility for the stated principles. The Institute shall not be liable for any loss or damage arising there from. Reference to this document shall not be made in contract documents. If items found in this document are desired by the Architect/ Engineer to be a part of the contract documents, they shall be restated in mandatory language for incorporation by the Architect/Engineer.

The materials, processes, quality control measures, and inspections described in this document should be tested, monitored, or performed as applicable only by individuals holding the appropriate ACI Certification or equivalent.

ACI 318-14, Building Code Requirements for Structural Concrete, and ACI 318R-14, Commentary, are presented in a side-by-side column format. These are two separate but coordinated documents, with Code text placed in the left column and the corresponding Commentary text aligned in the right column. Commentary section numbers are preceded by an "R" to further distinguish them from Code section numbers.

The two documents are bound together solely for the user's convenience. Each document carries a separate enforceable and distinct copyright.

INTRODUCTION

This Commentary discusses some of the considerations of Committee 318 in developing the provisions contained in "Building Code Requirements for Structural Concrete (ACI 318-14)," hereinafter called the Code or the 2014 Code. Emphasis is given to the explanation of new or revised provisions that may be unfamiliar to Code users. In addition, comments are included for some items contained in previous editions of the Code to make the present commentary independent of the previous editions. Comments on specific provisions are made under the corresponding chapter and section numbers of the Code.

The Commentary is not intended to provide a complete historical background concerning the development of the Code, nor is it intended to provide a detailed résumé of the studies and research data reviewed by the committee in formulating the provisions of the Code. However, references to some of the research data are provided for those who wish to study the background material in depth.

As the name implies, "Building Code Requirements for Structural Concrete" is meant to be used as part of a legally adopted building code and as such must differ in form and substance from documents that provide detailed specifications, recommended practice, complete design procedures, or design aids.

The Code is intended to cover all buildings of the usual types, both large and small. Requirements more stringent than the Code provisions may be desirable for unusual construction. The Code and Commentary cannot replace sound engineering knowledge, experience, and judgment.

A building code states only the minimum requirements necessary to provide for public health and safety. The Code is based on this principle. For any structure, the owner or the licensed design professional may require the quality of materials and construction to be higher than the minimum requirements necessary to protect the public as stated in the Code. However, lower standards are not permitted.

The Commentary directs attention to other documents that provide suggestions for carrying out the requirements and intent of the Code. However, those documents and the Commentary are not a part of the Code.

The Code has no legal status unless it is adopted by the government bodies having the police power to regulate building design and construction. Where the Code has not been adopted, it may serve as a reference to good practice even though it has no legal status.

The Code provides a means of establishing minimum standards for acceptance of designs and construction by legally appointed building officials or their designated representatives. The Code and Commentary are not intended for use in settling disputes between the owner, engineer, architect, contractor, or their agents, subcontractors, material suppliers, or testing agencies. Therefore, the Code cannot define the contract responsibility of each of the parties in usual construction. General references requiring compliance with the Code in the project specifications should be avoided since the contractor is rarely in a position to accept responsibility for design details or construction requirements that depend on a detailed knowledge of the design. Design-build construction contractors, however, typically combine the design and construction responsibility. Generally, the contract documents should contain all of the necessary requirements to ensure compliance with the Code. In part, this can be accomplished by reference to specific Code sections in the project specifications. Other ACI publications, such as "Specifications for Structural Concrete (ACI 301)" are written specifically for use as contract documents for construction.

It is recommended to have testing and certification programs for the individual parties involved with the execution of work performed in accordance with this Code. Available for this purpose are the plant certification programs of the Precast/Prestressed Concrete Institute, the Post-Tensioning Institute, and the National Ready Mixed Concrete Association; the personnel certification programs of the American Concrete Institute and the Post-Tensioning Institute; and the Concrete Reinforcing Steel Institute's Voluntary Certification Program for Fusion-Bonded Epoxy Coating Applicator Plants. In addition, "Standard Specification for Agencies Engaged in Construction Inspecting and/or Testing" (ASTM E329-09) specifies performance requirements for inspection and testing agencies.

Design reference materials illustrating applications of the Code requirements may be found in the following documents. The design aids listed may be obtained from the sponsoring organization.

Design aids:

"ACI Design Handbook," Publication SP-17(11), American Concrete Institute, Farmington Hills, MI, 2011, 539 pp. (This provides tables and charts for design of eccentrically loaded columns by the Strength Design Method of the 2009 Code. Provides design aids for use in the engineering design and analysis of reinforced concrete slab systems carrying loads by two-way action. Design aids are also provided for the selection of slab thickness and for reinforcement required to control deformation and assure adequate shear and flexural strengths.)

For a history of the ACI Building Code, see Kerekes, F., and Reid, H. B., Jr., "Fifty Years of Development in Building Code Requirements for Reinforced Concrete," ACI Journal*, V. 50, No. 6, Feb. 1954, p. 441. For a discussion of code philosophy, see Siess, C. P., "Research, Building Codes, and Engineering Practice,"* ACI Journal*, V. 56, No. 5, May 1960, p. 1105.*

"ACI Detailing Manual—2004," ACI Committee 315, Publication SP-66(04), American Concrete Institute, Farmington Hills, MI, 2004, 212 pp. (Includes the standard, ACI 315-99, and report, ACI 315R-04. Provides recommended methods and standards for preparing engineering drawings, typical details, and drawings placing reinforcing steel in reinforced concrete structures. Separate sections define responsibilities of both engineer and reinforcing bar detailer.)

"Guide to Durable Concrete (ACI 201.2R-08)," ACI Committee 201, American Concrete Institute, Farmington Hills, MI, 2008, 49 pp. (This describes specific types of concrete deterioration. It contains a discussion of the mechanisms involved in deterioration and the recommended requirements for individual components of the concrete, quality considerations for concrete mixtures, construction procedures, and influences of the exposure environment.)

"Guide for the Design and Construction of Durable Parking Structures (362.1R-12)," ACI Committee 362, American Concrete Institute, Farmington Hills, MI, 2012, 24 pp. (This summarizes practical information regarding design of parking structures for durability. It also includes information about design issues related to parking structure construction and maintenance.)

"CRSI Handbook," Concrete Reinforcing Steel Institute, Schaumburg, IL, tenth edition, 2008, 777 pp. (This provides tabulated designs for structural elements and slab systems. Design examples are provided to show the basis and use of the load tables. Tabulated designs are given for beams; square, round, and rectangular columns; one-way slabs; and one-way joist construction. The design tables for two-way slab systems include flat plates, flat slabs, and waffle slabs. The chapters on foundations provide design tables for square footings, pile caps, drilled piers (caissons), and cantilevered retaining walls. Other design aids are presented for crack control and development of reinforcement and lap splices.)

"Reinforcement Anchorages and Splices," Concrete Reinforcing Steel Institute, Schaumburg, IL, fifth edition, 2008, 100 pp. (This provides accepted practices in splicing reinforcement. The use of lap splices, mechanical splices, and welded splices are described. Design data are presented for development and lap splicing of reinforcement.)

"Structural Welded Wire Reinforcement Manual of Standard Practice," Wire Reinforcement Institute, Hartford, CT, eighth edition, Apr. 2010, 35 pp. (This describes welded wire reinforcement material, gives nomenclature and wire size and weight tables. Lists specifications and properties and manufacturing limitations. Book has latest code requirements as code affects welded wire. Also gives development length and splice length tables. Manual contains customary units and soft metric units.)

"Structural Welded Wire Reinforcement Detailing Manual," Wire Reinforcement Institute, Hartford, CT, 1994, 252 pp. (The manual, in addition to including ACI 318 provisions and design aids, also includes: detailing guidance on welded wire reinforcement in one-way and two-way slabs; precast/prestressed concrete components; columns and beams; cast-in-place walls; and slabs-on-ground. In addition, there are tables to compare areas and spacings of high-strength welded wire with conventional reinforcing.)

"PCI Design Handbook—Precast and Prestressed Concrete," Precast/Prestressed Concrete Institute, Chicago, IL, seventh edition, 2010, 804 pp. (This provides load tables for common industry products, and procedures for design and analysis of precast and prestressed elements and structures composed of these elements. Provides design aids and examples.)

"Design and Typical Details of Connections for Precast and Prestressed Concrete," Precast/Prestressed Concrete Institute, Chicago, IL, second edition, 1988, 270 pp. (This updates available information on design of connections for both structural and architectural products, and presents a full spectrum of typical details. This provides design aids and examples.)

"Post-Tensioning Manual," Post-Tensioning Institute, Farmington Hills, MI, sixth edition, 2006, 354 pp. (This provides comprehensive coverage of post-tensioning systems, specifications, design aids, and construction concepts.)

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