IN-LB Inch-Pound Units

Nuclear Safety-Related Concrete Structures—Code Requirements and Commentary

Reported by ACI Committee 349

ACI CODE-349-23

American Concrete Institute
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An ACI Standard

Reported by ACI Committee 349

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This Code covers the design and construction of concrete structures that form part of a nuclear facility and that have nuclear safety-related functions but does not cover concrete reactor vessels and concrete containment structures, as defined by ASME BPVC Section III Division 2:2019, or steel-plate composite walls and steel-plate composite slabs, as defined by ANSI/AISC N690.

The structures covered by this Code include concrete structures inside and outside the containment system.

This Code may be referenced and applied subject to agreement between the owner and the Regulatory Authority.

The format of this Code is such that it depends on the "Building Code Requirements for Structural Concrete (ACI CODE-318-14)" and should be used in conjunction with that Code. Unless otherwise stated, all instances of ACI 318 are referring to ACI CODE-318-14. When searching for subsections, tables, and figures in this Code, first refer to the main section of this Code to see if it is included and to find potential exceptions to the corresponding subsection, table or figure in ACI-318.

The Commentary, which is presented after the Code, discusses some of the considerations of ACI Committee 349 in developing "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349)." This information is provided in the Commentary because the Code is written as a legal document and therefore cannot present background details or suggestions for carrying out its requirements.

CONTENTS

ACI CODE-349-23 supersedes ACI 349-13 and was approved by the ACI Standards Board for publication December 2023, and published October 2024. This Code was first published in 1976 and revised in 1980, 1997, 2001, 2006, and 2013.

CODE

CHAPTER 1—GENERAL

1.1—Scope

1.1.1 This chapter addresses (a) through (h):

(a) General requirements of this Code
(b) Purpose of this Code
(c) Applicability of this Code
(d) Interpretation of this Code
(e) Definition and role of the authority having jurisdiction (AHJ) and the licensed design professional (LDP)
(f) Construction documents
(g) Testing and inspection
(h) Approval of special systems of design, construction, or alternative construction materials

Nuclear safety-related structures and structural members subject to this Code are those concrete structures that support, house, or protect nuclear safety class systems or component parts of nuclear safety class systems.

Specifically excluded from this Code are those structures covered by ASME BPVC Section III Division 2:2019.

This Code includes design and loading conditions that are unique to nuclear facilities, including shear design under biaxial tension conditions, consideration of thermal and seismic effects, and impact and impulsive loads.

1.2—General

1.2.1 ACI 349, "Code Requirements for Nuclear Safety-Related Concrete Structures," is hereafter referred to as "this Code."

1.2.2 If provisions in a given section of this Code differ from provisions in the same section of ACI 318, the ACI 349 provision governs. In cases where a section of this Code is deemed "Same as ACI 318," the user must check all embedded references within the given Section for applicable changes to ACI 318 provisions given in this Code. If the provision in the embedded section reference differs, the provisions of ACI 349 govern.

1.2.3 Same as ACI 318.

1.2.4 Same as ACI 318.

1.2.5 This Code provides minimum requirements for the materials, design, construction, and strength evaluation of nuclear safety-related concrete structures and structural members for nuclear facilities.

1.2.6 This Code shall govern in all matters pertaining to design and construction of reinforced concrete structures, as defined in Section 1.1.1, except wherever this Code is in conflict with the specific provisions of the AHJ.

COMMENTARY

CHAPTER R1—GENERAL

R1.1—Scope

R1.1.1 This Code includes provisions for the design of concrete used for structural purposes, including concrete containing nonprestressed reinforcement, prestressed reinforcement, or both; and anchorage to concrete.

This chapter includes numerous provisions that explain where this Code applies and how it is to be interpreted.

In general, the code requirements are based on concrete having a compressive strength of between 3000 and 6000 psi. Although no maximum compressive strength is specified, the applicability of various requirements and formulation should be verified when concrete compressive strengths are higher than 6000 psi.

Minimum concrete compressive strength has been established as 3000 psi to be consistent with the seismic provisions of Chapter 18.

R1.2—General

R1.2.1 The American Concrete Institute recommends that this Code be adopted in its entirety.

R1.2.2 As a dependent code, ACI 349 states in many places "Same as ACI 318." These sections sometimes have embedded references. The embedded reference may not always be the same in ACI 318 and this Code.

R1.2.3 ACI Committee 349 developed this Code in English, using inch-pound units. Based on that version, ACI Committee 349 approved a version that is in English using SI units. Jurisdictions may adopt this Code.

R1.2.5 Same as ACI 318.

CODE

1.2.7 Intentionally left blank.

1.3—Purpose

1.3.1 The purpose of this Code is to provide for public health and safety by establishing minimum requirements for strength, stability, serviceability, durability, and integrity of nuclear safety-related concrete structures.

1.3.2 Same as ACI 318.

1.3.3 Same as ACI 318.

1.4—Applicability

1.4.1 This Code shall apply to nuclear safety-related concrete structures.

1.4.2 Intentionally left blank.

1.4.3 Intentionally left blank.

1.4.4 Same as ACI 318.

1.4.5 Intentionally left blank.

1.4.6 The following provisions (a) or (b) apply to concrete piles, drilled piers, and caissons:

(a) Portions in air or water, or in soil incapable of providing adequate lateral restraint to prevent buckling throughout their length, shall be designed in accordance with the applicable provisions of Chapter 13 and Chapter 18.

(b) Portions fully embedded in ground shall be designed in accordance with the applicable provisions of Chapter 18. This Code does not include all necessary design and installation provisions for portions fully embedded in ground.

COMMENTARY

R1.2.7 Section 1.2.7 has been intentionally left blank because this Code is not intended to be adopted as a general building code.

R1.3—Purpose

R1.3.1 This Code provides a means of establishing minimum requirements for the design and construction of structural concrete, as well as for acceptance of design and construction of nuclear safety-related concrete structures by the AHJ.

This Code does not provide a comprehensive statement of all duties of all parties to a contract or all requirements of a contract for a project constructed under this Code.

R1.3.2 Same as ACI 318.

R1.4—Applicability

R1.4.1 Concrete structures that are not nuclear safety-related are not specifically addressed by this Code.

R1.4.2 Section 1.4.2 has been intentionally left blank because the Code is not intended to be adopted as a general building code.

R1.4.3 Section 1.4.3 has been intentionally left blank because the scope of the Code does not include the design of thin shells and folded plate concrete structures.

R1.4.4 In its most basic application, the noncomposite steel deck serves as a form, and the concrete slab is designed to resist all loads whereas, in other applications, the concrete slab may be designed to resist only the superimposed loads. The design of a steel deck in a load-resisting application is given in ANSI/SDI NC.

R1.4.5 Section 1.4.5 has been intentionally left blank because the scope of this Code does not include the design of one- and two-family dwellings, multiple single-family dwellings, townhouses, and accessory structures.

R1.4.6 The design and installation of concrete piles fully embedded in the ground is regulated by the AHJ. Recommendations for concrete piles are given in ACI PRC-543. Recommendations for drilled piers are given in ACI PRC-336.3.

Recommendations for precast prestressed concrete piles are given in Precast/Prestressed Concrete Institute (1993). Refer to Section 18.13.4 for supplemental requirements for concrete piles, drilled piers, and caissons in nuclear safety-related concrete structures.

CODE

1.4.7 The provisions of this Code apply to slabs-on-ground.

1.4.8 This Code, along with relevant sections of ACI CODE-350, govern design and construction of tanks and reservoirs (nonlined) associated with nuclear safety-related structures.

1.4.9 Same as ACI 318.

1.5—Interpretation

Same as ACI 318.

1.6—Authority having jurisdiction

1.6.1 All references in this Code to the AHJ shall be understood to mean agencies who enforce this Code as governed by the licensing basis of the nuclear safety-related structure.

1.6.2 Actions and decisions by the AHJ affect only the specific nuclear safety-related structure and do not change this Code.

1.6.3 The owner shall have the right to order testing of any materials used in concrete construction to determine if materials are of the quality specified.

1.7—Licensed design professional

Same as ACI 318.

1.8—Construction documents and design records

1.8.1 Same as ACI 318.

1.8.2 Calculations pertinent to design shall be filed with the construction documents if required by the AHJ. Analyses and designs using computer programs shall be permitted, provided design assumptions, user input, and computer-generated output are submitted. Documentation of verification and validation for each computer program used shall be provided. Model analysis shall be permitted to supplement calculations.

COMMENTARY

R1.4.7 In addition to the requirements of this Code, the LDP should consider other issues, as outlined in ACI PRC-360 and PTI DC10.1.

R1.4.8 This Code is applied to the spent fuel pool pit and refueling canal as well as other nuclear safety-related tanks. In addition, detailed recommendations given in ACI CODE-350 should be followed for nonlined tanks and reservoirs associated with safety-related nuclear structures. In case of a conflict, the more restrictive provision of this Code or ACI CODE-350 should be followed.

R1.4.9 In this type of construction, the steel deck serves as the positive moment reinforcement. ANSI/AISC N690:2018, Chapter NI, contains design provisions for composite steel members by reference to ANSI/AISC 360. Also refer to ANSI/SDI C. This standard refers to the appropriate portions of ACI 318 for the design and construction of the concrete portion of the composite assembly. ANSI/SDI C also provides guidance for design of composite concrete-steel deck slabs. The design of negative moment reinforcement to create continuity at supports is a common example where a portion of the slab is designed in conformance with this Code.

R1.5—Interpretation

Same as ACI 318.

R1.6—Authority having jurisdiction

R1.6.1 AHJ is defined in Chapter 2.

R1.6.2 Same as ACI 318.

R1.6.3 Section 1.6.3 has been intentionally left blank because the scope of the Code does not include the responsibilities of the building official.

R1.7—Licensed design professional

Same as ACI 318.

R1.8—Construction documents and design records

R1.8.1 Additional information may be required by the AHJ.

R1.8.2 Documented computer output is acceptable instead of manual calculations. The extent of input and output information required will vary according to the specific requirements of the AHJ. This should consist of sufficient input and output data and other information to allow the AHJ to perform a detailed review and make comparisons using another program or manual calculations. Input data should be identified as to member designation, applied loads, and span lengths. The related output data should include member