

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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Nuclear Safety-Related Concrete Structures—Code Requirements and Commentary

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Nuclear Safety-Related Concrete Structures— Code Requirements and Commentary

An ACI Standard

Reported by ACI Committee 349

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Note: ACI Committee 349 would like to thank O. Gurbuz and N. Orbovic for their many years of membership to ACI Committee 349 and their hard work and dedication to this Code. Special acknowledgment is given G. Leon Flores, K. McBride, and J. Draper to for their contributions to this Code.

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

CHAPTER 1—GENERAL, p. 5

- 1.1—Scope, p. 5
- 1.2—General, p. 5
- 1.3—Purpose, p. 6
- 1.4—Applicability, p. 6
- 1.5—Interpretation, p. 7
- 1.6—Authority having jurisdiction, p. 7
- 1.7—Licensed design professional, p. 7
- 1.8—Construction documents and design records, p. 7
- 1.10—Approval of special systems of design, construction, or alternative construction materials, p. 8

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CHAPTER 2—NOTATION AND TERMINOLOGY, p. 9

- 2.1—Scope, p. 9
- 2.2—Notation, p. 9
- 2.3—Terminology, p. 22

CHAPTER 3—REFERENCED STANDARDS, p. 37

- 3.1—Scope, p. 37
- 3.2—Referenced standards, p. 37

CHAPTER 4—STRUCTURAL SYSTEM REQUIREMENTS, p. 40

- 4.1—Scope, p. 40
- 4.2—Materials, p. 40
- 4.3—Design loads, p. 40
- 4.4—Structural system and load paths, p. 40
- 4.5—Structural analysis, p. 42
- 4.6—Strength, p. 42
- 4.7—Serviceability, p. 23
- 4.8—Durability, p. 43
- 4.9—Sustainability, p. 43
- 4.10—Structural integrity, p. 43
- 4.11—Fire resistance, p. 43
- 4.12—Requirements for specific types of construction, p. 43
- 4.13—Construction and inspection, p. 44
- 4.14—Strength evaluation of existing structures, p. 44

CHAPTER 5—LOADS, p. 45

- 5.1—Scope, p. 45
- 5.2—General, p. 45
- 5.3—Load factors and combinations, p. 47

CHAPTER 6—STRUCTURAL ANALYSIS, p. 52

- 6.1—Scope, p. 52
- 6.2—General, p. 52
- 6.3—Modeling assumptions, p. 52
- 6.4—Arrangement of live load, p. 52
- 6.5—Simplified method of analysis for nonprestressed continuous beams and one-way slabs, p. 52
- 6.6—First-order analysis, p. 52
- 6.7—Elastic second-order analysis, p. 52
- 6.8—Intentionally left blank, p. 53
- 6.9—Acceptability of finite element analysis, p. 53

CHAPTER 7—ONE-WAY SLABS, p. 54

- 7.1—Scope, p. 54
- 7.2—General, p. 54
- 7.3—Design limits, p. 54
- 7.4—Required strength, p. 54
- 7.5—Design strength, p. 54
- 7.6—Reinforcement limits, p. 55
- 7.7—Reinforcement detailing, p. 55

CHAPTER 8—TWO-WAY SLABS, p. 56

- 8.1—Scope, p. 56
- 8.2—General, p. 56
- 8.3—Design limits, p. 56
- 8.4—Required strength, p. 58

- 8.5—Design strength, p. 58
- 8.6—Reinforcement limits, p. 58
- 8.7—Reinforcement detailing, p. 59
- 8.8—Nonprestressed two-way joist systems, p. 59
- 8.9—Lift-slab construction, p. 59
- 8.10—Direct design method, p. 59
- 8.11—Equivalent frame method, p. 59

CHAPTER 9—BEAMS, p. 60

- 9.1—Scope, p. 60
- 9.2—General, p. 60
- 9.3—Design limits, p. 60
- 9.4—Required strength, p. 60
- 9.5—Design strength, p. 60
- 9.6—Reinforcement limits, p. 61
- 9.7—Reinforcement detailing, p. 61
- 9.8—Nonprestressed one-way joist systems, p. 61
- 9.9—Deep beams, p. 61

CHAPTER 10—COLUMNS, p. 62

- 10.1—Scope, p. 62
- 10.2—General, p. 62
- 10.3—Design limits, p. 62
- 10.4—Required strength, p. 62
- 10.5—Design strength, p. 62
- 10.6—Reinforcement limits, p. 63
- 10.7—Reinforcement detailing, p. 63

CHAPTER 11—WALLS, p. 64

- 11.1—Scope, p. 64
- 11.2—General, p. 64
- 11.3—Design limits, p. 64
- 11.4—Required strength, p. 64
- 11.5—Design strength, p. 64
- 11.6—Reinforcement limits, p. 65
- 11.7—Reinforcement detailing, p. 65
- 11.8—Alternative method for out-of-plane slender wall analysis, p. 65

CHAPTER 12—DIAPHRAGMS, p. 66

- 12.1—Scope, p. 66
- 12.2—General, p. 66
- 12.3—Design limits, p. 67
- 12.4—Required strength, p. 67
- 12.5—Design strength, p. 68
- 12.6—Reinforcement limits, p. 70
- 12.7—Reinforcement detailing, p. 70

CHAPTER 13—FOUNDATIONS, p. 72

- 13.1—Scope, p. 72
- 13.2—General, p. 72
- 13.3—Shallow foundations, p. 73
- 13.4—Deep foundations, p. 73

CHAPTER 14—INTENTIONALLY LEFT BLANK, p. 75**CHAPTER 15—BEAM-COLUMN AND SLAB-COLUMN JOINTS, p. 76**

- 15.1—Scope, p. 76
- 15.2—General, p. 76
- 15.3—Transfer of column axial force through the floor system, p. 76
- 15.4—Detailing of joints, p. 76

CHAPTER 16—CONNECTIONS BETWEEN MEMBERS, p. 77

- 16.1—Scope, p. 77
- 16.2—Connections of precast members, p. 77
- 16.3—Connections to foundations, p. 77
- 16.4—Horizontal shear transfer in composite concrete flexural members, p. 77
- 16.5—Brackets and corbels, p. 77

CHAPTER 17—ANCHORING TO CONCRETE, p. 79

- 17.1—Scope, p. 79
- 17.2—General, p. 86
- 17.3—Design limits, p. 90
- 17.4—Required strength, p. 91
- 17.5—General requirements for strength of anchors, p. 91
- 17.7—Design requirements for shear loading, p. 110
- 17.8—Tension and shear interaction, p. 119
- 17.9—Required edge distances, spacings, and thicknesses to preclude splitting failure, p. 120
- 17.10—Attachments with shear lugs, p. 122

CHAPTER 18—PROVISIONS FOR EARTHQUAKE-RESISTANT DESIGN, p. 129

- 18.1—Scope, p. 129
- 18.2—General, p. 129
- 18.3—Intentionally left blank, p. 132
- 18.4—Intentionally left blank, p. 132
- 18.5—Intentionally left blank, p. 132
- 18.6—Beams, p. 133
- 18.7—Columns, p. 139
- 18.8—Joints of moment frame, p. 144
- 18.9—Intentionally left blank, p. 148
- 18.10—Structural walls, p. 148
- 18.11—Intentionally left blank, p. 159
- 18.12—Diaphragms, p. 159
- 18.13—Foundations, p. 164
- 18.14—Intentionally left blank, p. 166

CHAPTER 19—CONCRETE DESIGN AND DURABILITY, p. 167

- 19.1—Scope, p. 167
- 19.2—Concrete design properties, p. 167
- 19.3—Concrete durability requirements, p. 168
- 19.4—Grout durability requirements, p. 170

CHAPTER 20—STEEL REINFORCEMENT PROPERTIES, DURABILITY, AND EMBEDMENTS, p. 171

- 20.1—Scope, p. 171
- 20.2—Nonprestressed bars and wires, p. 171
- 20.3—Prestressing strands, wires, and bars, p. 174
- 20.4—Structural steel, pipe, and tubing for composite columns, p. 174
- 20.5—Headed shear stud reinforcement, p. 174
- 20.6—Provisions for durability of steel reinforcement, p. 174
- 20.7—Embedments, p. 175

CHAPTER 21—STRENGTH REDUCTION FACTORS, p. 176

- 21.1—Scope, p. 176
- 21.2—Strength reduction factors for structural concrete members and connections, p. 176

CHAPTER 22—SECTIONAL STRENGTH, p. 178

- 22.1—Scope, p. 178
- 22.2—Design assumptions for moment and axial strength, p. 178
- 22.3—Flexural strength, p. 178
- 22.4—Axial strength or combined flexural and axial strength, p. 178
- 22.5—One-way shear strength, p. 178
- 22.6—Two-way shear strength, p. 178
- 22.7—Torsional strength, p. 179
- 22.8—Bearing, p. 179
- 22.9—Shear-friction, p. 180

CHAPTER 23—STRUT-AND-TIE MODELS, p. 181

- 23.1—Scope, p. 181
- 23.2—General, p. 181
- 23.3—Design strength, p. 181
- 23.4—Strength of struts, p. 181
- 23.5—Reinforcement crossing bottle-shaped struts, p. 181
- 23.6—Strut reinforcement detailing, p. 181
- 23.7—Strength of ties, p. 181
- 23.8—Tie reinforcement detailing, p. 181
- 23.9—Strength of nodal zones, p. 181

CHAPTER 24—SERVICEABILITY REQUIREMENTS, p. 182

- 24.1—Scope, p. 182
- 24.2—Control of deflections, p. 182
- 24.3—Distribution of flexural reinforcement in one-way slabs and beams, p. 184
- 24.4—Minimum reinforcement, p. 185
- 24.5—Permissible stresses in prestressed concrete flexural members, p. 186
- 24.6—Walls, p. 186

CHAPTER 25—REINFORCEMENT DETAILS, p. 187

- 25.1—Scope, p. 187
- 25.2—Minimum spacing of reinforcement, p. 187

25.3—Standard hooks, seismic hooks, crossties, and minimum inside bend diameters, p. 187

25.4—Development of reinforcement, p. 187

25.5—Splices, p. 199

25.6—Bundled reinforcement, p. 201

25.7—Transverse reinforcement, p. 201

25.8—Post-tensioning anchorages and couplers, p. 201

25.9—Anchorage zones for post-tensioned tendons, p. 201

CHAPTER 26—CONSTRUCTION DOCUMENTS AND INSPECTION, p. 204

26.1—Scope, p. 204

26.2—Design criteria, p. 205

26.3—Member information, p. 205

26.4—Concrete materials and mixture requirements, p. 205

26.5—Concrete production and construction, p. 208

26.6—Reinforcement materials and construction requirements, p. 210

26.7—Anchoring to concrete, p. 211

26.8—Embedments, p. 212

26.9—Additional requirements for precast concrete, p. 213

26.10—Additional requirements for prestressed concrete, p. 214

26.11—Formwork, p. 214

26.12—Concrete evaluation and acceptance, p. 214

26.13—Inspection, p. 215

CHAPTER 27—STRENGTH AND EVALUATION OF EXISTING STRUCTURES, p. 218

27.1—Scope, p. 218

27.2—General, p. 218

27.3—Analytical strength evaluation, p. 218

27.4—Strength evaluation by load test, p. 219

27.5—Reduced load rating, p. 221

APPENDIX A—SHELLS, p. 222

A.1—Scope and definitions, p. 222

A.2—General, p. 222

A.3—Design strength of materials, p. 223

A.4—Section design and reinforcement requirements, p. 224

A.5—Construction, p. 224

APPENDIX B—INTENTIONALLY LEFT BLANK, p. 225

APPENDIX C—ALTERNATIVE LOAD AND STRENGTH-REDUCTION FACTORS, p. 226

C.1—Scope, p. 226

C.2—Required strength, p. 226

C.3—Design strength, p. 228

APPENDIX D—INTENTIONALLY LEFT BLANK, p. 231

APPENDIX E—THERMAL CONSIDERATIONS, p. 232

E.1—Scope, p. 232

E.2—General design requirements, p. 233

E.3—Concrete temperatures, p. 234

APPENDIX F—SPECIAL PROVISIONS FOR IMPULSIVE AND IMPACTIVE EFFECTS, p. 237

F.1—Scope, p. 237

F.2—Dynamic strength increase, p. 238

F.3—Deformation, p. 240

F.4—Requirements to assure ductility, p. 245

F.5—Shear strength, p. 247

F.6—Impulsive effects, p. 249

F.7—Impactive effects, p. 252

F.8—Impactive and impulsive loads, p. 262

F.9—Splices, p. 263

Authored documents, p. 267

Summary of Changes in the Code, p. 272

CODE

COMMENTARY

CHAPTER 1—GENERAL

CHAPTER R1—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.

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

COMMENTARY

1.2.7 Intentionally left blank.

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.

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.

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.

1.3.2 Same as **ACI 318**.

R1.3.2 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.

R1.4—Applicability

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

1.4.2 Intentionally left blank.

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.

1.4.3 Intentionally left blank.

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.

1.4.4 Same as ACI 318.

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**.

1.4.5 Intentionally left blank.

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.

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.

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