

Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-06) and Commentary

An ACI Standard

Reported by ACI Committee 349

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This standard covers the proper design and construction of concrete structures that form part of a nuclear power plant and that have nuclear safety-related functions, but does not cover concrete reactor vessels and concrete containment structures (as defined by Joint ACI-ASME Committee 359).

The structures covered by the 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.

All notation sections have been removed from the beginning of each chapter and consolidated into one list in Chapter 2.

The format of this Code is based on the "Building Code Requirements for Structural Concrete (ACI 318-05)" and incorporates recent revisions of that standard.

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 349-06)." 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.

ACI Committee Reports, Guides, Standard Practices, and Commentaries are intended for guidance in planning, designing, executing, and inspecting construction. This document 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 material it contains. The American Concrete Institute disclaims any and all responsibility for the stated principles. The Institute shall not be liable for any loss or damage arising therefrom.

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.

Keywords: admixtures; aggregates; anchorage (structural); authority having jurisdiction (AHJ); 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; concretes; concrete cover; concrete slabs; construction joints; continuity (structural); cracking (fracturing); creep properties; curing; deep beams; deflection; drawings (drafting); earthquake-resistant structures; edge beams; embedded service ducts; flexural strength; floors; folded plates; footings; formwork (construction); frames; hot weather construction; inspection; joists; load tests (structural); loads (forces); mixing; mixture proportioning; modulus of elasticity; moments; nuclear power plants; nuclear reactor containments; nuclear reactor safety; nuclear reactors; pipe columns; pipes (tubes); placing; precast concrete; prestressed concrete; prestressing steels; quality control; reinforced concrete; reinforcing steels; roofs; safety; serviceability; shear strength; shearwalls; shells (structural forms); spans; specifications; splicing; strength; strength analysis; structural analysis; structural design; T-beams; temperature; torsion; walls; water; welded wire reinforcement.

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CODE

CHAPTER 1—GENERAL REQUIREMENTS

1.1—Scope

1.1.1 This Code provides minimum requirements for design and construction of nuclear safety-related concrete structures and structural members for nuclear power generating stations. Safety-related structures and structural members subject to this standard 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 “Code for Concrete Reactor Vessels and Containments,” ASME Boiler and Pressure Vessel Code Section III, Division 2, and pertinent General Requirements (ACI 359).

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.

For structural concrete, f'_c shall not be less than 2500 psi, unless otherwise specified.

1.1.2 This Code shall govern in all matters pertaining to design and construction of reinforced concrete structures, as defined in 1.1.1, except wherever this Code is in conflict with the specific provisions of the authority having jurisdiction (AHJ).

1.1.3 This Code shall govern in all matters pertaining to design, construction, and material properties wherever this Code is in conflict with requirements contained in other standards referenced in this Code.

1.1.4 For special structures, such as arches, tanks, reservoirs, bins and silos, blast-resistant structures, and chimneys, provisions of this Code shall govern where applicable.

1.1.5 Intentionally left blank.

1.1.6 Intentionally left blank.

1.1.7 *Concrete on steel form deck*

1.1.7.1 Design and construction of structural concrete slabs cast on stay-in-place, noncomposite steel form deck are governed by this Code.

1.1.7.2 This Code does not govern the design of structural concrete slabs cast on stay-in-place, composite steel form deck. Concrete used in the construction of such slabs shall be governed by Chapters 1 through 7 of this Code, where applicable.

1.1.8 *Special provisions for earthquake resistance*—Provisions of Chapter 21 shall be satisfied. See 21.2.1.

1.2—Drawings and specifications

1.2.1 Copies of design drawings, typical details, and specifications for all structural concrete construction shall

bear the seal of a licensed engineer. These drawings (including supplementary drawings to generate the as-built condition), typical details, and specifications shall be retained by the owner, or his designee, as a permanent record for the life of the structure. As a minimum, these drawings, details, and specifications together shall show:

- (a) Name and date of issue of Code and supplement to which design conforms;
- (b) Live load and other loads used in design;
- (c) Specified compressive strength of concrete at stated ages or stages of construction for which each part of structure is designed;
- (d) Specified strength or grade of reinforcement;
- (e) Size and location of all structural members, reinforcement, and anchors;
- (f) Provision for dimensional changes resulting from creep, shrinkage, and temperature;
- (g) Magnitude and location of prestressing forces;
- (h) Anchorage length of reinforcement and location and length of lap splices;
- (i) Type and location of mechanical and welded splices of reinforcement;
- (j) Details and location of all contraction or isolation joints;
- (k) Minimum concrete compressive strength at time of post tensioning;
- (l) Stressing sequence for post-tensioning tendons;
- (m) Statement if slab-on-ground is designed as a structural diaphragm, see 21.10.3.4.

1.2.2 Calculations pertinent to design and the basis of design (including the results of model analysis, if any) shall be retained by the owner or his designee, as a permanent record for the life of the structure. Accompanying these calculations shall be a statement of the applicable design and analysis methods. When computer programs are used, design assumptions and identified input and output data may be retained instead of calculations. Model analysis shall be permitted to supplement calculations.

1.3—Inspection

1.3.1 The owner is responsible for the inspection of concrete construction throughout all work stages. The owner shall require compliance with design drawings and specifications. The owner shall also keep records required for quality assurance and traceability of construction, fabrication, material procurement, manufacture, or installation.

1.3.2 The owner shall be responsible for designating the records to be maintained and the duration of retention. Records pertinent to plant modifications or revisions, in-service inspections, and durability and performance of structures shall be maintained for the life of the plant. The owner shall be responsible for continued maintenance of the records. The records shall be maintained at the power plant site, or at other locations as determined by the owner. As a minimum, the following installation/construction records shall be considered for lifetime retention:

- (a) Check-off sheets for tendon, reinforcing steel, and anchor installation;
- (b) Concrete cylinder test reports and charts;