

ACI Reference Specifications

Consensus standards are designed for use in construction contract documents

by Bruce A. Suprenant

A specification is a standard that establishes uniform criteria for a building product, assembly, technology, or project. In much of the world, such specifications are developed and maintained by committees comprising industry representatives with expertise in the covered subject matter. Each issued standard therefore reflects a consensus opinion that establishes the standard of care for the relevant industry; hence, the documents are commonly termed industry standards, and it helps to form the common language for an industry.

While compliance with a code or regulation is mandatory, compliance with a standard may be voluntary unless the standard's contents are included as a provision of a code, regulation, or contract documents for a project. When so applied, a standard establishes the minimum requirements for services to be provided or for the manufacture, fabrication, and installation of materials, products, and equipment. Further, if compliance with a standard is specified, that standard can be used to predict the results of an activity.



Citing an ACI reference specification in project specifications improves the quality of contract documents by providing an industry consensus standard that establishes uniform criteria for concrete construction. Both ACI 117 and ACI 301 were cited reference specifications for the construction of this post-tensioned podium structure

Reference specifications can thus be important resources for code officials and specifiers creating contract documents. This article provides guidance in the use of such standards with particular focus on ACI's vast collection of construction standards.

Why Use Reference Specifications

The Construction Specification Institute (CSI) lists many advantages for the use of reference specifications, including:

- **Quality assurance**—The organizations that develop specifications are experts in their respective fields of interest, and their specifications are the product of extensive research, experience, and lessons learned;
- **Uniformity**—Specifications represent the consensus of a national network within a field of interest;
- **Reduced conflict and duplication**—The American National Standards Institute (ANSI) coordinates standards development and adopts and promotes the standards developed by its accredited members to ensure reliability; and
- **Reduced work**—Incorporation of standards into contract documents by reference saves the time required for writing an elaborate and lengthy text. Of course, any reference standard should be reviewed, and its content and purpose must be understood before including it in the specifications.

However, there can also be risk in using reference standards. CSI cautions that the specifier should specify only those standards that are most appropriate for the product and application. The specifier must carefully consider the level of quality defined by the reference standard, as some standards may define quality in terms of minimum requirements that are so restrictive that they exclude most commercially available materials. Alternatively, other standards may be so liberal that nearly anything produced can meet them.

Specifiers should maintain a current library of reference standards, and they must understand how the standards apply to the products they intend for each project. Each reference specification must be reviewed as part of the full project specification, not only to ensure that the owner's requirements are being met but also to avoid the creation of duplicate or conflicting product requirements. The specifier also must understand the effects of references within the reference standards, as these can also result in conflicting requirements. Lastly, the specifier must address optional provisions within reference specifications, with the goal of producing coherent and complete instructions.

Citing and Using Reference Specifications

The entirety of a reference specification can be incorporated into contract documents for a project by referring to the name of the association that developed the specification and including number, title, or other designation of the specification (Fig. 1). The specification then becomes a reference specification, and it becomes a part of the project specifications. Incorporation of an ACI specification by reference takes advantage of an established body of

SECTION 03 30 00 Page x

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

117-10(15), Specifications for Tolerances for Concrete Construction and Materials, 2015

301-16, Specifications for Structural Concrete, 2016

Fig. 1: An excerpt from a project specification. The ACI documents are reference specifications that are listed in Division 03 00 00 in the AIA MasterSpec[®] and are commonly used in project specifications

knowledge developed by the concrete industry, and it saves the architect and/or the engineer the work (and alleviates much of the risk) of writing an elaborate and lengthy specification.

ACI Specifications

ACI specifications undergo standardization, which provides the widest input and highest overall quality assurance for a document. This is the most rigorous consensus process used by ACI, and it is approved by ANSI. ACI standards are written in mandatory language and can be referenced by model codes, by authorities having jurisdiction over local building codes, persons or agencies that provide specifications, or in legal documents such as project specifications and manuals.

ACI specifications are developed in a seven-step process comprising:

- Preparation of a new document or revision of an existing document;
- Letter balloting of the draft document by the committee;
- Submission of the committee-approved document for review by ACI's Technical Activities Committee (TAC);
- Revision of the document in response to comments from TAC;
- A 45-day public discussion period in which members of the design, construction, owner, and general public are invited to submit comments regarding the document;
- Submission of committee-approved responses to comments received during the public discussion period for TAC review; and
- Submission to ACI Standards Board for final approval.

ACI specifications must be worded in explicit, mandatory language designed to avoid misinterpretation. Specifications must also cite only mandatory-language documents. References to nonmandatory-language documents such as guides, reports, papers, and research results can be made in the document's notes to the specifier, which is a form of commentary.

ACI construction standards include the following document types that can be incorporated by reference within

contracts, either between an owner and a contractor, between an owner and a producer, or between an owner and a testing or inspection agency:

- **Construction specifications**—Documents that provide requirements for the products and finishes to be used in a project are instructions written to the contractor, and may be incorporated by reference into contracts between an owner and a contractor (typically called contract documents);
- **Material specifications**—Documents that prescribe requirements for materials used in projects are instructions written to the producer, and may be incorporated by reference into construction specifications or into contract documents;
- **Test methods**—Documents that prescribe means of testing for compliance (acceptance testing) of materials or construction methods to be used in projects are written as

instructions to the testing agency, and may be incorporated by reference in material specifications, construction specifications, or contract documents;

- **Inspection services specifications**—Documents that prescribe the test methods and scope to be used for quality assurance testing are written as instructions to the inspection agency, and may be incorporated by reference in a contract between an owner and an inspection agency; and
- **Testing services specifications**—Documents written as instructions to the testing agency as part of a contract between an owner and a testing agency or between a contractor and a testing agency.

What's Inside an ACI Reference Specification

Current ACI reference specifications are listed in Table 1. These documents are written in the three-part section format

Table 1:
A listing of ACI reference specifications as of September 2019

Construction specifications	
ACI 117-10(15)	Specification for Tolerances for Concrete Construction and Materials and Commentary
ACI 301-16	Specifications for Structural Concrete
ACI 305.1-14	Specification for Hot Weather Concreting
ACI 306.1-90	Standard Specification for Cold Weather Concreting
ACI 308.1-11	Specification for Curing Concrete
ACI 330.1-14	Specification for Unreinforced Concrete Parking Lots and Site Paving
ACI 336.1-01	Specification for the Construction of Drilled Piers
ACI 350.1-10	Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary
ACI 440.5-08	Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars
ACI 503.3-10	Specification for Producing a Skid-Resistant Surface on Concrete by the Use of Epoxy and Aggregate
ACI 503.4-92	Standard Specification for Repairing Concrete with Epoxy Mortars
ACI 503.7-07	Specification for Crack Repair by Epoxy Injection
ACI 506.2-13(18)	Specification for Shotcrete
ACI 522.1-13	Specification for Pervious Concrete Pavement
ACI 548.4-11	Specification for Latex-Modified Concrete Overlays
ACI 548.8-19	Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks
ACI 548.9-08	Specification for Type ES (Epoxy Slurry) Polymer Overlay for Bridge and Parking Garage Decks
ACI 548.10-10	Specification for Type MMS (Methyl Methacrylate Slurry) Polymer Overlays for Bridge and Parking Garage Decks
ACI 548.12-12	Specification for Bonding Hardened Concrete and Steel to Hardened Concrete with an Epoxy Adhesive
ACI 548.13-14	Specification for Bonding Fresh Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive
ACI 548.14-14	Specification for Repairing Concrete with Epoxy Mortar
ITG-07-09	Specification for Tolerances for Precast Concrete
Testing services specifications	
ACI 311.6-18	Specification for Testing Ready Mixed Concrete
Inspection services specifications	
ACI 311.7-18	Specification for Inspection of Concrete Construction
ACI 350.5-12	Specification for Environmental Concrete Structures
Materials specifications	
ACI 423.7-14	Specification for Unbonded Single-Strand Tendon Materials
ACI 440.6-08(17)	Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement
ACI 440.8-13	Specification for Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures

of CSI as modified by ACI:

- Part 1 covers general administrative requirements such as definitions, submittals, referenced standards, and acceptance criteria;
- Part 2 addresses products and materials; and
- Part 3 deals with execution.

ACI single-item specifications address a single product or process, and they are like the CSI narrow-scope specifications. ACI multiple-item specifications address more than one technical product or process, and they are like CSI's broad-scope specifications.

ACI construction specifications are written to the contractor and must be referenced in contract documents. ACI specifications do not include commentaries. The specification is followed by notes to specifiers and checklists, which are directed to the specifier and are not part of the specification.

Notes to Specifier—Includes a list of cited references, a mandatory requirements checklist, and an optional requirements checklist. The general notes provide guidance on how to incorporate the ACI specification into contract documents. The foreword to the checklists explains how to modify the ACI specification in contract documents for the project.

The mandatory requirements checklist identifies provisions that do not have a default requirement and specific requirements must be provided in contract documents. The optional requirements checklist identifies alternatives to default requirements or optional requirements that the specifier may want to incorporate through contract documents. Checklists do not provide explanations for the requirements; instead, refer to ACI guides and reports for additional information.

Mandatory Requirements

Checklist—Identifies information that **is required** to be included in contract documents because there is no default requirement in the specification. A default requirement is a limiting

requirement that has been selected for the specification. Unless otherwise specified in contract documents, default requirements are mandatory conditions of the specification. Table 2 shows the mandatory requirements checklist for the first five Sections of ACI 301-16. Because ACI 301 does not provide a

default value for the items listed, the specifier must include a requirement in the project specifications; otherwise, there is no contractor requirement.

Optional Requirements

Checklist—Describes items that the specifier may wish to include in the contract documents. These items can

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Table 2:
Mandatory requirements checklist for the first five sections of ACI 301-16

MANDATORY REQUIREMENTS CHECKLIST	
Section/Part/ Article	Notes to Specifier
<i>Formwork and formwork accessories</i>	
2.2.1.5	Specify materials and design for waterstops, sleeves, inserts, anchors, and other embedded items as required for the Work.
2.2.2.5(b)	Indicate in Contract Documents the locations of required movement joints.
2.2.2.5(c)	Indicate in Contract Documents where keyways are required.
2.2.2.5(d)	Indicate in Contract Documents the locations where waterstops are required in joints.
<i>Reinforcement and reinforcement supports</i>	
3.1.2.1(f)	Specify locations where field bending or straightening of reinforcing bars is permitted.
3.2.1.1	Specify required grades, types of steel, and sizes of reinforcing bars.
3.2.1.2(a)	For zinc-coated (galvanized) reinforcing bars conforming to ASTM A767/A767M, specify coating class, whether galvanizing is to be performed before or after fabrication, and indicate which bars require special finished bend diameters.
3.2.1.2(b)	Specify ASTM specification to which epoxy-coated reinforcing bars are to conform.
3.2.1.6	Specify the following for wire reinforcement: (a) Material specification (b) Wire size (c) Special minimum yield strength or grade (d) Additional specification for galvanizing or epoxy coating
3.2.1.7	Specify the following for welded wire reinforcement: (a) Material specification (b) Sheets or rolls (c) Wire size and spacing (longitudinal and transverse) (d) Minimum yield strength or grade (e) Additional specification for galvanizing or epoxy coating
3.2.1.9	Specify types of reinforcement supports and location used within structure. Refer to Chapter 3 in CRSI MSP 2.
3.3.2.5(a)	Specify location and tolerance for placement of welded wire reinforcement.
3.3.2.5(b)	Specify method of lapping at edges and ends of wire reinforcement.
3.3.2.7	Indicate splices in Contract Documents.
<i>Concrete mixtures</i>	
4.2.2.7(a)	Designate in Contract Documents the exposure class for portions of the structure requiring concrete resistant to sulfate attack. Refer to ACI 318 for description of exposure classes.
4.2.2.7(b)	Designate in Contract Documents the exposure class for portions of the structure requiring resistance to freezing and thawing. For Exposure Class F3, indicate if it is plain concrete. Refer to ACI 318 for additional guidance.
4.2.2.7(c)	Designate in Contract Documents the exposure class for portions of the structure requiring low permeability when in contact with water. Refer to ACI 318 for description of exposure classes.
4.2.2.7(d)	Designate in Contract Documents the exposure class for portions of the structure requiring corrosion protection of reinforcement. Refer to ACI 318 for additional guidance. Refer to ACI 201.2R and ACI 222R for additional information on the effects of chlorides on corrosion of reinforcement.
4.2.2.8	Indicate the specified compressive strength of concrete, f'_c , for various portions of the Work. For most structural members, the requirements of the design will dictate the required strength. A higher compressive strength may be required for durability considerations. For floors, the specified compressive strength f'_c will generally depend upon the intended use and expected wear unless durability considerations dictate higher strengths. If the floor will be exposed to abrasive wear from early construction traffic, consider requiring a minimum compressive strength at 3 days of 1800 psi or higher. Refer to ACI 302.1R for guidance on compressive strengths to specify for various classes of floors. Concrete assigned to Exposure Class S1, S2, S3, F1, F2, F3, C2, or P1 as defined in ACI 318, is required to meet the maximum w/cm limits given in Table 4.2.2.7(a), Table 4.2.2.7(b), Table 4.2.2.7(c), and Table 4.2.2.7(d).
<i>Handling, placing, and constructing</i>	
5.3.1.4	Specify requirements of base and subgrade preparation for slab-on-ground.
5.3.3.3	Specify required as-cast finish.
5.3.4.2(f)	For heavy-duty topping for two-course slabs, specify location, materials, and final finishing method.

include requirements to be used in place of the default requirements in the reference specification, or the items can include requirements that are not included in the default requirements in the specification. The optional requirements checklist informs the specifier of the options that may be invoked and can provide sample language that the specifier can use in contract documents. The ACI optional requirements checklist can provide:

- Concise instruction to the specifier;
- Concise guidance to the specifier—recommended values or alternative products or installation procedures;
- References for additional guidance; and
- Sample language to invoke the optional requirement.

Table 3 shows the optional requirements checklist for ACI 117-10(15).

A Checklist for Specifiers

The following checklist is provided as guidance on the use of ACI reference specifications:

- **Know the Entire Reference Specification**—Determine if the reference specification should be used. If conflicts exist between the reference specification and the project or product specifications, rectify those conflicts with explicit

instructions for the contractor. Do not incorporate a general statement such as “when a conflict exists, choose the most stringent requirement,” as it is not always obvious which is the most stringent requirement;

- **Consider Standards Cited in the Reference Specification**—Many ACI reference specifications cite other standards. As a result, these cited standards are also part of the contract documents. As the specifier, you must read and understand the cited standards, and you must look for and rectify conflicts;
- **Require a Reference Specification at Project Site**—Require the contractor to keep a copy of the ACI reference specification and the cited standards at the project site and available for resolution of on-site questions;
- **Cite the ACI Specification in the Project Specifications**—Take advantage of the experience and expertise that was used in developing the ACI reference specification. A statement such as the following will serve to make ACI Specification XXX a part of the Project Specification: “Work on (Project Title) shall conform to all requirements of ACI (Specification number with date suffix and title) published by the American Concrete Institute, Farmington Hills, MI, except as modified by these Contract Documents.”;

Table 3:
Optional requirements checklist in ACI 117-10(15)

OPTIONAL REQUIREMENTS CHECKLIST	
Section/Part/Article	Notes to the Specifier
Section 1—General requirements	
1.1 Scope	Specialized concrete construction or construction procedures require the Specifier to include specialized tolerances. ACI committee documents covering specialized construction may provide guidance on specialized tolerances. Specify tolerances for Architectural Concrete. Refer to ACI 303.1 for guidance.
Section 2—Materials	
2.2	CRSI 10MSP, Appendix C, provides valuable information concerning development of details for placement of reinforcement.
2.2.2 Concrete cover	The tolerance for reduction in cover in reinforcing steel may require a reduction in magnitude where the reinforced concrete is exposed to chlorides or the environment. Where possible, excess cover to other protection of the reinforcing steel should be specified instead of reduced tolerance because of the accuracy of locating reinforcing steel using standard fabrication accessories and installation procedures.
2.2.6.1	The Specifier may elect to specify alternate tolerance for horizontal deviation of prestressing reinforcing or prestressing ducts.
2.3.2 Embedded items	Tolerance given is for general application. Specific design use of embedded items may required the Specifier to designate tolerances of reduced magnitude for various embedded items.
Section 3—Foundations	
3.1, 3.2, 3.3, 3.4, and 3.5	Tolerances given are for general application. Refer to ACI 336.1 for guidance.
3.5.3	Plus tolerance for the vertical dimension is not specified because no limit is imposed. Specifier should designate plus tolerance if desired.
Section 4—Cast-in-place concrete for buildings	
4.5.3	Chose plus tolerance for slab thickness.
4.9.1	Specifiers are cautioned that a tighter tolerance should be specified where there is a potential for cutting reinforcement.
4.8	Choose Waviness Index as alternative to methods specified in Section 4.8.5 or 4.8.6. Testing shall be in accordance with ASTM E1486. Specified Overall Surface Waviness Index and Minimum Local Surface Waviness Index must be specified.
4.8.4.3	Designate testing agency.
4.8.4.5	Designate distribution of test reports.
4.8.6.3	Choose computerized simulation of manual straightedge. Specify minimum number of samples, test procedure (must be reproducible), and acceptance criteria.

- **Complete the Mandatory Requirements Checklist**—Each ACI reference specification includes a checklist for work requirements that are not defined in the ACI reference specification. You must provide these requirements in the project specification. If items on the checklist are ignored, the project specification will not provide instructions or contractual requirements to the contractor on those items; and
- **Appreciate the Options**—Each ACI reference specification also includes a checklist that identifies alternatives to the requirements provided in the ACI reference specification. The checklist also defines the actions required or available to you, the specifier. You should review each of the items in the checklist and adjust according to the needs of a project by including those selected alternatives as mandatory requirements in the project specification.

Specifiers minimize their risk by using reference specifications to exploit each industry's expertise. To reap these benefits and reduce conflicts, however, specifiers must know the contents of reference specifications, recognizing that providing clear and concise instructions to the

contractor ultimately benefits the owner.

Note: Additional information on the ACI specifications discussed in this article and AIA MasterSpec® can be found at www.concrete.org and www.aia.org, respectively.

Selected for reader interest by the editors.



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