

# How to Develop Better Project Specifications

Guidance for incorporating ACI 301 and other reference specifications in project specifications

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This is the third and final article on ACI 301-10, “Specifications for Structural Concrete.”<sup>1</sup> The first article discussed major changes since the last edition of ACI 301 and the second discussed some of the key items in ACI 301-10.<sup>1</sup> This article contains information on how to develop clear, concise specifications, with specific emphasis on how to better use ACI 301 as a project specification for structural concrete projects or as part of the specification package for more complex building projects.

ACI 301 is typically incorporated by reference into the contract documents. Once ACI 301 is referenced in the contract documents, the requirements in ACI 301 become part of the project specifications. The architect/engineer (A/E) must be aware that he or she has specified these requirements and should be certain that the requirements are appropriate for the specific project. The contractor must also review ACI 301 and understand that requirements in ACI 301 are part of the project specifications.

On many occasions, I’ve heard Jeffrey W. Coleman, an ACI colleague, engineer, and attorney, comment:

It is not good enough for specifications to be written so that they can be understood; specifications must be written so that they cannot be misunderstood.

Producing specifications that cannot be misunderstood can be difficult, even under the best of circumstances. A big step toward that goal is to clearly state requirements for a project, state them only once, and only reference documents that are written in mandatory language. Proper use of ACI 301 can also help achieve that goal.

## WHAT SHOULD SPECIFICATIONS INCLUDE?

A project’s specifications should list only the requirements that apply to that particular project. The A/E should know what is required to meet the specific project code requirements and the owner’s requirements and understand which reference documents can help to define those requirements for the contractor.

Each document that is referenced in the project specifications should only be referenced if it provides specific instructions to the contractor. Documents should not be referenced for any other reason.

It appears that in some cases, however, the A/E references documents that do not provide specific requirements to the contractor; some of these documents are written in nonmandatory language and do not pertain to the specific project. They appear to be referenced only because they were in previous specifications. In the course of my consulting practice, I’ve found that many A/Es are not familiar with the requirements specified in their own contract documents. An even larger number of these professionals are unfamiliar with the requirements in documents referenced in their specifications.

This article is Part 3 of a three-part series contributed for ACI Committee E707, Specification Education. The author is a member of ACI Committee E707 and was Chair of ACI Committee 301, Specifications for Concrete, during the writing and balloting of ACI 301-10.

## Satisfying building code requirements

Project specifications must include minimum requirements listed in the governing building code. Because almost all local jurisdictions reference ACI 318<sup>2</sup> or ACI 349,<sup>3</sup> the specification developed by the A/E must be at least as restrictive as the code requirements in those documents. In most cases, however, the specification should not reference ACI 318 or ACI 349, as the language in an ACI code requirements document is directed to the designer, not the contractor. The introduction to ACI 318 emphasizes the document's purpose, stating:

The Code provides a means of establishing minimum standards for acceptance of designs and construction by legally appointed building officials or their designated representatives. ...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 drawings, specifications, and 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.

ACI 301 contains specifications for the materials and construction requirements that are required in ACI 318 or ACI 349; however, ACI 301 states them in specification language directed to the contractor. So, if the A/E references ACI 301 in the specification for the project,

**TABLE 1:**  
DESCRIPTIONS OF ACI CODES, SPECIFICATIONS, GUIDES, MANUALS, AND REPORTS

ACI document type	Language	Description*
Code requirements (Codes)	Mandatory	An ACI code provides minimum requirements for concrete or masonry structures within its scope to safeguard the public safety, health, and general welfare. ACI codes are written with the expectation that they will be adopted by a generalized building code or a regulatory agency. Code requirements are written to the design professional. They are not written to direct other members of the design and construction team, such as a contractor.
Construction specifications	Mandatory	Construction specifications are reference specifications written as part of a contract between an owner and a builder. ACI specifications are written to the contractor. ACI specifications do not include commentaries. The attached Notes to Specifiers are written to specifiers in nonmandatory language and are not a part of the specification.
Guides	Nonmandatory	ACI guides present committee recommendations for analysis, design, specifying, selection, evaluation, testing, construction, or repair of concrete materials or structures.
Handbooks	Nonmandatory	Handbooks provide information and guidance on how to apply design standards in practice and typically contain charts and tables to facilitate the design of concrete structures.
Manuals	Nonmandatory	Manuals generally provide guidance and instructions to field personnel involved in different aspects of concrete construction.
Reports	Nonmandatory	Reports provide information on concrete technology. Reports may include recommended action but are not required to do so. Reports can cover topics such as research results, design or construction methods, or current knowledge on a particular concrete technology.

\*Descriptions excerpted from Reference 6

the construction and materials requirements in ACI 318 and ACI 349 are covered.

ACI 318 should only be included in project specifications when the contractor is required to design parts of the structure. For example, precast structural concrete is designed by the contractor through the precast manufacturer, so the A/E for a precast concrete building may need to specify design requirements contained in ACI 318. When ACI 318 is referenced in the contract documents, the specific parts of the structure that must be designed in accordance with ACI 318 should be clearly indicated.

### Avoiding conflicts

The specifications for most building projects follow MasterFormat<sup>®</sup>,<sup>4</sup> a numbered and titled list that has been developed to organize construction specifications. Depending on the edition, this system breaks the specification into 16 or 50 divisions. The A/E should review the full set of specifications to identify conflicts within the specification and remove inappropriate requirements.

Tolerances are critical items covered in the project specifications. They must be achievable, clearly stated, and coordinated among the various divisions. For example, the floor flatness requirements for the concrete contractor in the concrete section of the specification (Division 3) may or may not meet the needs of the flooring contractor (whose work is governed in Division 9). These requirements should be coordinated to avoid confusion between the respective contractors.

The A/E's specifications typically reference ACI 117, "Specification for Tolerances for Concrete Construction and Materials"<sup>5</sup> (ACI 117 is also a reference in ACI 301). If the tolerances shown in ACI 117 are not adequate, the A/E should modify the tolerances and explicitly state the tolerances in the project specifications. The A/E should also realize, however, that there is no perfection in the construction industry, so terms like "perfectly," "flat," "level," or "smooth" should not be used in a specification.

### WHAT SHOULD NOT BE IN A SPECIFICATION?

ACI publishes different types of documents, many of which are written in nonmandatory language (Table 1).<sup>6</sup> Specifications should never reference documents that are not written in mandatory language. Unfortunately, many specifications include such documents. This increases the chances for confusion and misinterpretation; in a few specifications, I have seen the entire Manual of Concrete Practice (MCP) referenced.

The MCP is a very useful compilation that includes documents written in mandatory language, but it also includes many guides and reports. Guides and reports are written in nonmandatory language and they are not intended to be included in contract documents (Fig. 1).

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 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.

**Fig. 1: The ACI Technical Committee Manual<sup>6</sup> requires this information to be provided on the first page of nonmandatory language documents**

When guides and reports are referenced in project specifications, it appears that the A/E is trying to create a specification that covers any and every possibility. In fact, such a scattershot approach has the opposite effect, as the many contradictory requirements and instructions render the specification confusing.

In other cases, I've seen specifications that include the following statement: "Whenever 'should or may' is used in the referenced documents, it should be replaced with 'shall.'" While such a statement seems to effectively convert instructions into mandatory language, it really does the opposite. It creates confusion because there will almost always be conflicting requirements when recommendations, as they are listed in guides and reports, are converted to requirements. An example is provided in Fig. 2, which illustrates the effects of converting sections of ACI 309R-05, "Guide for Consolidation of Concrete,"<sup>7</sup> into mandatory language. Although ACI 309R provides some of the best information available regarding consolidating concrete, converting the document to mandatory language creates confusion and conflicts. It may also place the A/E in the position of assuming responsibility for means and methods.

As indicated in the previous section, ACI 318 and ACI 349 are not construction standards and they should not be referenced in a project specification unless the contractor is designing a portion of the structure.

## CHAPTER 7—RECOMMENDED VIBRATION PRACTICES FOR GENERAL CONSTRUCTION

### 7.1—General

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Internal vibration is generally best suited for normal construction, provided the section is large enough for the vibrator to be effectively used. External vibration or consolidation aids, however, ~~may~~ shall be needed to supplement internal vibration in areas congested with reinforcement or otherwise inaccessible (Chapter 18). In many thin sections, especially in precast work and slabs, external vibration ~~should~~ shall be the primary method of consolidation.

## CHAPTER 10—NORMAL-DENSITY CONCRETE FLOOR SLABS

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### 10.3—Structural slabs

Structural slabs that contain reinforcement and embedded items such as conduits, pipes, pipe sleeves, etc., ~~should~~ shall be internally vibrated. Vibrating screeds are also used to facilitate finishing; a high-frequency, low-amplitude type ~~may~~ shall be used in this case.

information required for Sections 1 through 5 of ACI 301-10. The A/E will also need to review ACI 301-10, Sections 6 through 14, to determine which of the special concrete requirements are needed for the specific project. When these sections are included in the contract documents, there are additional items in the Mandatory Requirements Checklist that must be included in the contract documents.

The A/E must recognize that just because something is clear to the design team, it may not be clear to the construction team. For example, the design team may design a portion of a structure using architectural concrete; however, the contractor may not realize that the particular area is designed to be architectural concrete. It should be noted that there is a mandatory requirement that the A/E state which portions of the structure must be constructed in accordance with Section 6, Architectural Concrete:

Mandatory Requirements Checklist 6.1.1.1:

Designate areas to be treated as architectural concrete. Describe special requirements of each designated area.

The A/E should also review the Optional Requirements Checklist to determine if alternative tolerances or other specification items will be required. These alternatives should be included in the specification.

## Referencing ACI 301 into specifications that do not use MasterFormat

On projects that only involve structural concrete, or if the specifications are delineated so that only the structural concrete requirements are issued in a package, ACI 301 can be the basis for specifications for the project. This method of developing specifications can be used on small or large projects. The most direct way to reference ACI 301 is to use general note G3, provided in the notes to the specifier section of ACI 301:

Work on (Project Title) shall conform to all requirements of ACI 301-10, "Specifications for Structural Concrete," published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by these Contract Documents.

When only Sections 1 through 5 of ACI 301 are applicable, the A/E must specify up to a maximum of 11 mandatory items. The requirements for the items listed in the Mandatory Requirements Checklist can easily be included as part of the notes on the drawings.

This is an efficient way to use ACI 301 in developing the specifications, but it should be noted that the default requirements in ACI 301 are somewhat conservative; the requirements may not be needed for all projects and may pose additional, unnecessary costs. This may be acceptable for small projects, but for larger projects, the A/E should review the Optional Requirements Checklist and make

Fig. 2: Examples of the contradictory statements created when a guide (Reference 7) is converted into mandatory language

## REFERENCING ACI 301 INTO THE CONTRACT DOCUMENTS

ACI 301-10 provides requirements to the contractor; however, notes to the A/E for using ACI 301-10 are provided in the same binding but are not part of the specification. These instructions to the A/E, listed in a section titled, "Notes to Specifier," indicate the proper way to incorporate ACI 301 into project specifications.

The notes to the specifier include three checklists for the A/E to use in incorporating ACI 301 into the concrete specification. The first of these checklists, the Mandatory Requirements Checklist, indicates specific qualities, procedures, and performance criteria that the specifier must define in a project specification. The second, the Optional Requirements Checklist, identifies choices and alternatives that the specifier can include as requirements in a specification. The third, the Submittals Checklist, identifies items that will be submitted by the contractor and reviewed by the A/E.

There are different ways of referencing ACI 301 into the contract documents, depending on the specific format that the A/E uses to develop the project specifications. The A/E must specify the items in the Mandatory Requirements Checklist. These will always include

changes to the specifications based on specific needs. In cases where the optional requirements are invoked, the A/E must incorporate them into the contract documents.

### **Referencing ACI 301 into specifications that use MasterFormat**

ACI 301-10 can and should be used as the basis for MasterFormat's Division 3, Concrete, for projects that contain a variety of different types of concrete materials, including cast-in-place, architectural, lightweight, shrinkage-compensating, mass, post-tensioned, and precast concrete items; industrial floor slabs; and tilt-up panels. Section 1 of Division 3 normally contains a list of documents that are used in this part of the specification. ACI 301, along with all of the other reference documents that are also referenced, is included in this list.

ACI 301 is different from most of the other reference documents because the requirements in ACI 301 pertain to many different parts of the specifications and should be referenced in the project specifications at the appropriate locations. For example, when the A/E specifies that concrete must meet the requirements of ASTM C94, this requirement can be clearly stated in the materials section, as it relates to ready mixed concrete. ACI 301 covers such a wide range of subjects in the project specifications, it would also have to be referenced for the formwork, reinforcement, reinforcement placing, materials to be used on concrete, requirements for developing concrete mixture proportions, placing concrete, curing concrete, hot weather concrete, cold weather concrete, protection requirements, and many more items.

It is critical that the A/E convey to the construction team that the requirements in Division 3 of the project specifications are based on the specifications written by the A/E and on ACI 301 and the other reference specifications. It may be beneficial to add the following words to the project specifications:

The requirements herein are based on ACI 301-10, "Specifications for Structural Concrete," published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by these Contract Documents.

Because ACI 301 is listed in the project specifications, this statement does not change the requirements in the specifications; however, it does clarify to the contractor that ACI 301 is part of the specified requirements and must be complied with.

### **HOW SHOULD THE CONTRACTOR USE ACI 301?**

The obvious answer: the contractor should thoroughly review the specification, including the reference specifications. This includes ACI 301. The contractor should ask for clarification on items that are not clear. To

reiterate, the reference documents should also be part of this review. They may contain many items that the contractor decides to ignore, as he or she is of the opinion that they do not apply to the particular project. If these items are ignored, however, they have a way of becoming an issue at some point in the project.

As most contractors are aware, there are floor flatness and levelness requirements for industrial floor slabs; however, many contractors are not aware that there are finish requirements for all concrete slabs. ACI 301 has the following default requirements for floor flatness:

5.3.4.2.c Trowel finish—Float concrete surface, then trowel the surface. Unless otherwise specified, tolerances for concrete floors shall be for a conventional surface in accordance with ACI 117. Addition of water to surface during finishing is prohibited.

Unless the contractor reads ACI 301 thoroughly, this and other details may be overlooked.

The contractor can always ask for a variance to the specification; where ACI 301 contains the phrase "unless otherwise permitted," the committee intended this as a suggestion to the contractor that he or she may want to ask for an alternative requirement. In effect, while ACI Committee 301 reached consensus that a specific requirement was necessary, the committee also acknowledged that there could be different ways to accomplish the same goal. For every place that contains the term "unless otherwise permitted," there is an item in the Submittals Checklist to alert the A/E that the contractor may choose to submit an alternative item.

The contractor should realize that ACI 117 is typically part of the reference documents within the A/E's specifications. If it is not referenced by the A/E, however, ACI 117 is referenced in ACI 301. The contractor should review these requirements and be sure that he or she can construct the structure within those tolerances or ask for a variance.

It is common to require that subcontractors and materials suppliers complete their specific tasks in accordance with contract documents. ACI 301 is written to the contractor, not to subcontractors or materials suppliers. If the contractor wants subcontractors and materials suppliers to follow the requirements in the project specifications, the contractor should make specification requirements part of the contract for the subcontractor services.

The A/E or contractor should not expect the materials supplier or subcontractor to follow the code requirements if they are not in the specifications. For example, the concrete producer should not be responsible for the design of durable concrete. If the engineer specifies concrete that does not meet the code requirements for durable concrete, or the contractor does not order what is specified by the A/E, the



concrete producer is required to provide concrete that meets the purchase order requirements rather than the general code requirements. The A/E should not expect the subcontractor or materials supplier to be familiar with the code requirements and produce a product that meets these requirements; it is the responsibility of the A/E to state his or her requirements in the project specifications.

## RECOMMENDATIONS

### My best advice to the A/E is to:

- Determine the needs and wants of the owner and develop specifications that represent the requirements for the project, rather than those of previous projects. Be assured that if the project is constructed within the project specifications, the owner will get the product that he or she desires;
- Reference ACI 301 when the project is designed in accordance with ACI 318 or ACI 349; this assures the designer that the requirements that are in ACI 318 or ACI 349 are written in specification language;
- Strive to develop a reputation that your firm enforces the project specifications. This eliminates confusion both within your office and on the part of the contractor;
- State the project requirements concisely and only once;
- Eliminate specification references to documents that are written in nonmandatory language. They do not provide requirements and they will most likely make the specification confusing;
- If appearance is a concern, require the construction of mockups and require approval by the A/E team prior to construction;
- Do not use ACI 318 or ACI 349 as a reference in the specification unless the contractor will be required to develop plans and specifications for the project;
- Eliminate specification gaps—coordinate specifications among the various contractors so that all MasterFormat divisions are in agreement;
- Ensure that the project requirements will provide the owner with a structure that meets the code requirements and the owner's desires if it is constructed within the specified tolerances; and
- Evaluate variances from the specifications and determine their impacts on the structure.

### My best advice to the contractor is to:

- Read the project specifications;
- Review and understand ACI 301 and other reference documents in a project specification;
- Plan to construct the structure in accordance with the contract documents;
- Before agreeing to a contract, be sure you understand the project specifications and are willing to adhere to all of the requirements; and

- Submit requests for information if the specifications have ambiguities, apparent omissions, errors, or conflicts.

One of the most important tools for a successful project is a clear, concise, accurate specification that is written so that it cannot be misunderstood. The proper incorporation of ACI 301-10 in a specification will increase the chances of producing such a document and that it will be used as a resource document during construction.

## References

1. ACI Committee 301, "Specifications for Structural Concrete (ACI 301-10)," American Concrete Institute, Farmington Hills, MI, 2010, 77 pp.
2. ACI Committee 318, "Building Code Requirements for Structural Concrete (ACI 318-08) and Commentary," American Concrete Institute, Farmington Hills, MI, 2008, 473 pp.
3. ACI Committee 349, "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-06) and Commentary," American Concrete Institute, Farmington Hills, MI, 2006, 153 pp.
4. MasterFormat 2011 Update, The Construction Specifications Institute, Alexandria, VA.
5. ACI Committee 117, "Specification for Tolerances for Concrete Construction and Materials (ACI 117-10) and Commentary," American Concrete Institute, Farmington Hills, MI, 2010, 76 pp.
6. ACI Technical Activities Committee, "ACI Technical Committee Manual (2011 TCM)," American Concrete Institute, Farmington Hills, MI, 2011, 63 pp.
7. ACI Committee 309, "Guide for Consolidation of Concrete (ACI 309R-05)," American Concrete Institute, Farmington Hills, MI, 2005, 36 pp.

Note: Additional information on the ASTM standards discussed in this article can be found at [www.astm.org](http://www.astm.org).

Selected for reader interest by the editors.



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