

ACI 336.1
ACI 336.1R-98

**Reference Specifications
for the Construction of
Drilled Piers (ACI 336.1) and
Commentary (ACI 336.1R-98)**

Reported by ACI Committee 336



american concrete institute

P.O. BOX 9094
FARMINGTON HILLS, MICHIGAN 48333-9094

Construction of Drilled Piers

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**American Concrete Institute
P.O. Box 9094
Farmington Hills, MI 48333-9094**

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1. Title and number of the document containing the problem and specific section in the document;
2. Concise description of the problem;
3. If possible, suggested revisions for mitigating the problem.

The Institute's Engineering Staff will review and take appropriate action on all comments and suggestions received. Members as well as nonmembers of the Institute are encouraged to assist in enhancing the accuracy and usefulness of ACI documents.

Reference Specification for the Construction of Drilled Piers (ACI 336.1) and Commentary (ACI 336.1R-98)

Reported by ACI Committee 336

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M. T. Davisson

Fred H. Kulhawy

John F. Seidensticker

Jagdish S. Syal

Ronald W. Harris

Samuel S. White

* Chairman at the time of document preparation.

This specification covers requirements for drilled pier construction. It includes delivery, handling and storage of the casing, excavation, soil testing, placing of concrete and reinforcing steel, and inspection. Drilled piers are sometimes called drilled shafts, caissons, or bored piles.

The Specification and Commentary are listed concurrently throughout this document. To distinguish the Specification from the Commentary, the Specification has been printed in Helvetica, the same type face in which this paragraph is set.

This paragraph is set in Times Roman. All portions of the text exclusive to the Commentary are printed in this typeface. To further distinguish the Specification from the Commentary, a gray bar appears immediately to the left of each paragraph of Commentary (as shown here).

ACI Committee Reports, Guides, and Commentaries are intended for guidance in planning, designing, executing, and inspecting construction. These documents are 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 the Commentary (336.1R-98) shall not be made in contract documents. If items found in the Commentary 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: bored piles; caissons; concrete construction; drilled piers; drilled shafts; excavation; foundations; placing; reinforced concrete; reinforcing steel; slurries; soil mechanics; specifications; standards; tests; tolerances.

FOREWORD

F1. This foreword is included for explanatory purposes only; it does not form a part of Reference Specification ACI 336.1.

F2. Reference Specification ACI 336.1 is an ACI standardized document that the Owner's Representative can cite in the project specifications for any building project, together with supplementary requirements for the specific project.

F3. The Reference Specification is written in the Three-Part Section Format of the Construction Specifications Institute, as adopted by ACI; the numbering system is modified to satisfy ACI requirements. The language is imperative and terse.

F4. A Specification Checklist is included as a preface to, but not forming a part of, Reference Specification ACI 336.1. The purpose of this checklist is to assist the Owner's Representative in properly choosing and specifying the necessary supplementary requirements for the Project Specifications.

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CONTENTS

Foreword	1	Section 2—PRODUCTS	20
Preface to specification checklists	2	2.1—General	
Mandatory requirements	3	2.2—Steel casing	
Optional requirements	6	2.3—Reinforcing steel	
Submittal checklist	17	2.4—Concrete	
Section 1—GENERAL REQUIREMENTS	18	2.5—Sand-cement grout	
1.1—Scope		2.6—Controlled slurry	
1.2—Definitions		Section 3—EXECUTION	21
1.3—Reference organizations		3.1—Tolerances	
1.4—SI units		3.2—Dry method	
1.5—Reference standards		3.3—Steel casing	
1.6—Project conditions		3.4—Reinforcing steel	
1.7—Quality assurance		3.5—Concrete	
1.8—Submittals		3.6—Casing withdrawal	
		3.7—Slurry displacement method	
		3.8—Placement of anchorage embedments	

PREFACE TO SPECIFICATION CHECKLISTS

P1. Reference Specification ACI 336.1 is intended to be used by reference or incorporation in its entirety in the Project Specifications. Individual sections, articles, or paragraphs shall not be copied into the Project Specifications, since taking them out of context may change their meanings.

P2. If sections or parts of Reference Specification ACI 336.1 are edited into project specifications or any other document, they shall not be referred to as ACI Standards, since the Reference Specification will have been altered.

P3. Building codes set minimum requirements necessary to protect the public. This Reference Specification, ACI 336.1, may stipulate requirements more restrictive than the minimum. Adjustments to the needs of a particular project shall be made by the Owner's Representative after reviewing each of the items in the Specification Checklist and then including the Owner's Representative's decision on each item as a mandatory requirement in the Project Specifications.

P4. These mandatory requirements designate the specific qualities, procedures, materials, and performance

criteria for which provisions were not made in the Reference Specification. The optional requirements designate the specific qualities, procedures, materials and performance criteria for which alternatives are permitted. Exceptions to the Reference Specifications shall be made in the Project Specifications, if required.

P5. A statement such as the following will serve to make Reference Specification ACI 336.1 a part of the Project Specifications.

"Work on (Project Title) shall conform to all requirements of ACI 336.1- 97, Reference Specification for the Construction of Drilled Piers, published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by the requirements of these Contract Documents."

P6. The Reference Specification Checklists identify Owner's Representative's choices and alternatives. The checklists identify the sections, parts, and articles of the Reference Specification and the action required by the Owner's Representative.

SPECIFICATION CHECKLIST

M. MANDATORY REQUIREMENTS

Section/ Part/ Article	Notes to Owner's Representative
1.1.1	Specify which installation methods are compatible with the design. Exclude methods that are not compatible. Installation methods can adversely affect design parameters such as end bearing and side friction. Examples of this would be the effect of using temporary or permanent casing on design side friction and the effect of in-hole dewatering on loosening of the bearing soil with resulting reduction in end-bearing capacity. Designers sometimes take into account the effects of different installation methods on their design parameters, such as reducing the allowable end bearing to allow for bottom loosening. However, if a designer does not feel that appropriate reductions can be determined, those installation methods that may adversely affect the design assumptions should be excluded.
1.5	Determine applicability of reference Standards. Delete those not used. Add other references as needed. Incorporate applicable portions of the following or other documents. The following documents are useful as guides. Since they are not written in specification format they cannot be incorporated by reference. However, applicable portions, modified into specification language, can be incorporated into the Contract Documents. American Concrete Institute ACI 311.5 Batch Plant Inspection and Field Testing of Ready-Mixed Concrete ACI 336.3 Design and Construction of Drilled Piers Deep Foundations Institute DFI-ADSC Drilled Shaft Inspectors Manual DFI-100 Day Document The International Association of Foundation Drilling (ADSC) DFI-ADSC Drilled Shaft Inspectors Manual ADSC Downhole Entry Manual ADSC-FHWA The Effects of Free-Fall Concrete in Drilled Shafts Federal Highway Administration FHWA-RD-92-004 Drilled Shafts for Bridge Foundations.

M. MANDATORY REQUIREMENTS

Section/ Part/ Article	Notes to Owner's Representative
	The above publications can be obtained from the following organizations: American Concrete Institute P. O. Box 9094 Farmington Hills, MI 48333-9094 Deep Foundations Institute 120 Charlotte Place, Third Floor Englewood Cliffs, New Jersey 07632 ADSC 10925 Estate Lane, Suite 134 P. O. Box 280329 Dallas, Texas 75228 Federal Highway Administration Turner Fairbank Highway Research Center 6300 Georgetown Pike McLean, VA 22101-2296
1.6	Include in the qualification requirements for bidders certain specific actions. Because drilled piers require that Contractors have specific knowledge and expertise, the following actions should be required of all bidders. 1. Visit the site. 2. Attend all pre-bid conferences. 3. Submit and have accepted a written resume of drilled pier experience including quantity, depth, diameter, installation method, owner, engineer, and addresses and telephone numbers of references. Any general contractor desiring to subcontract the drilled pier work shall ensure that the proposed subcontractor has fulfilled those requirements. Failure to do so is ample cause for disapproval of the subcontractor.
2.2	Specify size, wall thickness, type of steel, and length of required permanent casing or liner. Permanent casing, when part of the design, must be specified and shown on the Contract Documents. Permanent casing is normally of two types: smooth-wall steel casing strong enough to resist all imposed pressures and thin-walled metal liner for use as an economical concrete form when not subject to soil and water pressures. An example of the latter case would be when used inside temporary casing that is later withdrawn after concrete has been placed and has taken initial set within the metal liner. Normally this liner is a corrugated steel pipe. When permanent casing is used to carry part of the design load, all joints should have full-penetration welds or an acceptable mechanical alternative.

M. MANDATORY REQUIREMENTS

Section/ Part/ Article	Notes to Owner's Representative
2.4	Specify the minimum 28-day strength, maximum aggregate size, and concrete characteristics. Special concrete characteristics are vital for successful pier installation. These characteristics are different from those needed to build above-ground structures. In addition to strength, the principal characteristics are fluidity, aggregate size, and setting time. The amount of time the concrete remains fluid is especially important for piers installed by the slurry displacement method. The concrete mix must maintain minimum slump requirements throughout the concrete placement time and extraction of any temporary casing in contact with the concrete. Combinations of retarders and superplasticizers used to extend fluid properties should be tested in advance of construction and should meet requirements of ACI 212.4R-93 and ASTM C 494-92. The selection of the concrete characteristics and construction method should be consistent with Table 2.4.3, and based on an intimate knowledge of the installation process, subsurface conditions, and design objectives. The geotechnical engineer's guidance in design and construction is a prerequisite to successful construction.

O. OPTIONAL REQUIREMENTS

Section/ Part/ Article	Notes to Owner's Representative
1.1.1	If some pier diameters are less than 30 in. (750 mm), review the Reference Specification and modify as required. If pier diameters are less than 30 in. (750 mm), certain elements of the Reference Specification may be inappropriate, such as the permitted use of free-fall concrete or any requirements for physical down-hole inspection. The risk of free-fall concrete scraping the sides of the shaft while falling increases dramatically as the shaft diameter decreases below 30 in. (750 mm), and physical bottom inspection of pier diameters less than 30 in. (750 mm) is impractical.
1.2	Review definitions. Modify as required. Owner's Representative—At different times, different persons are authorized to act as the Owner's Representative. The decision as to which person is acting on behalf of the owner at a specific time or under a specific circumstance rests with the Owner and should be established in the Contract Documents. It is recommended that the design structural engineer and the design geotechnical engineer be retained for construction inspection and construction engineering because design decisions will be required during construction of the foundations. Owner's Representative - Geotechnical Engineer—Generally, the Owner's Representative could be any one of a number of qualified persons. However, under specific circumstances only a qualified geotechnical engineer should act. These specific circumstances are set forth in this reference specification. The geotechnical engineer is also known as a soils engineer, soils and foundation engineer, or earthwork and foundation engineer. It is recommended that the design geotechnical engineer also be the inspecting geotechnical engineer. When the inspecting geotechnical engineer is not the design geotechnical engineer, the inspecting geotechnical engineer will have the responsibilities and authority of the design geotechnical engineer and must be knowledgeable of and in agreement with the design assumptions. Pig—Also called a rabbit or go-devil. Testing Agency—The contractual relationship between the Testing Agency and the Owner must be established in the Contract Documents. It is recommended that the Testing Agency be retained by the Owner.

O. OPTIONAL REQUIREMENTS

Section/ Part/ Article	Notes to Owner's Representative
1.6.2	Give location of subsurface investigation reports, if not included in bid documents. Logs of borings and test data are available for the Contractor's information and for the Contractor's interpretation. Logs and test data are not represented as a complete description of the site subsurface condition, but only display what was found in borings at the indicated locations on the day the holes were drilled. The earth and groundwater conditions may be different from those described in the subsurface investigation. However, this information serves as a baseline from which significant variations that affect the contractor's work and costs can be noted. Procedures for a changed, or unexpected, conditions claim should be established in the Contract Documents and should include procedures for dispute resolution that reduce the likelihood and cost of litigation. The most common alternative dispute-resolution procedures involve mediation, arbitration, or dispute review boards. Appropriate alternative dispute-resolution procedures are available from the following organizations: Deep Foundations Institute 120 Charlotte Place, Third Floor Englewood Cliffs, New Jersey 07632 The American Arbitration Association 140 West 51st Street New York, New York 10020-1203 ASFE/The Association of Engineering Firms Practicing in the Geosciences 8811 Colesville Road Suite 6106 Silver Springs, Maryland 20901
1.6.4	Specify if Prebid or Preconstruction conferences <u>are not</u> required. Requirements for prebid conference attendance by Contractors are important on large and complex projects to make certain that any unusual aspects of the foundation system that can significantly affect the Contractor's costs are well understood prior to bidding. A preconstruction conference with the successful bidder is recommended, except for small or routine projects. The preconstruction conference is normally organized by the general Contractor and is attended by the drilled pier subcontractor, Owner's Representative, and Testing Agency. The purpose of the preconstruction meeting is to establish or confirm lines of communication and roles of the parties involved, review the construction procedures and schedule to be followed, and to answer any questions that the parties involved might raise.