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American Society of Civil Engineers

Standard Guidelines for the Design and Installation of Pile Foundations

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Standard Guidelines for the Design and Installation of Pile Foundations

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Abstract:

This *Standard* provides a guideline for an engineering approach to the design and subsequent installation of pile foundations. The purpose is to furnish a rational basis for this process, taking into account published model building codes and general standards of practice. It covers such topics as: 1) Administrative requirements; 2) pile shaft strength requirements; 3) soil-pile interface strength requirements and capacity; 4) design loads; 5) design stresses; 6) construction and layout guidelines for pile design; and 7) installation guidelines for pile construction. In addition, the *Standard* includes information on applicable standards from ASTM, AWPA, and ACI. It concludes with an Appendix on partial factors of safety.

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STANDARDS

In April 1980, the Board of Direction approved ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by the Society. All such standards are developed by a consensus standards process managed by the Management Goup F (MGF), Codes and Standards. The consensus process includes balloting by the balanced standards committee made up of Society members and non-members, balloting by the membership of ASCE as a whole and balloting by the public. All standards are updated or reaffirmed by the same process at intervals not exceeding five years.

The following standards have been issued:

ANSI/ASCE 1-82 N-725 Guidelines for Design and Analysis of Nuclear Safety Related Earth Structures

ANSI/ASCE 2-91 Measurement of Oxygen Transfer in Clean Water

ANSI/ASCE 3-91 Standard for the Structural Design of Composite Slabs and ANSE/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs

ASCE 4-86 Seismic Analysis of Safety-Related Nuclear Structures

Building Code Requirements for Masonry Structures (ACI530-95/ASCE5-95/TMS402-95) and Specifications for Masonry Structures (ACI530.1-95/ASCE6-95/TMS602-95)

Specifications for Masonry Structures (ACI530-95/ASCE6-95/TMS602-95)

ANSI/ASCE 7-95 Minimum Design Loads for Building and Other Structures

ANSI/ASCE 8-90 Standard Specification for the Design of Cold-Formed Stainless Steel Structural Members

ANSI/ASCE 9-91 listed with ASCE 3-91

ANSI/ASCE 10-90 Design of Latticed Steel Transmission Structures

ANSI/ASCE 11-90 Guideline for Structural Condition Assessment of Existing Buildings

ANSI/ASCE 12-91 Guideline for the Design of Urban Subsurface Drainage

ASCE 13-93 Standard Guidelines for Installation of Urban Subsurface Drainage

ASCE 14-93 Standard Guidelines for Operation and Maintenance of Urban Subsurface Drainage

ANSI/ASCE 15-93 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)

ASCE 16-95 Standard for Load and Resistance Factor Design (LRFD) of Engineered Wood Construction

ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations

ASCE 21-96 Automated People Mover Standards–Part 1

FOREWORD

Piles differ from most other portions of a structure in that with few exceptions they are not able to be visually inspected after installation. Driven piles are generally subjected to considerable stress during installation. For both driven and drilled piles, the potential for the pile shaft to sustain damage during installation should be considered in the determination of minimum dimensions and maximum design stresses. Furthermore, consistently identifiable soil strength parameters, coupled with consistent or uniform bearing strata are generally not luxuries found in foundation design.

This Standard provides a guideline for an engineering approach to the design and subsequent installation of pile foundations. The purpose is to provide a rational basis for this process, taking into account published model building codes and general standards of practice. It is intended for use by professional personnel of sufficient competency to evaluate the essence and limitations of the provisions contained herein and who will accept the responsibility for the application of the material presented.

In general, the expertise required to properly implement this Standard is seldom found in one individual. A common design team includes both a structural engineer and a geotechnical engineer, and may in addition include a pile contractor to provide construction expertise and cost estimates. Communication among all members of the design team and the client will aid in the successful implementation of this Standard.

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These Standard Guidelines were prepared through the consensus standards process by balloting in compliance with procedures of ASCE's Codes and Standards Activities Committee (CSAC). Those individuals who serve on the Standards Committee are:

Carroll L. Crowther, Chairman
Girish Agrawal
James E. Barris
James C. Benton, Jr.
Edward Demsky
Thomas D. Dismuke
Michael F. Engestrom
C. Scott Fletcher
Frank Gaasch
James S. Graham
Ahmad Habibian
Joseph C. Harden
Steven W. Hunt
Mohamad H. Hussein
Barry A. Johnson
Michael L. Jones
Jai Kim
Robert G. Lukas
Daniel M. McGee
Cetin A. Okcuoglu
Robert F. Pierry, Jr.
Abdulreza A. Sadjadi
Jerry A. Steding
Yuanhui Sun

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CHAPTER 1

General

1.1 Scope

The provisions of this Standard establish guidelines for the design and construction of pile foundations. Many of the design considerations contained herein require a working knowledge of soil mechanics and foundation engineering. Such knowledge is necessary for the design part of this Standard.

1.2 Referenced Standards

In addition to local codes and ordinances having jurisdiction, the provisions of the Referenced Standards, Sec. 9 of this Standard should be considered where they apply and where noted.

1.3 Deviations from This Standard

Deviations from the requirements of this Standard Guideline should be permitted only under the conditions stated in Sec. 6.1.1 and 6.4.7. Use of proprietary, new and/or improved pile types, materials, evaluation techniques, and pile installation techniques are not prohibited, as long as the design and installation of the piles are shown to comply with these guidelines.

1.4 Engineer Required

All work covered by this Standard should be under the direction of a professional engineer (1) having current experience and qualifications in pile foundation design, construction, and understanding verification techniques as dictated by the project requirements, and (2) having a valid professional engineering license in the locality where the piles are to be installed. This professional engineer is hereinafter referred to as the Engineer. The Engineer may delegate portions of the exploration, design, testing, and inspection to qualified personnel, working under his or her direction, where permitted by local law.

1.5 Definitions

The following terms are defined with reference to the work covered by this Standard. Terms in the Standard that are not defined shall have their ordinarily accepted meanings within the context with which they are used. *Webster's New International Dictionary of English Language, Unabridged,* latest edition, shall be considered as providing ordinarily accepted meanings.

Acceptable or Accepted: Meets with the approval of the Engineer or Geotechnical Engineer. Documentation of such approval usually constitutes acceptance or approval.

Accepted (Engineering) Practice: The practice of Civil Engineering that conforms to principles, tests, and standards of care and skill ordinarily applied by qualified civil engineering professionals.

Augered Pressure Grouted Pile (APGP): A cast-in-place concrete pile made by rotating a continuous-flight, hollow shaft auger into the ground to a specific depth, or until other specified criteria are reached. Grout is then injected through the auger shaft in such a way as to exert pressure on the soil surrounding the augered hole as the auger is withdrawn.

Building Official: The official or his or her duly authorized representative or other designated authority charged with the administration and enforcement of the building code.

Cast-in-Place: Concrete placed into a pile shaft at the site during, or after, installation of the pile.

Capacity (Ultimate Load): The load at which the pile failure first occurs due to exceeding the structural strength of the shaft, or the ultimate resistance of the supporting materials.

Critical Section: The cross-section of a pile shaft where the maximum stresses occur.

Cut-off Elevation: The elevation at the top of pile (also called the head or butt) as shown in plans and specifications.

Current Experience: Experience within the last five years utilizing design, testing, and installation techniques applicable to the current project.

Design Load: The maximum compressive, tensile, or lateral load, or combination thereof, considered to act on the pile during the life of the structure.

Design Stress: The stress imposed on the pile cross-section by the design load and calculated in accordance with accepted engineering practice.

Drive Head (Drive Cap, Anvil, or Helmet): A steel casting or forging generally shaped to fit the pile-driving hammer base to the pile, so as to uniformly distribute the hammer blows to the top of the pile.