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ASCE STANDARD

American Society of Civil Engineers

Design and Construction of Frost-Protected Shallow Foundations

ASCE
SEI Structural Engineering Institute
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Design and Construction of Frost-Protected Shallow Foundations

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ABSTRACT
This standard addresses the design and construction of frost-protected shallow foundations in areas subject to seasonal ground freezing. Foundation insulation requirements to protect heated and unheated buildings from frost heave are presented in easy-to-follow steps with reference to design tables, climate maps, and other necessary data to furnish a complete frost-protection design. The advantages of this technology include improved construction efficiency over conventional practices, increased energy efficiency, minimized site disturbance, and enhanced frost protection. A commentary is included to provide background information and important technical insights.

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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 Group F (MGF), Codes and Standards. The consensus process includes balloting by the balanced standards committee made up of Society members and nonmembers, 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 5 years.

The following Standards have been issued.

ANSI/ASCE 1-82 N-725 Guideline 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 ANSI/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs

ASCE 4-98 Seismic Analysis of Safety-Related Nuclear Structures

Building Code Requirements for Masonry Structures (ACI 530-99/ASCE 5-99/TMS 402-99) and Specifications for Masonry Structures (ACI 530.1-99/ASCE 6-99/TMS 602-99)

ASCE 7-98 Minimum Design Loads for Buildings 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

ASCE 10-97 Design of Latticed Steel Transmission Structures

SEI/ASCE 11-99 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

ASCE 15-98 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 17-96 Air-Supported Structures

ASCE 18-96 Standard Guidelines for In-Process Oxygen Transfer Testing

ASCE 19-96 Structural Applications of Steel Cables for Buildings

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

ASCE 21-96 Automated People Mover Standards—Part 1

ASCE 21-98 Automated People Mover Standards—Part 2

SEI/ASCE 23-97 Specification for Structural Steel Beams with Web Openings

SEI/ASCE 24-98 Flood Resistant Design and Construction

ASCE 25-97 Earthquake-Actuated Automatic Gas Shut-Off Devices

ASCE 26-97 Standard Practice for Design of Buried Precast Concrete Box Sections

ASCE 27-00 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction

ASCE 28-00 Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction

EWRI/ASCE 33-01 Comprehensive Transboundary International Water Quality Management Agreement

EWRI/ASCE 34-01 Standard Guidelines for Artificial Recharge of Ground Water

FOREWORD

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This Standard was prepared through a consensus standards process by balloting in compliance with procedures of the ASCE Structural Engineering Institute. Those individuals who serve on the Frost-Protected Shallow Foundations Standard Committee are:

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Design and Construction of Frost-Protected Shallow Foundations

1. SCOPE AND LIMITATIONS

This Standard addresses the design and construction of frost-protected shallow foundations to prevent frost damage in cold climates with seasonal ground freezing. For the purpose of this Standard, a frost-protected shallow foundation is a foundation that does not extend below the design frost depth, but is protected against effects of frost. This Standard applies to buildings on potentially frost-susceptible ground with slab-on-ground or suspended floor foundations. This Standard does not apply to buildings on permafrost, to areas with mean annual outdoor air temperatures less than 32°F (0°C), or to areas with design air-freezing indexes greater than 4,500°F-days (60,000°C-hr).

This Standard addresses heated, unheated, and semi-heated structures, as classified by the minimum average monthly indoor temperature expected during the building's intended useful life. For the purpose of using this Standard, the building shall be classified in accordance with Table 1.

This Standard does not preclude the judgment and practice of those competent in foundation design and the prevention of frost damage, nor does it preclude compliance with other design considerations or local building code requirements. Structural requirements, other than frost protection, shall be in accordance with the building code or accepted design practices and are not included in this Standard.

TABLE 1. Classification of Building Based on Indoor Air Temperature

Minimum Average Monthly Indoor Temperature, T	Thermal Classification
$T \geq 63°$ F (17° C)	Heated
41° F(5° C) $< T <$ 63°F (17° C)	Semi-heated
$T \leq 41°$ F (5° C)	Unheated

2. REFERENCES

American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). *Handbook of Fundamentals*, Atlanta, GA (1997).

American Society for Testing and Materials (ASTM). ASTM C578-95. *Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation,* West Conshohocken, PA (1995).

American Society for Testing and Materials. ASTM D422-63 (90). *Test Method for Particle-Size Analysis of Soils,* West Conshohocken, PA (1990).

American Society for Testing and Materials. ASTM D2487-93. *Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System),* West Conshohocken, PA (1993).

3. SYMBOLS, UNITS, AND DEFINITIONS

3.1 SYMBOLS AND UNITS

The symbols and units used throughout this Standard are found in Table 2. Conversion factors for units are found in Table 3. English units accompanied by soft conversions to SI units (shown in parentheses) are used throughout the Standard.

3.2 DEFINITIONS

Approved: Accepted by the building official of the jurisdiction as the result of investigations, analysis, tests, or any combination of these evaluation approaches or by reason of accepted principles or local experience.

Air-Freezing Index (AFI): Determined from cumulative degree days above and below 32°F (0°C), recorded for an annual cycle. The AFI for a given winter is the largest difference between the maximum freezing degree day cumulative total reached at the start of the winter season and the minimum total reached during the winter.

Cold-Bridges: Discontinuities in insulation that create thermally conductive pathways and increase the potential for frost damage.

Design Air-Freezing Index (F_{100}): The 100-year mean return period AFI used in this Standard for protection of building foundations against frost damage.

Design Frost Depth: The minimum depth at which the soil temperature remains above freezing for an extreme winter event, based on analysis, local regulations, or experience.

Effective Thermal Resistivity (r_{eff}): An adjusted thermal resistivity to account for long-term use in a moist, below-ground condition. Commonly referred to in this Standard as an effective R per inch.

Effective Thermal Resistance (R_{eff}): An adjusted R-value to account for long-term use in a moist, below-ground condition.