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Wind Tunnel Testing for Buildings and Other Structures

This document uses both the International System of Units (SI) and customary units

ASCE

SEI ASCE STRUCTURAL ENGINEERING INSTITUTE

American Society of Civil Engineers

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STANDARDS

In 2006, the Board of Direction approved the revision to the 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 Society's Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee made up of Society members and nonmembers, balloting by the membership of the Society 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 Guideline for Design and Analysis of Nuclear Safety Related Earth Structures

ASCE/EWRI 2-06 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 530-02/ASCE 5-02/TMS 402-02) and Specifications for Masonry Structures (ACI 530.1-02/ASCE 6-02/TMS 602-02)

ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures

SEI/ASCE 8-02 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

ASCE/EWRI 12-05 Guideline for the Design of Urban Subsurface Drainage

ASCE/EWRI 13-05 Standard Guidelines for Installation of Urban Subsurface Drainage

ASCE/EWRI 14-05 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 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 19-10 Structural Applications of Steel Cables for Buildings

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

ANSI/ASCE/T&DI 21-05 Automated People Mover Standards—Part 1

ANSI/ASCE/T&DI 21.2-08 Automated People Mover Standards—Part 2

ANSI/ASCE/T&DI 21.3-08 Automated People Mover Standards—Part 3

ANSI/ASCE/T&DI 21.4-08 Automated People Mover Standards—Part 4

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

ASCE/SEI 24-05 Flood Resistant Design and Construction

ASCE/SEI 25-06 Earthquake-Actuated Automatic Gas Shutoff 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

ASCE/SEI/SFPE 29-05 Standard Calculation Methods for Structural Fire Protection

SEI/ASCE 30-00 Guideline for Condition Assessment of the Building Envelope

SEI/ASCE 31-03 Seismic Evaluation of Existing Buildings

SEI/ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations

EWRI/ASCE 33-09 Comprehensive Transboundary International Water Quality Management Agreement

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

EWRI/ASCE 35-01 Guidelines for Quality Assurance of Installed Fine Pore Aeration Equipment

CI/ASCE 36-01 Standard Construction Guidelines for Microtunneling

SEI/ASCE 37-02 Design Loads on Structures during Construction

CI/ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data

EWRI/ASCE 39-03 Standard Practice for the Design and Operation of Hail Suppression Projects

ASCE/EWRI 40-03 Regulated Riparian Model Water Code

ASCE/SEI 41-06 Seismic Rehabilitation of Existing Buildings

ASCE/EWRI 42-04 Standard Practice for the Design and Operation of Precipitation Enhancement Projects

ASCE/SEI 43-05 Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities

ASCE/EWRI 44-05 Standard Practice for the Design and Operation of Supercooled Fog Dispersal Projects

ASCE/EWRI 45-05 Standard Guidelines for the Design of Urban Stormwater Systems

ASCE/EWRI 46-05 Standard Guidelines for the Installation of Urban Stormwater Systems

ASCE/EWRI 47-05 Standard Guidelines for the Operation and Maintenance of Urban Stormwater Systems

ASCE/SEI 48-11 Design of Steel Transmission Pole Structures

ASCE/SEI 49-12 Wind Tunnel Testing for Buildings and Other Structures

ASCE/EWRI 50-08 Standard Guideline for Fitting Saturated Hydraulic Conductivity Using Probability Density Functions

ASCE/EWRI 51-08 Standard Guideline for Calculating the Effective Saturated Hydraulic Conductivity

ASCE/SEI 52-10 Design of Fiberglass-Reinforced Plastic (FRP) Stacks

ASCE/G-I 53-10 Compaction Grouting Consensus Guide
ASCE/EWRI 54-10 Standard Guideline for Geostatistical Estimation and Block-Averaging of Homogeneous and Isotropic Saturated Hydraulic Conductivity
ASCE/SEI 55-10 Tensile Membrane Structures
ANSI/ASCE/EWRI 56-10 Guidelines for the Physical Security of Water Utilities
ANSI/ASCE/EWRI 57-10 Guidelines for the Physical Security of Wastewater/Stormwater Utilities
ASCE/T&DI/ICPI 58-10 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways
ASCE/SEI 59-11 Blast Protection of Buildings
ASCE/EWRI 60-12 Guideline for Development of Effective Water Sharing Agreements

FOREWORD

The material presented in this standard has been prepared in accordance with recognized engineering principles. This standard should not be used without first securing competent advice with respect to its suitability for any given application. The publication of the material contained herein is not intended as a representation or warranty on the part of the American Society of Civil Engineers, or of any other person named herein, that this information is suitable for any general or particular use or promises freedom from infringement of any patent or patents. Anyone making use of this information assumes all liability from such use.

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This standard was prepared through the consensus standards process by balloting in compliance with procedures of ASCE's Codes and Standards Committee. Those individuals who serve on the Wind Tunnel Testing Standards Committee are:

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Chapter 1
GENERAL

1.1 SCOPE

This standard provides minimum requirements for wind tunnel tests to determine wind loads on and responses of buildings and other structures. Loads considered in this standard are wind loads for main wind-force-resisting systems (MWFRSs) and for individual structural components and cladding (C&C) of buildings and other structures. Loads produced by these tests are suitable for use in building codes and standards.

Provisions of this standard satisfy the requirements for wind tunnel testing of ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. Wind tunnel testing has the capability to perform measurements beyond those specifically addressed in this standard, including pedestrian wind evaluations, dispersion of airborne pollutants, fugitive particulates, and wind energy siting studies. These studies are permitted to be included within the test report addressing wind loads.

1.2 REPORT CONTENT

The wind tunnel test report, hereinafter referred to as the report, shall be prepared to document the wind tunnel test and results. This report shall, at a minimum, include (1) a description of the properties of the simulated atmospheric boundary layer, including mean velocity and longitudinal turbulence intensity profiles, a spectrum of longitudinal turbulence with computed integral scale, and comparison to approved atmospheric models; (2) a description of the test and test methodology; and (3) results of the test. Detailed requirements are described in following sections.

The report shall address how the test laboratory met the requirements of this standard for instrumentation capability, and how the wind climate was defined and used to produce results given in the report.

For some wind tunnel tests, atmospheric boundary-layer modeling as described in this standard is not appropriate. Examples include (1) tests for parts and portions of a building where matching of turbulent length scales is not important for determining the important responses; and (2) tests that are intended to model nonboundary-layer winds. For these tests, the report shall discuss the deviation from the requirements of this standard and its implications, including the desirability of full-scale test validation.

Where wind tunnel test conditions vary from those specified in this standard, a justification for the variance shall be included in the report.

1.3 COORDINATE SYSTEMS

The following coordinate systems with mean and fluctuating velocities are defined:

x, y, z = right-hand coordinate axes, z is vertical;
U, V, W = mean velocities in x, y, z directions; and
u, v, w = fluctuating portion of velocity vector in x, y, z directions.

1.4 DEFINITIONS

Unless specified in this section, all terms used in this standard are consistent with definitions of the ASCE 7 wind load provisions.

Aeroelastic Feedback: The process by which motion of a body in the wind causes changes in applied wind pressures.

Aeroelastic Model: A model that simulates the stiffness, mass, and damping of the full-scale structure.

Approved: Acceptable to the authority having jurisdiction.

Atmospheric Boundary Layer (ABL): The lower part of the atmosphere, typically 800 to 2,000 ft (250 to 600 m) thick, in which the velocity increases with height and in which the flow is turbulent.

Atmospheric Surface Layer (ASL): The lower portion of the ABL in which the wind flow over flat, uniformly rough terrain has a logarithmic profile.

Integral (Macro) Scale: A characteristic length that represents a measure of the average size of turbulent eddies or gusts present in the atmospheric boundary layer.

Longitudinal Turbulence: Fluctuations in wind velocity in the direction of the mean wind.

Monte Carlo Simulation: A simulation process in which a series of events, such as hurricane speeds, is predicted by drawing on statistical properties of the underlying phenomena.

Neutral Thermal Stratification: Wind conditions in which thermal buoyancy forces are negligible; normally found in high-wind situations.

Nonboundary-Layer Winds: Winds that do not conform to the properties of the standard atmospheric boundary layer.

Recognized Literature: Published research findings and technical papers that are approved.

Reynolds Number: $U_b L_b / \nu$ (refer to the individual terms in Section 1.5, Symbols and Notation).

Turbulence: Random fluctuations in the wind velocity, or "gusts."

Upcrossing Procedure: A statistical method of calculating the mean recurrence rate for events of a stated magnitude.

Vortex Excitation: Time-varying pressures that are applied to a body predominantly in a direction perpendicular to the wind direction due to quasiperiodic shedding of vortices from alternate sides of the body.

1.5 SYMBOLS AND NOTATION

ABL = Atmospheric Boundary Layer;
ASL = Atmospheric Surface Layer;
h = mean roof height of a building or height of other structure;