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American Society of Civil Engineers

Tensile Membrane Structures

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

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STANDARDS

In 2003, 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 19-96 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 33-01 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 48-05 Design of Steel Transmission Pole 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 the Geostatistical Estimation and Block-Averaging of Homogeneous and Isotropic Saturated Hydraulic Conductivity
ASCE/SEI 55-10 Tensile Membrane Structures

FOREWORD

The material presented in this standard has been prepared to be 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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GENERAL

1.1 SCOPE

1.1.1 This standard provides minimum criteria for the design and performance of membrane-covered cable and rigid member structures, including frame structures, collectively known as tensile membrane structures, including permanent and temporary structures as defined herein. The requirements of this standard shall apply whether the tensile membrane structure is independent of or attached to another structure. This standard does not apply to air-supported or air-inflated structures.

1.1.2 This standard is applicable to all tensile membrane structures as follows:

a. temporary structures with a plan area greater than 1,000 ft^2 (100 m^2) or with any membrane span exceeding 10 ft (3 m) or
b. permanent structures with a plan area greater than 225 ft^2 (22.5 m^2), regardless of span.

1.1.3 This standard is applicable to tensile membrane structures erected under the requirements of the legally adopted building code of which this standard forms a part. In areas without a legally adopted building code, this standard defines minimum acceptable standards of design and construction practice.

1.1.4 This standard supplements the building code and shall govern in all matters pertaining to design, construction, and material properties. This standard may be used in the absence of a building code or where the building code does not adequately address membrane structures.

1.1.5 Elements of a tensile membrane structure not governed by this standard (e.g., structural steel, cables, timber, aluminum, or concrete) shall be proportioned in accordance with their respective standards.

1.2 DEFINITIONS

The following definitions apply in this standard:

Air-inflated structure—A membrane structure with a shape that is maintained by air pressure acting within cells or tubes enclosing all or part of the occupied space.

Air-supported structure—A membrane structure that encloses an occupied space and has a shape that is maintained by air pressure acting within the occupied space.

Anchorage—A device used to secure a membrane or cable to a support.

Authority having jurisdiction—The organization, political subdivision, office, or individual charged with responsibility of administering and enforcing the provisions of this standard.

Biaxial stress—Stresses taken simultaneously along two concurrent orthogonal directions, usually warp and fill.

Cable—A flexible linear or curvilinear element acting in tension. Cable may be wire rope, strand, or web.

Compensation (and decompensation)—Adjustment during patterning of membrane panel dimensions to allow for stretching of the material as required to achieve the desired initial prestress and geometry.

Design strength—The strength determined by multiplying the ultimate strength by one or more strength reduction factors.

Effective membrane breaking strength—The strength of the membrane or seam, whichever is less.

Effective prestress—The prestress remaining in the structure after all losses, including long-term losses, have occurred.

Fabric—A two-dimensional cloth made up of yarns or slit tapes that may be impregnated with a matrix that binds them together. The yarns may be woven or laid. The fabric is frequently coated or laminated.

Factored load—The product of the nominal loads and load factors used to proportion members by strength design.

Fibers—Lengths of threads of a material. When twisted together, they make a yarn.

Fill—The yarns that are placed in the narrow direction of the fabric as it is manufactured (also known as Weft).

Film—An unreinforced plastic. Film does not contain fibers or yarn.

Frame-supported structure—A membrane structure consisting of a series of arches or frames where the membrane is pretensioned primarily uniaxially and