

ASCE STANDARD

ASCE/SEI

55-16

View, click buy full version

Tensile Membrane Structures

ASCE STANDARD

ASCE/SEI

55-16

Tensile Membrane Structures



PUBLISHED BY THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Library of Congress Cataloging-in-Publication Data

Names: American Society of Civil Engineers.

Title: Tensile membrane structures / American Society of Civil Engineers.

Description: Reston, Virginia : American Society of Civil Engineers, 2017. |

"ASCE/SEI 55-16." | Includes index.

Identifiers: LCCN 2016034190 | ISBN 9780784414378 (soft cover : alk. paper) |

ISBN 9780784479995 (PDF)

Subjects: LCSH: Tensile architecture--Standards--United States. | Lightweight construction--Standards--United States. | Roofs, Fabric--Standards--United States. | Synthetic fabrics--Standards--United States. | Structural frames--Standards--United States.

Classification: LCC TA663 .T45 2017 | DDC 624.1/77--dc23 LC record available at <https://lccn.loc.gov/2016034190>

Published by American Society of Civil Engineers

1801 Alexander Bell Drive

Reston, Virginia, 20191-4382

www.asce.org/bookstore | ascelibrary.org

This standard was developed by a consensus standards development process that has been accredited by the American National Standards Institute (ANSI). Accreditation by ANSI, a voluntary accreditation body representing public and private sector standards development organizations in the United States and abroad, signifies that the standards development process used by ASCE has met the ANSI requirements for openness, balance, consensus, and due process.

While ASCE's process is designed to promote standards that reflect a technical and reasoned consensus among all interested participants, while preserving the public health, safety, and welfare that is paramount to its mission, it has not made an independent assessment of and does not warrant the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed herein. ASCE does not intend, nor should anyone interpret, ASCE's standards to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this standard.

ASCE has no authority to enforce compliance with its standards and does not undertake to certify products for compliance or to render any professional services to any person or entity.

ASCE disclaims any and all liability for any personal injury, property damage, financial loss, or other damages of any nature whatsoever, including without limitation any direct, indirect, special, exemplary, or consequential damages, resulting from any person's use of, or reliance on, this standard. Any individual who relies on this standard assumes full responsibility for such use.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

Photocopies and permissions. Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to permissions@asce.org or by locating a title in ASCE's Civil Engineering Database (<http://cedb.asce.org>) or ASCE Library (<http://ascelibrary.org>) and using the "Permissions" link.

Errata: Errata, if any, can be found at <https://doi.org/10.1061/9780784414378>

Copyright © 2016 by the American Society of Civil Engineers

All Rights Reserved.

ISBN 978-0-7844-1437-8 (soft cover)

ISBN 978-0-7844-7999-5 (PDF)

doi: /10.1061/9780784414378

Manufactured in the United States of America.

24 23 22 21 20 19 18 17 2 3 4 5

ASCE STANDARDS

In 2014, the Board of Direction approved revisions to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by ASCE. All such standards are developed by a consensus standards process managed by the ASCE Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee, and reviewing during a public comment period. All standards are updated or reaffirmed by the same process every five to ten years. Requests for formal interpretations shall be processed in accordance with Section 7 of ASCE Rules for Standards Committees, which are available at www.asce.org. Errata, addenda, supplements, and interpretations, if any, for this standard can also be found at www.asce.org.

This standard has been prepared in accordance with recognized engineering principles and should not be used without the user's competent knowledge for a given application. The publication of this standard by ASCE is not intended to warrant that the information contained therein is suitable for any general or specific use, and ASCE takes no position respecting the validity of patent rights. The user is advised that the determination of patent right or risk of infringement is entirely their own responsibility.

A complete list of currently available standards is available in the ASCE Library (<http://ascelibrary.org/page/books/s-standards>).

Currently in preview, click buy full version

Currently in preview, click buy full version

CONTENTS

PREFACE	ix
ACKNOWLEDGMENTS	xi
1 GENERAL	1
1.1 Scope	1
1.2 Definitions	1
1.3 Design Documents	2
1.4 Field Observation	2
1.4.1 Qualifications	2
1.4.2 Records	2
1.5 Alternate Designs	3
1.6 References	3
2 MEMBRANE MATERIALS	5
2.1 General	5
2.1.1 Membranes	5
2.1.2 Quality	5
2.2 Testing Qualifications	5
2.2.1 Tests	5
2.3 Physical Testing	5
2.3.1 Frequency	5
2.3.2 Conditions	5
2.3.3 Flexfold	5
2.3.4 Biaxial Testing	5
2.3.5 Uniaxial Testing	5
2.3.6 Frequency	5
2.4 Physical Properties	5
2.4.1 General	5
2.4.2 Published Values	6
2.4.3 Biaxial Testing for Compensation (Fabrication Properties)	6
2.5 Membrane Classification and Fire Performance	6
2.5.1 Classification	6
2.5.2 Liners	6
2.5.3 Height Limitations	6
2.5.4 Conformance	6
2.6 Seams	6
2.6.1 General	6
2.6.2 Processes	6
2.6.3 Tolerances	6
2.6.4 Quality	6
2.6.5 Characteristics	6
2.6.6 Strength	6
2.6.7 Breaking Strength	6
2.7 Cables and Reinforcing	6
3 CONNECTIONS	7
3.1 General	7
3.2 Fabric to Fabric	7
3.3 Fabric to Nonfabric	7
3.4 Other	7
4 DESIGN	9
4.1 Notation	9

4.2	Loads	9
4.2.1	General	9
4.2.2	Dead Load	9
4.2.3	Superimposed Loads	9
4.2.4	Snow, Rain, and Seismic Loads	9
4.2.5	Wind Loads	9
4.2.6	Minimum Roof Live Loads	9
4.2.7	Ice Loads	9
4.2.8	Temporary Loads	9
4.2.9	Internal Pressure for Air-Supported Membranes	9
4.3	Considerations for Design and Analysis	10
4.3.1	General	10
4.3.2	Disproportionate Collapse	10
4.3.3	Structural Stability	10
4.3.4	Design	10
4.3.5	Analysis	10
4.3.6	Strength Requirements under Sustained Loading	10
4.3.7	Corrosion Protection	10
4.3.8	Deterioration	10
4.4	Member Proportioning	10
4.4.1	General	10
4.4.2	Life-cycle Factor	10
4.5	Load Combinations	10
4.5.1	Applicability	10
4.5.2	Load Combinations and Strength Reduction Factors	10
4.6	Component Resistance	10
4.6.1	Membrane	10
4.6.2	Cables, Webs, and Mechanical Joints	11
4.7	Anchorage	11
4.7.1	Reactions	11
4.7.2	Design Considerations	11
5	FABRICATION AND ERECTION	13
5.1	Fabrication	13
5.1.1	Fabrication Drawings	13
5.1.2	Tolerances	13
5.1.3	Quality	13
5.1.4	Records	13
5.1.5	Membrane Compensation	13
5.2	Erection	13
5.2.1	General	13
5.2.2	Analysis	13
5.2.3	Safety	13
5.2.4	Rigging	13
6	SPECIAL PROVISIONS FOR AIR-SUPPORTED STRUCTURES	15
6.1	Notation	15
6.2	General	15
6.3	Inflation Air Supply Equipment	15
6.3.1	Requirements	15
6.3.1.1	Equipment Requirements	15
6.3.1.2	Auxiliary Inflation System	15
6.3.1.3	Blower Equipment	15
6.3.1.4	Standby Power	15
6.3.1.5	Support Provisions	15
6.3.1.6	Alarm System	15
6.3.2	Deflation Index	15
6.4	Ducting	16
6.5	Ventilation	16
6.6	Fire Protection	16
6.6.1	General	16
6.6.2	Fire Detection	16

6.7	Entrances and Exits	16
6.7.1	General	16
6.8	Plumbing Systems	16
6.8.1	General	16
6.8.2	Special Plumbing Provisions	16
6.9	Electrical Systems	16
6.9.1	General	16
6.9.2	Lighting	16
6.10	Clearances	16
6.11	Snow Load	16
6.11.1	Pressure Method	16
6.11.2	Snow-melting Method	16
6.11.3	Combined Method	16
APPENDIX A: AREA LIMITS AND STRUCTURE CLASSIFICATIONS		17
A.1	Scope	17
A.1.1	Purpose	17
A.1.2	Area Limits	17
A.1.2.1	Area Increases	17
A.1.2.1.1	Frontage Increase Determination	17
A.1.2.1.2	Automatic Sprinkler Systems	17
A.1.3	Unlimited Area Buildings	17
A.1.4	Class III, Combustible Membranes	17
A.2	Mezzanines	17
A.3	Roof Structures	17
A.4	Attachment to Existing Buildings	17
APPENDIX B: A PROCEDURE FOR DETERMINING MODULUS OF ELASTICITY		23
B.1	General	23
B.2	Theory of Elasticity for Fabrics	23
B.3	Methods of Testing Fabrics	24
B.4	Linearizing the Curves	24
COMMENTARY		27
C1	GENERAL	29
C1.1	Scope	29
C1.2	Definitions	29
C1.3	Design Documents	30
C1.4	Field Observation	31
C2	MEMBRANE MATERIALS	33
C2.1	General	33
C2.3	Physical Testing	33
C2.4	Physical Properties	33
C2.5	Membrane Classification and Fire Performance	33
C2.6	Seams	34
C3	CONNECTIONS	35
C3.1	General	35
C3.2	Fabric to Fabric	35
C4	DESIGN	37
C4.2	Loads	37
C4.3	Considerations for Design and Analysis	37
C4.5	Load Combinations	38
C4.6	Component Resistance	38
C4.7	Anchorage	39

C5	FABRICATION AND ERECTION	41
C5.1	Fabrication	41
C5.2	Erection	41
C6	SPECIAL PROVISIONS FOR AIR-SUPPORTED STRUCTURES	43
C6.2	General	43
C6.3	Inflation Air Supply Equipment	43
C6.3.1	Requirements	43
C6.3.1.1	Equipment Requirements	43
C6.3.1.2	Auxiliary Inflation System	42
C6.3.1.4	Standby Power	42
C6.3.1.5	Support Provisions	43
C6.3.2	Deflation Index	43
C6.4	Ducting	44
C6.5	Ventilation	44
C6.6	Fire Protection	44
C6.6.1	General	44
C6.6.2	Fire Detection	44
C6.7	Entrances and Exits	44
C6.7.1	General	44
C6.8	Plumbing Systems	45
C6.9	Electrical Systems	45
C6.9.1	Lighting	45
C6.10	Clearances	45
C6.11	Snow Load	45
C6.11.1	Pressure Method	45
C6.11.2	Snow-melting Method	45
APPENDIX CA: SPECIAL PROVISIONS	47	
Table A-1 and Table A-2	Maximum Footprint Areas	47
INDEX	49	

PREFACE

This version of ASCE 55 improves on the previous edition in three ways:

1. The inclusion of load resistance factor design (LRFD) and allowable stress design (ASD) load combinations;
2. The inclusion of air-supported membrane structures as Chapter 6 of this standard, which now replaces Standard ASCE 17-96, *Air-Supported Structures*; and
3. Providing a single document that deals with conventional tensile membrane structures, frame-covered membrane structures, and air-supported tensile membrane structures.