

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

19-16

Structural Applications of Steel Cables for Buildings



PUBLISHED BY THE AMERICAN SOCIETY OF CIVIL ENGINEERS

This is a preview of "ASCE/SEI 19-2016". Click here to purchase the full version from the ANSI store.

Names: American Society of Civil Engineers, issuing body.
Title: Structural applications of steel cables for buildings / American Society of Civil Engineers.
Description: Reston : American Society of Civil Engineers, 2016. | Series: ASCE standard | "ASCE/SEI 19-16." | Includes bibliographical references and index.
Identifiers: LCCN 2016043932 (print) | LCCN 2016044815 (ebook) | ISBN 9780784414392 (pbk.) | ISBN 9780784479759 (pdf)
Subjects: LCSH: Cable structures—Standards—United States. | Cables—Standards—United States.
Classification: LCC TA660.C3 S77 2016 (print) | LCC TA660.C3 (ebook) | DDC 690/.1—dc23
LC record available at <https://lcn.loc.gov/2016043932>

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 fair 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 <http://dx.doi.org/10.1061/9780784414392>.

Copyright © 2016 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-1439-2 (print)
ISBN 978-0-7844-7975-9 (PDF)
Manufactured in the United States of America.

21 20 19 18 17 16 1 2 3 4 5

This is a preview of "ASCE/SEI 19-2016". Click here to purchase the full version from the ANSI store.

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 5 to 10 years. Requests for formal interpretations shall be processed in accordance with Section 7 of ASCE Rules for Standards Committees, which is 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 rights 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>).

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

PREFACE	ix
ACKNOWLEDGMENTS	xi
1 GENERAL	1
1.1 Scope	1
1.2 Glossary	1
1.3 Symbols and Notation	1
1.4 Reference Standards	2
2 CONTRACT DOCUMENTS AND SHOP DRAWINGS	3
2.1 Contract Documents	3
2.1.1 Contract Drawings	3
2.1.2 Contract Specifications	3
2.2 Shop Drawings	3
3 DESIGN CONSIDERATIONS	5
3.1 Design Basis	5
3.1.1 Structural Integrity	5
3.1.2 Replacement of Members	5
3.2 Design Loadings	5
3.2.1 Loads	5
3.2.2 Load Combinations	5
3.2.3 Load Combinations Including Atmospheric Ice Loads	5
3.3 Cable Assembly Strength	5
3.3.1 Required and Allowable Strengths	5
3.3.1.1 Fitting Reduction Factor	5
3.3.1.2 Deflector Reduction Factor	5
3.3.1.3 Elevated Temperature Effect	5
3.3.1.4 Fatigue Strength	6
3.3.1.5 Creep Effect	6
3.3.2 End Fittings	6
3.4 Structural Analysis	6
3.4.1 General Considerations	6
3.4.2 Serviceability	6
3.4.3 Vibrations	6
3.4.4 Deflections	6
3.4.5 Erection Analysis	6
4 CABLE MATERIALS	7
4.1 Cable Specifications	7
5 FITTINGS	9
5.1 Materials	9
5.2 Inspection	9
5.3 End Fittings	9
5.3.1 Zinc-Poured and Mischmetal-Poured Fittings	9
5.3.2 Resin-Poured Fittings	9
5.3.3 Swaged Fittings	9
5.4 Saddles and Clamps	9

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

6	PROTECTIVE COATINGS	11
6.1	Corrosion Protection	11
6.2	Fire Protection	11
6.2.1	Fire-Resistance Ratings and Fire Tests	11
6.2.2	Alternative Methods for Determining Fire Resistance	11
7	FABRICATION, SHIPPING, AND RECEIVING	13
7.1	Socketing	13
7.2	Proof Loading of Assemblies	13
7.3	Prestretching	13
7.4	Cable Length Measurements	13
7.5	Striping	13
7.6	Shipping	13
7.7	Receiving	13
8	ERECTION	15
8.1	Erection Procedure	15
8.2	Cable Installation	15
8.3	Intermediate Fittings	15
9	POST-CONSTRUCTION CONSIDERATIONS AND INSPECTION	17
9.1	Maintenance Considerations	17
9.2	Routine Inspections	17
9.3	In-Depth Inspections	17
9.4	Emergency Inspections	17
9.5	Special Inspection and Testing	17
9.6	Inspection Results	17
	APPENDIX A: CABLES AND FITTINGS	19
A.1	Cable Cross Sections	19
A.2	Socket Fittings	20
A.3	Swaged Fittings	21
A.4	Mechanical Loop Splice with Sleeve and Thimble	21
	APPENDIX B: SADDLES	23
	APPENDIX C: CLAMPS	25
	APPENDIX D: CABLE FATIGUE	27
	APPENDIX E: SMALL DIAMETER CABLE FOR EARTHQUAKE RESISTANCE	29
E1.0	General	29
E1.1	Glossary	29
E1.2	Symbols and Notation	29
E2.0	Contract Documents and Shop Drawings	29
E2.1	Contract Documents	29
E2.1.1	Contract Drawings	29
E2.1.2	Contract Specifications	29
E2.2	Shop Drawings	29
E3.0	Design Considerations	29
E3.1	Design Basis	29
E3.1.1	Replacement of Members	29
E3.2	Design Loadings	29
E3.2.1	Loads	29
E3.2.2	Load Combinations	30
E3.3	Cable and Fitting Assembly Strength	30

This is a preview of "ASCE/SEI 19-2016". Click here to purchase the full version from the ANSI store.

	E3.3.1.1 Elevated Temperature Effect	30
	E3.3.2 End Fittings and Intermediate Fittings	30
	E3.3.2.1 Cable Loop Connections	30
E3.4	Structural Analysis	30
E4.0	Cable Materials	30
E4.1	Cable Specifications	30
E4.2	Prestretching	30
E4.3	Cable Verification Testing	30
E5.0	Fittings	30
E5.1	Materials	30
E5.2	Inspection	30
E5.3	End Fittings and Intermediate Fittings	30
E6.0	Protective Coatings	30
E6.1	Corrosion Protection	31
E6.2	Fire Protection	31
E7.0	Fabrication, Shipping, and Receiving	31
E7.1	Assembly Fabrication	31
E7.2	Testing of Cable and Fitting Assemblies	31
E7.3	Prestretching	31
	E7.3.1 Test Method for Determining Modulus of Elasticity (Young's Modulus) for Cables with Diameters 1/4 in. and Smaller In Lieu of Prestretching	31
E7.4	Color Coding	32
E7.5	Shipping	32
E7.6	Receiving	32
E8.0	Erection	32
E8.1	Cable Installation	32
E8.2	Intermediate Fittings	32
E9.0	Post-Construction Considerations and Inspection	32
E9.1	Emergency Inspections	32
COMMENTARY		33
C1	GENERAL	35
	C1.1 Scope	35
	C1.2 Glossary	35
	C1.3 Symbols and Notation	36
C2	CONTRACT DOCUMENTS AND SHOP DRAWINGS	37
	C2.1 Contract Documents	37
	C2.1.1 Contract Drawings	37
	C2.1.2 Contract Specifications	37
	C2.2 Shop Drawings	37
C3	DESIGN CONSIDERATIONS	39
	C3.1 Design Basis	39
	C3.1.1 Structural Integrity	39
	C3.2 Design Loadings	39
	C3.2.1 Loads	39
	C3.2.2 Load Combinations	39
	C3.3 Cable Assembly Strength	39
	C3.3.1 Required and Allowable Strengths	39
	C3.3.1.3 Elevated Temperature Effect	39
	C3.3.1.4 Fatigue Strength	39
	C3.3.1.5 Creep Effect	40
	C3.3.2 End Fittings	40
	C3.4 Structural Analysis	40
	C3.4.1 General Considerations	40
	C3.4.3 Vibrations	40
	C3.4.4 Deflections	40
	C3.4.5 Erection Analysis	40

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

C4	CABLE MATERIALS	41
	C4.1 Rope Lay	41
	C4.2 Prestretching	41
C5	FITTINGS	43
C6	PROTECTIVE COATINGS	45
	C6.1 Corrosion Protection	45
	C6.2 Fire Protection	45
	C6.2.1 Fire-Resistance Ratings and Fire Tests	45
	C6.2.2 Alternative Methods for Determining Fire Resistance	45
C7	FABRICATION, SHIPPING, AND RECEIVING	47
	C7.3 Prestretching	47
	C7.6 Shipping	47
C8	ERECTION	49
	C8.1 Erection Procedure	49
C9	POST-CONSTRUCTION CONSIDERATIONS AND INSPECTION	51
	C9.1 Maintenance Considerations	51
	C9.2 Routine Inspections	51
	C9.3 In-Depth Inspections	51
	C9.4 Emergency Inspections	51
	C9.5 Special Inspection and Testing	51
CE	SMALL DIAMETER CABLE FOR EARTHQUAKE RESISTANCE	53
	CE1.0 General	53
	CE1.1 Glossary	53
	CE3.0 Design Considerations	53
	CE3.1 Design Basis	53
	CE3.2 Design Loadings	53
	CE3.2.1 Loads	53
	CE3.2.2 Load Combinations	53
	CE3.3 Cable and Fitting Assembly Strength	53
	CE3.3.1.1 Elevated Temperature Effect	53
	CE3.3.2.1 Cable Loop Connections	53
	CE5.0 Fittings	53
	CE5.3 End Fittings and Intermediate Fittings	54
	CE6.0 Protective Coatings	54
	CE7.0 Fabrication, Shipping, and Receiving	54
	CE7.2 Testing of Cable and Fitting Assemblies	54
	CE7.3 Prestretching	54
	CE9.0 Post-Construction Considerations and Inspection	54
	CE9.1 Emergency Inspections	54
	REFERENCES	55
	INDEX	57

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

This Standard is an updated and expanded version of ASCE Standard 19-10, which it replaces. Development of Standard ASCE 19 can be traced to the *Tentative Criteria for Structural Applications of Steel Cables for Buildings* published by the American Iron and Steel Institute (AISI) in 1966. Later influential publications were *Design Fundamentals of Cable Roof Structures* published by AISI in 1969; the paper entitled "Cable-Suspended Roof Construction State-of-the-Art" in the *Journal of the Structural Division*, ASCE, 1971; the *Manual for Structural Applications of Steel Cables for Buildings*, AISI,

1973; and the prior editions of this Standard, ASCE 19-96 and ASCE/SEI 19-10. References used to develop particular provisions of this Standard are included in the Selected Bibliography to be found in the Commentary.

Standard ASCE/SEI 19-16 includes a new appendix to address small diameter cables used for seismic bracing of nonstructural building elements, updates the nomenclature for consistency with industry standards, and incorporates other miscellaneous additions and rearrangements.

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

The American Society of Civil Engineers acknowledges the devoted efforts of the Structural Applications of Steel Cables for Buildings Standards Committee (the Committee) of the Codes and Standards Activities Division of the Structural Engineering Institute. This group consists of individuals from many backgrounds, including consulting engineering, research, manufacturing, fabrication, education, and government.

This edition of Standard ASCE 19 supersedes Standard ASCE 19-96 and Standard ASCE/SEI 19-10. It was prepared through the standards process by balloting in compliance with procedures of ASCE's Codes and Standards Committee.

Structural Applications of Steel Cables for Buildings Standards Committee

Kevin G. Wood, P.E., S.E., *Chair*
Thomas E. Secules, P.E., *Vice Chair*
Karen A. Lynch, P.E., *Secretary*
Martin Bechtold
Kyle Bowland, P.E.
Peter Brugger
Daniel Duggan
Stefano M. Ferracini
Gregory C. Freeman, P.E.
Paul A. Gossen, P.E.

Dyab A. Khazem
Timothy W. Klein, P.E.
James M. Ronning, P.E.
Habib Tabatabai, P.E., S.E.
David E. Wallace, P.E.
David Ward
Mike Werner, P.E. (deceased)
Laura E. Champion, P.E., *ASCE Staff Contact*
James M. Neckel, *ASCE Staff Contact*

This is a preview of "ASCE/SEI 19-2016". [Click here to purchase the full version from the ANSI store.](#)

CHAPTER 1 GENERAL

1.1 SCOPE

This standard provides requirements for the structural design, contract documents, shop drawings, fabrication, and installation of cables for use as static structural elements for the support and bracing of buildings and other cable-supported structures not subjected to vehicle loads. Parts of buildings to which this standard is applicable include roofs, floors, curtain walls, masts, and nets. In addition, Appendix A addresses cables and fittings, Appendix B discusses saddles, Appendix C addresses clamps, and Appendix D reviews cable fatigue. Guyed utility towers and vehicular bridges are not covered by this standard. This standard applies to carbon-steel and stainless-steel cables. Requirements for earthquake load resistant sway bracing design for nonstructural components of buildings are contained in Appendix E.

1.2 GLOSSARY

Anchorage—The structural connection at which the cable is terminated

Cable—A flexible tension member, either strand or rope

Cable Assembly—A cable with all permanent shop attached fittings

Cable Assembly Strength—The minimum breaking strength multiplied by the fitting reduction factor or by the deflector reduction factor

Clamp—A cable fitting that transfers force by friction

Damper—An active or passive device attached to the cable structure that modifies the structural response to dynamic loads

Deflector—See Saddle

End Fitting—A device, also known as a Termination, attached to a cable to transfer tension between the cable and its supporting anchorage

Fitting—Any accessory used as an attachment to or support for the cable or its components

Grade—Classification of cable by minimum breaking strength and/or metallic composition of wire

Minimum Breaking Force—See Minimum Breaking Strength

Minimum Breaking Strength—Strength of a cable in units of force, as given in ASTM or other applicable standards; also known as Minimum Breaking Force or Nominal Cable Strength (see Fig. 1-1)

Modulus of Elasticity—The slope of the secant to the stress-strain curve between the stress at 10% of the minimum breaking strength and 90% of the prestretching force

Nominal Cable Strength—See Minimum Breaking Strength

Prestressing—Tensioning a cable at installation

Prestretching—Tensioning and detensioning a cable according to a predetermined program to minimize subsequent constructional (in-service) stretch

Prestretching Force—Tensile force applied to a cable one or more times and held for a specified duration during prestretching

Proof Load—A predetermined load prescribed by the engineer and applied in the shop to the cable assembly in performance of the proof test during the fabrication process

Proof Test—A nondestructive tension test to verify integrity and workmanship of an individual cable assembly

Rope—A plurality of strands twisted about an axis or about a core that may be a strand or another wire rope

Saddle—A grooved cable support used to create an angle change in the cable; also known as a Deflector

Strand—A plurality of wires helically twisted about an axis

Termination—See End Fitting

Wire—A single continuous length of steel with a circular or noncircular cross section; wires of circular cross section cold-drawn from rod; wires of noncircular cross section either cold-drawn or cold-rolled from rod

1.3 SYMBOLS AND NOTATION

C = erection or temporary load during construction

D = dead load due to weight of the structure and the permanent features on the structure

D_i = weight of ice

E = earthquake load

E_s = modulus of elasticity (secant)

L = live load due to occupancy and movable equipment

L_r = roof live load

N_d = deflector reduction factor

N_f = fitting reduction factor

P = prestress force

R = rain load

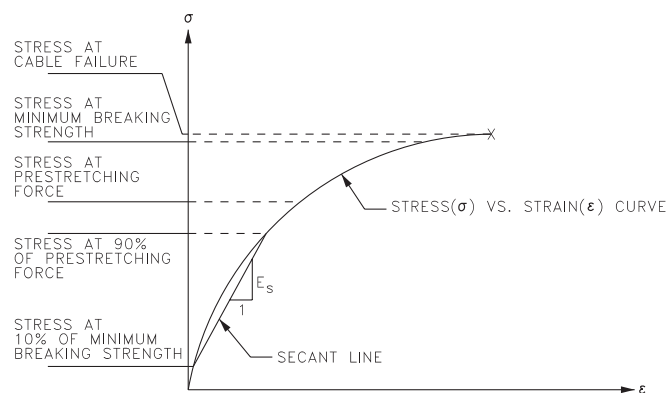


FIGURE 1-1. Cable Minimum Breaking Strength