

Design of Latticed Steel Transmission Structures

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

American Society of Civil Engineers

Design of Latticed Steel Transmission Structures

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



Published by the American Society of Civil Engineers

This is a preview. [Click here to purchase the full publication.](#)

Library of Congress Cataloging-in-Publication Data

Design of latticed steel transmission structures.

pages cm – (ASCE Standards)

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

ISBN 978-0-7844-1376-0 (soft cover : alk. paper) – ISBN 978-0-7844-7870-7 (PDF)

1. Electric lines—Poles and towers—Design and construction—Standards. 2. Steel framing (Building)—Standards. 3. Steel, Structural—Specifications. 4. Lattice theory. I. American Society of Civil Engineers.

TK3242.D45 2015

621.319'22—dc23

2014043646

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.

Whereas 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 are 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/10.1061/9780784413760>.

Copyright © 2015 by the American Society of Civil Engineers.

All Rights Reserved.

ISBN 978-0-7844-1376-0 (print)

ISBN 978-0-7844-7870-7 (PDF)

Manufactured in the United States of America.

22 21 20 19 18 17 16 15

1 2 3 4 5

ASCE 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.

This Standard includes commentary and appendices that are furnished as supplemental information. The commentary and appendices are not mandatory.

The material presented in 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 as a warrant that the information contained herein is suitable for any general or specific use, and the Society takes no position with regard to the validity of patent rights. Users are 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 page intentionally left blank

CONTENTS

| | | |
|--|--|------|
| PREFACE | | XI |
| DESIGN OF STEEL TRANSMISSION TOWERS STANDARDS COMMITTEE | | XIII |
| 1.0 GENERAL | | 1 |
| 1.1 Scope | | 1 |
| 1.2 Applicable Documents | | 1 |
| 1.3 Definitions | | 1 |
| 2.0 LOADING, GEOMETRY, AND ANALYSIS | | 3 |
| 2.1 Introduction | | 3 |
| 2.2 Loads | | 3 |
| 2.3 Geometric Configurations | | 3 |
| 2.4 Methods of Analysis | | 3 |
| 3.0 DESIGN OF MEMBERS | | 5 |
| 3.1 Introduction | | 5 |
| 3.2 Material | | 5 |
| 3.3 Minimum Sizes | | 5 |
| 3.4 Slenderness Ratios | | 5 |
| 3.5 Properties of Sections | | 5 |
| 3.6 Design Compression | | 5 |
| 3.7 Compression Members: Angles | | 5 |
| 3.7.1 Maximum w/t Ratio | | 5 |
| 3.7.2 Design Compressive Stress | | 6 |
| 3.7.3 Determination of F_a | | 6 |
| 3.7.4 Effective Lengths | | 6 |
| 3.7.4.1 Leg Members | | 6 |
| 3.7.4.2 Other Compression Members | | 6 |
| 3.7.4.3 Redundant Members | | 6 |
| 3.7.4.4 Unsupported Length with Varying Forces | | 7 |
| 3.7.4.5 Joint Restraint | | 7 |
| 3.7.4.6 Test Verification | | 7 |
| 3.8 Compression Members: Symmetrical Lipped Angles | | 7 |
| 3.8.1 Maximum w/t Ratio | | 7 |
| 3.8.2 Design Compressive Stress | | 7 |
| 3.8.3 Equivalent Radius of Gyration | | 8 |
| 3.8.4 Minimum Lip Depth | | 8 |
| 3.9 Compression Members Not Covered in Sections 3.7 and 3.8 | | 8 |
| 3.9.1 Design Compressive Stress | | 8 |
| 3.9.2 Maximum w/t Ratio | | 8 |
| 3.9.3 Effective Widths of Elements in Compression | | 8 |
| 3.9.3.1 Uniformly Compressed Elements | | 8 |
| 3.9.3.2 Elements with Stress Gradient | | 8 |
| 3.9.4 Doubly Symmetric Open Cross Sections | | 9 |
| 3.9.5 Singly Symmetric Open Cross Sections | | 9 |
| 3.9.6 Point-Symmetric Open Cross Sections | | 9 |
| 3.9.7 Closed Cross Sections | | 9 |
| 3.9.8 Nonsymmetric Cross Sections | | 9 |
| 3.9.9 Lips | | 9 |
| 3.9.10 Eccentric Connections | | 9 |

This is a preview. [Click here to purchase the full publication.](#)

| | | |
|--------|---|----|
| 3.10 | Tension Members | 9 |
| 3.10.1 | Design Tensile Stress | 9 |
| 3.10.2 | Angle Members | 9 |
| 3.10.3 | Eccentric Connections | 10 |
| 3.10.4 | Threaded Rods and Anchor Bolts | 10 |
| 3.10.5 | Guys | 10 |
| 3.11 | Stitch Bolts | 10 |
| 3.12 | Axial Compression and Bending | 10 |
| 3.13 | Axial Tension and Bending | 10 |
| 3.14 | Beams | 11 |
| 3.14.1 | Properties of Sections | 11 |
| 3.14.2 | Design Tension | 11 |
| 3.14.3 | Laterally Supported Beams | 11 |
| 3.14.4 | I, Channel, and Cruciform Sections | 11 |
| 3.14.5 | Other Doubly Symmetric Open Sections | 11 |
| 3.14.6 | Singly Symmetric I and T Sections | 11 |
| 3.14.7 | Other Singly Symmetric Open Sections | 11 |
| 3.14.8 | Equal Leg Angles | 11 |
| 3.15 | Design Shear | 12 |
| 3.15.1 | Beam Webs | 12 |
| 3.15.2 | Angles | 12 |
| 3.16 | Redundant Members | 13 |
| 3.17 | Welded Angles | 13 |
| 3.17.1 | Compression Members | 13 |
| 3.17.2 | Tension Members | 13 |
| 3.18 | Test Verification | 13 |
| 4.0 | DESIGN OF CONNECTIONS | 15 |
| 4.1 | Introduction | 15 |
| 4.2 | General Requirements | 15 |
| 4.3 | Fasteners | 15 |
| 4.3.1 | Materials | 15 |
| 4.3.2 | Bolt Shear Capacity | 15 |
| 4.3.3 | Bolt Tension Capacity | 15 |
| 4.3.4 | Bolts Subject to Combined Shear and Tension | 15 |
| 4.4 | Design Bearing Stress | 15 |
| 4.5 | Minimum Distances | 15 |
| 4.5.1 | End Distance | 15 |
| 4.5.2 | Center-to-Center Bolt Hole Spacing | 16 |
| 4.5.3 | Edge Distance | 16 |
| 4.6 | Attachment Holes | 16 |
| 4.7 | Post Angle Member Splices | 16 |
| 4.8 | Test Verification | 16 |
| 5.0 | DETAILING AND FABRICATION | 17 |
| 5.1 | Detailing | 17 |
| 5.1.1 | Drawings | 17 |
| 5.1.2 | Approval of Shop Drawings | 17 |
| 5.1.3 | Connections | 17 |
| 5.1.4 | Bolt Spacing | 17 |
| 5.1.5 | Detail Failures During Testing | 17 |
| 5.1.6 | Material | 17 |
| 5.1.7 | Weathering Steel | 17 |
| 5.1.8 | Tension-Only Members | 17 |
| 5.1.9 | Shop Check Assembly | 17 |
| 5.1.10 | Other Considerations | 17 |
| 5.2 | Fabrication | 17 |
| 5.2.1 | Material | 17 |
| 5.2.2 | Specifications | 17 |
| 5.2.3 | Shop Operations | 17 |
| 5.2.4 | Piece Marks | 18 |

This is a preview. Click here to purchase the full publication.

| | | |
|---------|---|----|
| 5.2.5 | Welding | 18 |
| 5.2.5.1 | Welding Requirements | 18 |
| 5.2.5.2 | Welded Angles | 18 |
| 5.2.6 | Galvanizing | 18 |
| 5.2.7 | Shipping | 18 |
| 6.0 | TESTING | 19 |
| 6.1 | Introduction | 19 |
| 6.2 | Foundations | 19 |
| 6.3 | Material | 19 |
| 6.4 | Fabrication | 19 |
| 6.5 | Strain Measurements | 19 |
| 6.6 | Assembly and Erection | 19 |
| 6.7 | Test Loads | 19 |
| 6.8 | Load Application | 19 |
| 6.9 | Loading Procedure. | 19 |
| 6.10 | Load Measurement | 19 |
| 6.11 | Deflections | 19 |
| 6.12 | Failures. | 20 |
| 6.13 | Disposition of Prototype. | 20 |
| 6.14 | Report | 20 |
| 7.0 | STRUCTURAL MEMBERS AND CONNECTIONS USED IN FOUNDATIONS | 21 |
| 7.1 | Introduction | 21 |
| 7.2 | General Considerations | 21 |
| 7.2.1 | Steel Grillages | 21 |
| 7.2.2 | Pressed Plates | 21 |
| 7.2.3 | Stub Angles in Concrete Piers | 21 |
| 7.2.4 | Anchor Bolts [See Fig. 7-1(e)] | 21 |
| 7.2.4.1 | Smooth Bars with Base Assembly in Contact with Concrete or Grout. | 21 |
| 7.2.4.2 | Deformed Bars with Base Assembly in Contact with Concrete or Grout. | 21 |
| 7.2.4.3 | Smooth or Deformed Bars with Base Assembly Not in Contact with Concrete or Grout. | 21 |
| 7.3 | Deterioration Considerations | 21 |
| 7.4 | Design of Stub Angles and Anchor Bolts | 21 |
| 7.4.1 | Stub Angles in Concrete | 21 |
| 7.4.2 | Anchor Bolts with Base Assembly in Contact with Concrete or Grout | 21 |
| 7.4.3 | Anchor Bolts with Base Plates on Leveling Nuts | 22 |
| 7.5 | Design Requirements for Concrete and Reinforcing Steel | 22 |
| 7.5.1 | Stub Angles | 22 |
| 7.5.2 | Smooth Bar Anchor Bolts. | 23 |
| 7.5.2.1 | Minimum Embedment for Anchor Bolts. | 23 |
| 7.5.3 | Deformed Bar Anchor Bolts | 23 |
| 7.6 | Shear Connectors | 23 |
| 7.6.1 | Stud Shear Connectors | 23 |
| 7.6.2 | Angle Shear Connectors. | 23 |
| 7.7 | Test Verification | 24 |
| 8.0 | QUALITY ASSURANCE AND QUALITY CONTROL | 25 |
| 8.1 | Introduction | 25 |
| 8.2 | Quality Assurance | 25 |
| 8.3 | Quality Control | 25 |
| | COMMENTARY | 27 |
| C2.0 | LOADING, GEOMETRY, AND ANALYSIS | 29 |
| C2.1 | Introduction. | 29 |
| C2.2 | Loads | 29 |
| C2.3 | Geometric Configurations | 29 |
| C2.4 | Methods of Analysis | 29 |

This is a preview. Click here to purchase the full publication.

| | | |
|-------|--|----|
| C3.0 | DESIGN OF MEMBERS | 35 |
| C3.1 | Introduction. | 35 |
| C3.2 | Material. | 35 |
| C3.3 | Minimum Sizes. | 35 |
| C3.4 | Slenderness Ratios | 35 |
| C3.5 | Properties of Sections | 35 |
| C3.6 | Design Compression | 35 |
| C3.7 | Compression Members: Angles | 35 |
| | C3.7.3 Determination of F_a | 36 |
| | C3.7.4 Effective Lengths | 36 |
| | C3.7.4.4 Unsupported Length with Varying Forces | 37 |
| C3.8 | Compression Members: Symmetrical Lipped Angles | 38 |
| C3.9 | Compression Members Not Covered in Sections 3.7 and 3.8. | 38 |
| | C3.9.2 Maximum w/t Ratio | 38 |
| | C3.9.3 Effective Widths of Elements in Compression | 38 |
| | C3.9.8 Nonsymmetric Cross Sections. | 38 |
| C3.10 | Tension Members. | 38 |
| | C3.10.5 Guys | 38 |
| C3.12 | Axial Compression and Bending. | 39 |
| C3.13 | Axial Tension and Bending | 39 |
| C3.14 | Beams. | 39 |
| | C3.14.4 I, Channel, and Cruciform Sections | 39 |
| | C3.14.6 Singly Symmetric I and T Sections | 39 |
| | C3.14.7 Other Singly Symmetric Open Sections. | 39 |
| | C3.14.8 Equal Leg Angles | 39 |
| C3.15 | Design Shear | 39 |
| | C3.15.1 Beam Webs. | 39 |
| C3.16 | Redundant Members | 40 |
| C3.17 | Welded Angles | 40 |
| C4.0 | DESIGN OF CONNECTIONS | 41 |
| C4.1 | Introduction. | 41 |
| C4.3 | Fasteners | 41 |
| | C4.3.2 Bolt Shear Capacity | 41 |
| | C4.3.3 Bolt Tension Capacity | 41 |
| | C4.3.4 Bolts Subject to Combined Shear and Tension | 41 |
| C4.4 | Design Bearing Stress | 41 |
| C4.5 | Minimum Distances | 41 |
| | C4.5.1 End Distance | 41 |
| | C4.5.2 Center-to-Center Bolt Hole Spacing. | 42 |
| | C4.5.3 Edge Distance | 43 |
| C4.6 | Attachment Holes | 43 |
| C4.7 | Post Angle Member Splices | 44 |
| C5.0 | DETAILING AND FABRICATION | 45 |
| C5.2 | Fabrication | 45 |
| | C5.2.5 Welding. | 45 |
| | C5.2.5.2 Welded Angles | 45 |
| C6.0 | TESTING | 47 |
| C6.1 | Introduction. | 47 |
| C6.2 | Foundations. | 47 |
| | C6.2.1 General. | 47 |
| | C6.2.2 Rigid Structures | 47 |
| | C6.2.3 Direct Embedded Structures | 47 |
| | C6.2.3.1 Embedded Portion | 47 |
| | C6.2.3.2 Aboveground Portion | 47 |
| | C6.2.4 Components | 47 |
| C6.3 | Material. | 47 |
| C6.4 | Fabrication | 47 |
| C6.5 | Strain Measurements | 47 |
| C6.6 | Assembly and Erection. | 48 |

This is a preview. Click here to purchase the full publication.