



**CSA  
Group**

**S136-16**

# North American specification for the design of cold-formed steel structural members

*Approved in Canada by CSA Group and in the United States by the American Iron and Steel Institute, and endorsed in Mexico by CANACERO*



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# CSA Preface

This is the ninth edition of CSA S136, *North American specification for the design of cold-formed steel structural members* (NASPEC). It supersedes the previous editions published in 2012, 2007, 2001, 1994, 1989, 1984, 1974, and 1963. This edition is a harmonized Standard intended for use in Canada, the United States, and Mexico.

The NASPEC was developed jointly by CSA's Technical Committee on Cold-Formed Steel Structural Members and the American Iron and Steel Institute's Committee on Specifications. This effort was coordinated through the North American Specification Committee, which consisted of six members, three from the CSA Technical Committee and three from the AISI Committee. A detailed summary of the development of the Standard can be found in the joint preface to the North American Specification.

This Standard was reviewed for use in Canada by the CSA Technical Committee on Cold-Formed Steel Structural Members, under the jurisdiction of the CSA Strategic Steering Committee on Construction and Civil Infrastructure, and has been formally approved by the CSA Technical Committee.

## Notes:

- (1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
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  - (a) *Standard designation (number);*
  - (b) *relevant clause, table, and/or figure number;*
  - (c) *wording of the proposed change; and*
  - (d) *rationale for the change.*



AISI S100-16



## **AISI STANDARD**

# **North American Specification for the Design of Cold-Formed Steel Structural Members**

2016 EDITION

Approved in Canada by CSA Group

Endorsed in Mexico by CANACERO



## DISCLAIMER

The material contained herein has been developed by a joint effort of the American Iron and Steel Institute (AISI) Committee on Specifications, CSA Group Technical Committee on Cold Formed Steel Structural Members (S136), and Camara Nacional de la Industria del Hierro y del Acero (CANACERO) in Mexico. The organizations and the Committees have made a diligent effort to present accurate, reliable, and useful information on cold-formed steel design. The Committees acknowledge and are grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. Specific references are included in the *Commentary on the Specification*.

With anticipated improvements in understanding of the behavior of cold-formed steel and the continuing development of new technology, this material may eventually become dated. It is anticipated that future editions of this *Specification* will update this material as new information becomes available, but this cannot be guaranteed.

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## DEDICATION

This edition of AISI S100 is dedicated to Roger L. Brockenbrough, P.E., who served as chairman of the AISI Committee on Specifications from 1991 to 2016. Roger led the development of the first unified ASD and LRFD steel design specification, as well as the first harmonized *North American Cold-Formed Steel Specification*. The *Direct Strength Method* was introduced under his leadership, and is incorporated into the main body of this edition of AISI S100. The Committee recognizes his significant contributions to the development of AISI S100, AISI S310, AISI test standards, and AISI design guides and manuals. The members of the AISI Committee on Specifications have valued Roger's open-minded leadership approach and his willingness to promote new ideas and suggestions. Roger has been instrumental in the successes of the Committee on Specifications. The staff and members of AISI, along with the members of the Committee, greatly appreciate his dedication and contributions toward advancing the cold-formed steel industry.

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## PREFACE

The *North American Specification for the Design of Cold-Formed Steel Structural Members*, as its name implies, is intended for use throughout Canada, Mexico, and the United States. This *Specification* supersedes the 2012 and previous editions of the *North American Cold-Formed Steel Specification*, the previous editions of the *Specification for the Design of Cold-Formed Steel Structural Members* published by the American Iron and Steel Institute (AISI), and the previous editions of CSA Group S136, *Cold Formed Steel Structural Members*, published by CSA Group.

The *Specification* was developed by a joint effort of the American Iron and Steel Institute Committee on Specifications, CSA Group Technical Committee on Cold Formed Steel Structural Members (S136), and Camara Nacional de la Industria del Hierro y del Acero (CANACERO) in Mexico. This effort was coordinated through the North American Specification Committee, which was made up of members from the AISI Committee on Specifications and the CSA Group S136 Committee.

Since the *Specification* is intended for use in Canada, Mexico, and the United States, it was necessary to develop a format that would allow for requirements particular to each country. This resulted in a main document, Chapters A through M and Appendices 1 and 2, that is intended for use in all three countries, and two country-specific appendices (A and B). Appendix A is for use in both the United States and Mexico, and Appendix B is for use in Canada. A symbol ( $\Rightarrow$  **A****B**) is used in the main document to point out that additional provisions are provided in the corresponding appendices indicated by the letters.

This *Specification* provides an integrated treatment of *Allowable Strength Design (ASD)*, *Load and Resistance Factor Design (LRFD)*, and *Limit States Design (LSD)*. This is accomplished by including the appropriate *resistance factors* ( $\phi$ ) for use with *LRFD* and *LSD* and the appropriate *safety factors* ( $\Omega$ ) for use with *ASD*. It should be noted that the use of *LSD* is limited to Canada and the use of *ASD* and *LRFD* is limited to the United States and Mexico.

The *Specification* also contains some terminology that is defined differently in Canada, the United States, and Mexico. These differences are set out in Section A1.3, "Definitions." In the *Specification*, the terms that are specifically applicable to *LSD* are included in square brackets. The *Specification* provides well-defined procedures for the design of load-carrying cold-formed steel members in buildings, as well as other applications, provided that proper allowances are made for dynamic effects. The provisions reflect the results of continuing research to develop new and improved information on the structural behavior of cold-formed steel members. The success of these efforts is evident in the wide acceptance of the previous editions of the *Specification*.

The AISI and CSA Group consensus committees responsible for developing these provisions provide a balanced forum, with representatives of steel producers, fabricators, users, educators, researchers, and building code regulators. They are composed of engineers with a wide range of experience and high professional standing from throughout Canada and the United States. AISI, CSA Group, and CANACERO acknowledge the continuing dedication of the members of the specifications committees and their subcommittees. The membership of these committees follows this Preface.

The 2016 Edition of the *Specification* has been reorganized by incorporating the *Direct Strength Method* design provisions into Chapters A through M. Also, the chapters are laid out to be more in line with ANSI/AISC 360-2010. A section reference table of the 2012 Edition of the

*Specification* and this edition is provided.

In addition to content reorganization, the following changes and additions are made in this edition:

Section A2, Referenced Specifications, Codes and Standards. All the references, including those specific to U.S. and Mexico or Canada, are listed in the main body of the *Specification*. All the referenced standards are updated.

Section A3.2, Other Steels. The country-specific provisions are consolidated by bringing the provisions into the main body of the *Specification*.

Section B2, Loads and Load Combinations. The applicable building codes for determining the loads and load combinations are introduced for the U.S., Mexico, and Canada.

Section B3, Design Basis. This section introduces three design methods: *ASD* and *LRFD* are applicable to the U.S. and Mexico, and *LSD* is applicable to Canada. It references *Specification* chapters or sections that provide design provisions for *required strength* [effect due to *factored loads*] and *available strengths* [*factored resistances*], structural members, connections, stability, structural assemblies and systems, serviceability, ponding, fatigue, and corrosion effects.

Section B4, Dimensional Limits and Considerations. The limitations for applying the *Effective Width Method* and the *Direct Strength Method* are streamlined.

Section C1, Design for System Stability. The provisions consider Appendix 2, Second-Order Analysis, included in the 2012 Edition of the *Specification*, and incorporate system stability analysis approaches provided in ANSI/AISC 360.

Chapters E, F and G. The provisions of the *Direct Strength Method* included in Appendix 1 of the 2012 Edition of the *Specification* are incorporated into these chapters.

Section F2.1.1, Singly- or Doubly-Symmetric Sections Bending About Symmetric Axis. Simplified Equation F2.1.1-6 to determine elastic *buckling stress*,  $F_{cre}$ , is no longer applicable to *singly-symmetric C-Sections*.

Section H1, Combined Axial Load and Bending. The interaction check equations for *ASD*, *LRFD*, and *LSD* are combined into one format, as applicable.

Section H1.2, Combined Compressive Axial Load and Bending. The interaction check equations are revised with the moment magnification effect taken into consideration through the system stability effect in accordance with Section C1.

Section I2, Floor, Roof, or Wall Steel Diaphragm Construction. AISI S310, AISI S240, and AISI S400 are introduced for *diaphragm* design, and the table of Safety and Resistance Factors for Diaphragms is moved to AISI S310.

Section I4, Cold-Formed Steel Light-Frame Construction. The cold-formed steel framing standards are updated.

Section I5, Special Bolted Moment Frame Systems. Special bolted moment frame systems should be designed in accordance with AISI S400.

Section I6.1, Members Strength: General Cross-Sections and System Connectivity. This section permits the bending and compression strengths of purlins and girts to be determined analytically provided the lateral, rotational, and composite stiffness provided by the deck or sheathing, bridging and bracing, and span continuity are included.

Section I7, Rack Systems. Rack system design should be in accordance with ANSI MH16.1.

Section J2, Welded Connections. The country-specific standards are brought into the main

body of the *Specification*.

Section J3, Bolted Connections. The table of Nominal Tensile and Shear Strengths for Bolts in Appendix A has been updated to be consistent with those in ANSI/AISC 360, and values for bolt diameters less than 0.5 in. (12 mm) have been revised.

Section J7.2, Power-Actuated Fasteners (PAFs) in Concrete. The PAF pull-out strength in shear in cold-formed steel framing track-to-concrete *connections* is added.

Section K1, Test Standards. The AISI S900 series of test standards are introduced, and the standards are also referenced in Section A2.

Section K2, Test for Special Cases. The sentence that the provisions shall not apply to cold-formed steel *diaphragms* was deleted.

Section K2.1.1, Load and Resistance Factor Design and Limit States Design. The table of Statistical Data for the Determination of Resistance Factor is simplified. The sentence that Section K2.1.1(b) is not applicable to floor, roof or wall steel *diaphragm* was deleted.

Appendix 1, Effective Width of Elements. This appendix provides provisions for determining the effective width of elements as needed for the *Effective Width Method*.

Appendix 2, Elastic Buckling Analysis of Members. This new appendix provides analytical and numerical approaches to determine the local, distortional, and global buckling strengths.

American Iron and Steel Institute  
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Camara Nacional de la Industria del Hierro y del Acero  
August 2016

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| A1.2  | Applicability   | A1.2  |
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| C3.7  | Stiffeners   | F5, G4                                      |
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| E4.5.2.1                                    | ASD Method   | J4.5.2                                      |
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| G4  | Bolts and Threaded Parts   | M4  |
| G5  | Special Fabrication Requirements   | M5  |
| <b>APPENDIX 1</b>                           | <b>DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS USING THE DIRECT STRENGTH METHOD</b>             | <b>E, F, G</b>                              |
| 1.1   | General Provisions   | E1, F1                                      |
| 1.1.1                                       | Applicability  | E, F, G, B4                                 |
| 1.1.1.1                                     | Prequalified Columns   | B4.1  |
| 1.1.1.2                                     | Prequalified Beams   | B4.1  |
| 1.1.2                                       | Elastic Buckling   | Appendix 2                                  |
| 1.1.3                                       | Serviceability Determination   | L2  |
| 1.2   | Members  | E, F  |
| 1.2.1                                       | Column Design  | E   |
| 1.2.1.1                                     | Flexural, Torsional, or Flexural-Torsional Buckling  | E2  |
| 1.2.1.1.1                                   | Columns Without Holes  | E2  |
| 1.2.1.1.2                                   | Columns With Hole(s)   | E2.5  |
| 1.2.1.2                                     | Local Buckling   | E3.2  |
| 1.2.1.2.1                                   | Columns Without Holes  | E3.2.1                                      |
| 1.2.1.2.2                                   | Columns With Hole(s)   | E3.2.2                                      |
| 1.2.1.3                                     | Distortional Buckling  | E4  |
| 1.2.1.3.1                                   | Columns Without Holes  | E4.1  |
| 1.2.1.3.2                                   | Columns With Hole(s)   | E4.2  |
| 1.2.2                                       | Beam Design  | F   |
| 1.2.2.1                                     | Bending  | F2  |
| 1.2.2.1.1                                   | Lateral-Torsional Buckling   | F2.1  |
| 1.2.2.1.1.1                                 | Beams Without Holes  | F2.1  |
| 1.2.2.1.1.1.1                               | Lateral-Torsional Buckling Strength [Resistance]   | F2.1  |
| 1.2.2.1.1.1.2                               | Inelastic Reserve Lateral-Torsional Buckling Strength [Resistance]                                 | F2.4.2                                      |
| 1.2.2.1.1.2                                 | Beams With Hole(s)   | F2.2  |
| 1.2.2.1.2                                   | Local Buckling   | F3.2  |
| 1.2.2.1.2.1                                 | Beams Without Holes  | F3.2.1                                      |
| 1.2.2.1.2.1.1                               | Local Buckling Strength [Resistance]   | F3.2.1                                      |
| 1.2.2.1.2.1.2                               | Inelastic Reserve Local Buckling Strength [Resistance]   | F3.2.3                                      |
| 1.2.2.1.2.2                                 | Beams With Hole(s)   | F3.2.2                                      |
| 1.2.2.1.3                                   | Distortional Buckling  | F4  |
| 1.2.2.1.3.1                                 | Beams Without Holes  | F4.1  |
| 1.2.2.1.3.1.1                               | Distortional Buckling Strength [Resistance]  | F4.1  |

**Section Numbering Comparison – AISI S100-12 Versus AISI S100-16**

| <b>AISI S100-12<br/>Section<br/>Numbers</b> | <b>Section Title</b>  | <b>AISI S100-16<br/>Section<br/>Numbers</b> |
|---|---|---|
| 1.2.2.1.3.1.2                               | Inelastic Reserve Distortional Buckling Strength [Resistance]                       | F4.3  |
| 1.2.2.1.3.2                                 | Beams With Hole(s)  | F4.2  |
| 1.2.2.2                                     | Shear   | G2  |
| 1.2.2.2.1                                   | Beams Without Web Stiffeners  | G2.1  |
| 1.2.2.2.2                                   | Beams With Web Stiffeners   | G2.2  |
| 1.2.2.3                                     | Combined Bending and Shear  | H2  |
| <b>APPENDIX 2</b>                           | <b>SECOND-ORDER ANALYSIS</b>  | C1.1  |
| 2.1   | General Requirements  | C1.1  |
| 2.2   | Design and Analysis Constraints   | C1.1  |
| 2.2.1                                       | General   | C1.1  |
| 2.2.2                                       | Types of Analysis   | C1.1  |
| 2.2.3                                       | Reduced Axial and Flexural Stiffnesses  | C1.1  |
| 2.2.4                                       | Notional Loads  | C1.1  |
| <b>APPENDIX A</b>                           | <b>PROVISIONS APPLICABLE TO THE UNITED STATES AND MEXICO</b>                        | Appendix A                                  |
| A1.1a                                       | Scope   | A1.2*                                       |
| A2.2  | Other Steels  | A3.2*                                       |
| A2.3.5a                                     | Ductility Requirements of Other Steels  | A3.2.1.1*                                   |
| A3  | Loads   | B2*   |
| A3.1  | Nominal Loads   | B2*   |
| A4.1.2                                      | Load Combinations for ASD   | B2*   |
| A5.1.2                                      | Load Factors and Load Combinations for LRFD   | B2*   |
| A9a   | Referenced Documents  | A2.1*                                       |
| D6.1.2                                      | Flexural Members Having One Flange Fastened to a Standing Seam Roof System          | I6.2.2                                      |
| D6.1.4                                      | Compression of Z-Section Members Having One Flange Fastened to a Standing Seam Roof | I6.2.4                                      |
| D6.2.1a                                     | Strength [Resistance] of Standing Seam Roof Panel Systems                           | I6.3.1a                                     |
| E2a   | Welded Connections  | J2*, J2a                                    |
| E3a   | Bolted Connections  | J3*   |
| E3.4  | Shear and Tension in Bolts  | J3.4  |
| E6a   | Rupture   | J6*   |
| <b>APPENDIX B</b>                           | <b>PROVISIONS APPLICABLE TO CANADA</b>  | Appendix B                                  |
| A1.3a                                       | Definitions   | Deleted                                     |
| A2.1.1a                                     | Applicable Steels   | A2*   |
| A2.2  | Other Steels  | A3.2*                                       |
| A2.2.1                                      | Other Structural Quality Steels   | A3.2*                                       |
| A2.2.2                                      | Other Steels  | A3.2*                                       |
| A2.3.5a                                     | Ductility Requirements of Other Steels  | A3.2.1.1*                                   |
| A3  | Loads   | B2*   |
| A3.1  | Loads and Effects   | B2*   |
| A3.2  | Temperature, Earth, and Hydrostatic Pressure Effects                                | Deleted                                     |
| A6.1.2                                      | Load Factors and Load Combinations for LSD  | Deleted                                     |
| A6.1.2.1                                    | Importance Categories   | Deleted                                     |
| A6.1.2.2                                    | Importance Factor (I)   | Deleted                                     |
| A9a   | Reference Documents   | A2.2*                                       |
| D3a   | Lateral and Stability Bracing   | C2a   |

**Section Numbering Comparison – AISI S100-12 Versus AISI S100-16**

| <b>AISI S100-12<br/>Section<br/>Numbers</b> | <b>Section Title</b>   | <b>AISI S100-16<br/>Section<br/>Numbers</b> |
|---|--|---|
| D3.1a                                       | Symmetrical Beams and Columns  | C2.1  |
| D3.1.1a                                     | Discrete Bracing for Beams   | C2.1.1                                      |
| D3.1.2a                                     | Bracing by Deck, Slab, or Sheathing for Beams and Columns                  | C2.1.2                                      |
| D3.2a                                       | C-Section and Z-Section Beams  | C2.2a                                       |
| D3.2.2                                      | Discrete Bracing   | C2.2.2                                      |
| D3.2.3                                      | One Flange Braced by Deck, Slab, or Sheathing                              | C2.2.3                                      |
| D3.2.4                                      | Both Flanges Braced by Deck, Slab, or Sheathing                            | C2.2.4                                      |
| D6.1.2                                      | Flexural Members Having One Flange Fastened to a Standing Seam Roof System | I6.2.2                                      |
| E2a   | Welded Connections   | J2a   |
| E3a   | Bolted Connections   | J3*   |
| E3.3a                                       | Bearing  | J3.3*                                       |
| E3.4  | Shear and Tension in Bolts   | J3.4  |
| E6a   | Rupture  | J6a   |
| F1.1a                                       | Load and Resistance Factor Design and Limit States Design                  | K2.1.1a                                     |

\* Refer to the section numbers in the main body of the *Specification*.

## SYMBOLS

| Symbol          | Definition  | Section   |
|-----------------|---|---|
| A               | Full, unreduced <i>cross-sectional area</i> of member   | A1.3, E2.2, E3.1.1.1, F2.1.1, F2.1.2, F2.1.3, I6.2.3, I6.2.4  |
| $A_{avg}$       | Weighted average of <i>cross-sectional area</i>   | 2.3.2.1.1   |
| $A_b$           | $b_1t + A_s$ , for bearing stiffener at interior support or under concentrated load, and $b_2t + A_s$ , for bearing stiffeners at end support   | F5.1  |
| $A_b$           | Gross <i>cross-sectional area</i> of bolt   | J3.4  |
| $A_c$           | $18t^2 + A_s$ , for bearing stiffener at interior support or under concentrated load, and $10t^2 + A_s$ , for bearing stiffeners at end support | F5.1  |
| $A_e$           | <i>Effective area</i> at stress $F_n$   | A1.3, E2.2, E3.1, E3.1.1, E3.1.1.1, E3.1.2, E4.1, E4.2  |
| $A_e$           | <i>Effective area</i> of bearing stiffener  | F5.2  |
| $A_e$           | <i>Effective net area</i> subject to tension  | J6.2  |
| $A_f$           | <i>Cross-sectional area</i> of compression <i>flange</i> plus edge stiffener  | 2.3.1.3   |
| $A_g$           | <i>Gross area</i> of cross-section  | A1.3, C1.1.1.3, D2, E2, J6.2, 2.1, 2.3.1.1, 2.3.1.2, 2.3.1.3, 2.3.2.1, 2.3.2.1.1, 2.3.2.1.2, 2.3.2.1.4, 2.3.2.2, 2.3.4.1.1, 2.3.4.1.2 |
| $A_g$           | <i>Gross area</i> of element including stiffeners   | 1.4.1   |
| $A_{gv}$        | <i>Gross area</i> subject to shear  | J6.3  |
| $A_n$           | <i>Net area</i> of cross-section  | A1.3, D3  |
| $A_{net}$       | <i>Net area</i> of cross-section at the location of a hole  | E3.2.2, E4.2, 2.3.2.1.1, 2.3.2.2  |
| $A_{nt}$        | <i>Net area</i> subject to tension  | J6.2, J6.3  |
| $A_o$           | Reduced area due to <i>local buckling</i>   | E3.1.1.1  |
| $A_{nv}$        | <i>Net area</i> subject to shear (parallel to force)  | J6.1, J6.3  |
| $A_p$           | <i>Gross cross-sectional area</i> of roof panel per unit width  | I6.4.1  |
| $A_s$           | <i>Cross-sectional area</i> of bearing stiffener  | F5.1  |
| $A_s$           | <i>Gross area</i> of stiffener  | 1.4.1, 1.4.1.1, 1.4.1.2   |
| $A_{st}$        | <i>Gross area</i> of shear stiffener  | G4.1  |
| $A_t$           | Net tensile area  | M4  |
| $A_w$           | Area of <i>web</i>  | G2.1, G2.3, 2.1, 2.3.5  |
| $A_{web,gross}$ | <i>Web</i> surface area along the member length   | 2.3.2.3, 2.3.4.3  |
| $A_{web,net}$   | <i>Web</i> surface area along member length subtracting the hole areas  | 2.3.2.3, 2.3.4.3  |
| a               | Longitudinal distance between centerline of braces  | C2.2.1  |
| a               | Shear panel length of unreinforced <i>web</i> element, or distance between shear stiffeners of reinforced <i>web</i> elements                   | G2.3, G4  |

## SYMBOLS

| Symbol     | Definition  | Section  |
|------------|---|--|
| a          | Intermediate fastener or spot weld spacing  | I1.2   |
| a          | Fastener distance from outside <i>web</i> edge  | I6.2.3   |
| a          | Longitudinal distance between centerline of bracing   | C2.2.1   |
| a          | Major diameter of the tapered <i>PAF</i> head   | J5, J5.2.3   |
| $B_c$      | Term for determining tensile <i>yield stress</i> of corners   | A3.3.2   |
| $B_1$      | Multiplier to account for <i>P-<math>\delta</math></i> effects  | C1.1.1.1, C1.2.1.1                                     |
| $B_2$      | Multiplier to account for <i>P-<math>\Delta</math></i> effects  | C1.1.1.1, C1.2.1.1                                     |
| b          | <i>Flat width</i> of element with edge stiffeners (disregard intermediate stiffeners)   | B4.1   |
| b          | <i>Effective design width</i>   | B4.3, 1.1, 1.1.1, 1.1.4, 1.2.1, 1.2.2, 1.3             |
| b          | <i>Flange width</i>   | I6.2.3, I6.2.4, I6.4.1                                 |
| b          | Centerline dimension of <i>flange</i>   | 2.3.1.3  |
| $b_d$      | <i>Effective width</i> for deflection calculation   | 1.1, 1.1.1, 1.2.1, 1.2.2, 1.3, 1.4.1.1, 1.4.1.2, 1.4.2 |
| $b_e$      | <i>Effective width</i> of elements, located at centroid of element including stiffeners   | 1.4.1  |
| $b_e$      | <i>Effective width, b</i> , determined in accordance with Section 1.1, with $f_1$ substituted for $f$ and with $k$ determined as given in Section 1.1.2 | 1.1.2  |
| $b_f$      | Out-to-out width of <i>flange</i> not connected   | J6.2   |
| $b_o$      | Out-to-out width of element with edge stiffeners (disregard intermediate stiffeners)  | B4.1   |
| $b_o$      | Out-to-out width of compression <i>flange</i> as defined in Figure 1.1.2-2  | 1.1.2  |
| $b_o$      | Overall width of unstiffened element as defined in Figure 1.2.2-3   | 1.2.2  |
| $b_o$      | Total <i>flat width</i> of stiffened element  | 1.4.1, 1.4.1.1, 1.4.1.2                                |
| $b_o$      | Total <i>flat width</i> of edge-stiffened element   | 1.4.2  |
| $b_p$      | Largest sub-element <i>flat width</i>   | 1.4.1, 1.4.1.1, 1.4.1.2                                |
| $b_w$      | Out-to-out width of <i>web</i> connected  | J6.2   |
| $b_1, b_2$ | <i>Effective widths</i>   | 1.1.2, 1.1.3   |
| $b_1, b_2$ | Portions of <i>effective width</i>  | 1.3  |
| $b_1, b_2$ | <i>Effective widths</i> of bearing stiffeners   | F5.1   |
| $b_1$      | Out-to-out width of angle leg not connected   | J6.2   |
| $b_2$      | Out-to-out width of angle leg connected   | J6.2   |

## SYMBOLS

| Symbol   | Definition   | Section   |
|--|--|---|
| C  | For compression members, ratio of total corner <i>cross-sectional area</i> to total <i>cross-sectional area</i> of full section; for flexural members, ratio of total corner <i>cross-sectional area</i> of controlling <i>flange</i> to full <i>cross-sectional area</i> of controlling <i>flange</i> | A3.3.2  |
| C  | Coefficient  | G5  |
| C  | Bearing factor   | J3.3.1  |
| C <sub>b</sub>                                     | Bending coefficient dependent on moment gradient   | F2.1.1, F2.1.3, F2.1.4, 2.3.4.1.1, 2.3.4.1.2, 2.3.4.1.3 |
| C <sub>c</sub>                                     | Correlation coefficient  | K2.1.1  |
| C <sub>f</sub>                                     | Constant from Table M1-1   | M1, M3  |
| C <sub>h</sub>                                     | <i>Web</i> slenderness coefficient   | G5  |
| C <sub>m</sub>                                     | Coefficient assuming no lateral translation of frame   | C1.2.1.1  |
| C <sub>N</sub>                                     | Bearing length coefficient   | G5  |
| C <sub>p</sub>                                     | Correction factor  | B4.2, K2.1.1  |
| C <sub>R</sub>                                     | Inside bend radius coefficient   | G5  |
| C <sub>s</sub>                                     | Coefficient for <i>lateral-torsional buckling</i>  | F2.1.2  |
| C <sub>TF</sub>                                    | End moment coefficient   | F2.1.2  |
| C <sub>v</sub>                                     | Shear stiffener coefficient  | G4.1  |
| C <sub>w</sub>                                     | Torsional warping constant of cross-section  | E2.2, F2.1.1, 2.3.1.1                                   |
| C <sub>w,net</sub>                                 | Net warping constant assuming cross-section <i>thickness</i> is zero at hole   | 2.3.2.1.2, 2.3.2.1.4, 2.3.4.1.1                         |
| C <sub>wf</sub>                                    | Torsional warping constant of <i>flange</i>  | 2.3.1.3, 2.3.3.3  |
| C <sub>y</sub>                                     | Compression strain factor  | F2.4.1  |
| C <sub>yd</sub>                                    | Compression strain factor  | F4.3  |
| C <sub>y<sup>l</sup></sub>                         | Compression strain factor  | F3.2.3  |
| C <sub>yt</sub>                                    | Ratio of maximum tension strain to yield strain  | F3.2.3  |
| C <sub>1</sub> , C <sub>2</sub> , C <sub>3</sub>   | Axial <i>buckling</i> coefficients   | I6.2.3  |
| C <sub>1</sub> , C <sub>2</sub> , C <sub>3</sub> , | Coefficients   | 2.3.5   |
| C <sub>4</sub>                                     |  |   |
| C1 to C6   | Coefficients tabulated in Tables I6.4.1-1 to I6.4.1-3  | I6.4.1  |
| C <sub>φ</sub>                                     | Calibration coefficient  | K2.1.1  |
| c  | Strip of <i>flat width</i> adjacent to hole  | 1.1.1   |
| c  | Variable in determining reduction factor, q <sub>s</sub>   | G3  |
| c <sub>f</sub>                                     | Amount of curling displacement   | L3  |
| c <sub>i</sub>                                     | Horizontal distance from edge of element to centerline of stiffener  | 1.4.1, 1.4.1.2  |
| D  | Outside diameter of cylindrical tube   | E3.1.1.1, F2.3, F3.1.1                                  |
| D  | Overall depth of lip   | 1.1.4, 1.3  |
| D  | Shear stiffener coefficient  | G4.1  |

## SYMBOLS

| Symbol        | Definition  | Section   |
|---------------|---|---|
| d             | <i>Flat width</i> of unstiffened element (disregard intermediate stiffeners)  | B4.1  |
| d             | Depth of cross-section  | C2.2.1, F2.1.1, F2.1.3, F5.2, G6, I6.2.1, I6.2.3, I6.2.4, I6.4.1, I6.4.2, L3, 1.1.4 |
| d             | Centerline dimension of lip   | 2.3.1.3   |
| d             | Nominal screw diameter  | J4, J4.3.1, J4.4.1, J4.5.1, J4.5.2  |
| d             | Flat depth of lip defined in Figure 1.3-1   | 1.3   |
| d             | Visible diameter of the outer surface of the arc spot weld  | J2.2.1, J2.2.2.1, J2.2.2.2, J2.2.4  |
| d             | Visible width of arc seam weld  | J2.3, J2.3.1, J2.3.2.1, J2.3.2.2  |
| d             | Nominal bolt diameter   | J3, J3.1, J3.2, J3.3.1, J3.3.2, J3.4, J6.2  |
| d             | Fastener diameter measured at near side of embedment or $d_s$ for <i>PAF</i> installed such that entire point is located behind far side of the embedment material  | J5, J5.2.1, J5.3.1  |
| $d_a$         | Average diameter of arc spot weld at mid- <i>thickness</i> of t   | J2.2.2.1, J2.2.2.2, J2.2.3, J2.2.4  |
| $d_a$         | Average width of seam weld  | J2.3.2.1, J2.3.2.2  |
| $d_{ae}$      | Average embedded diameter, computed as average of installed fastener diameters measured at near side and far side of embedment material or $d_s$ for <i>PAF</i> installed such that entire point is located behind far side of embedment material | J5, J5.3.3  |
| $d_b$         | Nominal diameter (body or shank diameter)   | M3  |
| $d_c$         | Thickness of supporting concrete  | J7.2.2  |
| $d_e$         | Effective diameter of fused area  | J2.2, J2.2.2.1, J2.2.2.2, J2.2.3  |
| $d_e$         | Effective width of arc seam weld at fused surfaces  | J2.3.2.1  |
| $d_h$         | Diameter of hole  | J3, J6.1, J6.2, 1.1.1   |
| $d_h$         | Depth of hole   | G3, G6, 1.1.3   |
| $d_h$         | Screw head diameter or hex washer head integral washer diameter   | J4, J4.4.2  |
| $d_o$         | Out-to-out width of unstiffened element (disregard intermediate stiffeners)   | B4.1  |
| $d_{p_{i,j}}$ | Distance along roof slope between the <i>i</i> th <i>purlin</i> line and the <i>j</i> th anchorage device   | I6.4.1  |
| $d_s$         | Reduced <i>effective width</i> of stiffener   | 1.3   |
| $d_s$         | Nominal shank diameter  | J5, J5.1, J5.2.3, J5.3.2, J5.3.3, J5.3.4, J5.3.5, J7.2.2                            |
| $d'_s$        | <i>Effective width</i> of stiffener calculated according to 1.2.1 or 1.2.2  | 1.3   |
| $d_w$         | Steel washer diameter   | J4, J4.4, J4.4.2  |

## SYMBOLS

| Symbol           | Definition   | Section   |
|------------------|--|---|
| $d_w$            | Larger value of screw head or washer diameter  | J4.5.1  |
| $d'_w$           | Effective pull-over resistance diameter  | J4, J4.4.2  |
| $d'_w$           | Actual diameter of washer or fastener head in contact with retained substrate  | J5, J5.2.3  |
| $d_1, d_2$       | Weld offset from flush condition   | J2.6  |
| E                | Modulus of elasticity of steel, 29,500 ksi (203,000 MPa, or 2,070,000 kg/cm <sup>2</sup> )   | A3.1.3, E2.1, E2.1.1, E2.2, E3.1.1.1, F2.1.1, F2.1.2, F2.1.3, F2.1.4, F2.3, F2.4.1, F3.1.1, F5.1, G2.1, G2.3, G4.1, I1.3, I6.2.3, I6.4.1, J2.2.2.1, L3, 1.1, 1.1.4, 1.3, 1.4.1, 2.3.1.1, 2.3.1.2, 2.3.1.3, 2.3.2.1.1, 2.3.2.1.2, 2.3.2.1.3, 2.3.3.2, 2.3.3.3, 2.3.4.1.1, 2.3.4.1.3, 2.3.5 |
| e                | Natural logarithmic base (=2.718)  | J5.2.1, K2.1.1  |
| e                | <i>Flat width</i> between first line of connector and edge stiffener   | 1.1.4   |
| $e_{net}$        | Clear distance between end of material and edge of fastener hole or weld   | J6.2  |
| $e_{sx}, e_{sy}$ | Eccentricities of <i>load</i> components measured from the shear center and in the x- and y- directions, respectively  | C2.2.1  |
| $e_y$            | Yield strain = $F_y/E$   | F2.4.1  |
| F                | Fabrication factor   | K2.1.1  |
| $F_a$            | Acceleration-based site coefficient, as defined in NBCC  | A3.2.1.1  |
| $F_{bs}$         | Base <i>stress</i> parameter (66,000 psi (455 MPa))  | J5, J5.2.1  |
| $F_c$            | Critical column <i>buckling stress</i>   | 1.1.4   |
| $F_{cr}$         | Elastic <i>shear buckling stress</i>   | G2.3, 2.1   |
| $F_{cr}$         | $F_{cre}$ – global (flexural, torsional, or flexural-torsional), $F_{cr\ell}$ – local, or $F_{crd}$ – distortional elastic <i>buckling stress</i> in compression     | 2.1   |
| $F_{cr}$         | $F_{cre}$ – global (lateral-torsional), $F_{cr\ell}$ – local, or $F_{crd}$ – distortional elastic <i>buckling stress</i> referenced to the extreme compression fiber | 2.1   |
| $F_{crd}$        | Elastic <i>distortional buckling stress</i>  | F4.1, 2.1, 2.3.1.3, 2.3.3.3   |
| $F_{cre}$        | Critical elastic ( <i>flexural</i> ) <i>buckling stress</i>  | C1.3.2, E2.1, 2.3.2.1.1   |
| $F_{cre}$        | <i>Flexural-torsional buckling stress</i>  | E2.2, 2.3.2.1.2, 2.3.2.1.3  |
| $F_{cre}$        | Least of applicable elastic global <i>buckling stresses</i>  | E2, E2.2, E2.3, E2.4, E2.5, 2.1, 2.3.1.1, 2.3.2.1, 2.3.4.1  |

## SYMBOLS

| Symbol           | Definition   | Section  |
|------------------|--|--|
| $F_{cre}$        | Least of applicable elastic global <i>buckling stresses</i> based on weighted average cross-section properties               | 2.3.2.1.4  |
| $F_{cre}$        | Critical elastic <i>lateral-torsional buckling stresses</i>  | F2.1, F2.1.1, F2.1.2, F2.1.3, F2.1.4, F2.2, F2.4.2, I6.1.2.1, 2.3.4.1.1, 2.3.4.1.2, 2.3.4.1.3              |
| $F_{crl}$        | Minimum critical <i>buckling stress</i> for cross-section  | E2.1.1, 1.1, 1.1.4   |
| $F_{crl}$        | Plate elastic <i>buckling stress</i>   | 1.4.1  |
| $F_{crl}$        | Smallest <i>local buckling stress</i> of all elements in cross-section   | 2.1, 2.3.1.2, 2.3.2.2, 2.3.4.2   |
| $F_{crl}$        | <i>Local buckling stress</i> at extreme compression fiber  | 2.3.3.2  |
| $F_{crd}$        | Elastic <i>distortional buckling stress</i>  | 2.1  |
| $F_m$            | Mean value of fabrication factor   | I6.3.1, K2.1.1   |
| $F_n$            | Nominal compressive <i>stress</i>  | E2, E3.1, E3.1.1   |
| $F_n$            | Nominal global flexural <i>stress</i>  | F2.1, F2.3, F3.1, F3.1.1, H2, H3, H4, I6.1.1.2, I6.1.2.2, I6.2.1, I6.2.2                                   |
| $F_n$            | <i>Nominal strength</i> of bolts   | J3.4   |
| $F_{nt}$         | <i>Nominal tensile strength</i> of bolts   | J3.4   |
| $F'_{nt}$        | <i>Nominal tensile strength</i> for bolts subject to combination of shear and tension  | J3.4   |
| $F_{nv}$         | <i>Nominal shear strength</i> of bolts   | J3.4   |
| $F_{SR}$         | Design <i>stress range</i>   | M3   |
| $F_{sy}$         | <i>Specified minimum yield stress</i> of connected sheets as determined in accordance with Section A3.1.1, A3.1.2, or A3.1.3 | J2.4.1   |
| $F_{sy}$         | <i>Specified minimum yield stress</i> as specified in Section A3.1 or A3.2   | A3.1.2, A3.1.3   |
| $F_{TH}$         | Threshold <i>fatigue stress range</i>  | M1, M3, M4   |
| $F_u$            | <i>Tensile strength</i>  | A3.1.2, D3, J2.2.2.1, J2.2.2.2, J2.2.3, J2.2.4, J2.3.2.1, J2.3.2.2, J2.4.1, J2.6, J4.5.2, J6.1, J6.2, J6.3 |
| $F_u$            | <i>Tensile strength</i> of bolt  | J3.4   |
| $F_{uh}$         | <i>Tensile strength</i> of hardened PAF steel  | J5, J5.2.1, J5.3.1   |
| $F_{ut}$         | <i>Tensile strength</i> of non-hardened PAF steel  | J5   |
| $F_{uv}$         | <i>Tensile strength</i> of <i>virgin steel</i> specified by Section A3 or established in accordance with Section K2.3.3      | A3.3.2   |
| $F_{u1}, F_{u2}$ | <i>Tensile strengths</i> of connected parts corresponding to <i>thicknesses</i> $t_1$ and $t_2$                              | J2.5   |
| $F_{u1}$         | <i>Tensile strength</i> of member in contact with screw head or washer   | J4, J4.3.1, J4.4.2, J4.5.1   |

## SYMBOLS

| Symbol             | Definition   | Section  |
|--------------------|--|--|
| $F_{u1}$           | Tensile strength of member in contact with <i>PAF</i> head or washer   | J5, J5.2.3, J5.3.2   |
| $F_{u2}$           | Tensile strength of member not in contact with screw head or washer  | J4, J4.3.1, J4.4.1, J4.5.2   |
| $F_{u2}$           | Tensile strength of member not in contact with <i>PAF</i> head or washer   | J5   |
| $F_{wy}$           | Lower value of $F_y$ for beam <i>web</i> or $F_{ys}$ for bearing stiffeners  | F5.1   |
| $F_{xx}$           | Tensile strength of electrode classification   | J2.1, J2.2.2.1, J2.2.2.2, J2.2.3, J2.2.4, J2.3.2.1, J2.3.2.2, J2.4.1, J2.5, J2.6   |
| $F_y$              | Yield stress   | A3.3.1, A3.3.2, B4.1, C1.1.1.3, D2, E2, E3.1.1.1, E3.2.2, E4.1, E4.2, F2.1, F2.1.4, F2.3, F2.4.1, F2.4.2, F3.1, F3.1.1, F3.2.2, F4.1, F5.1, G2.1, G4.1, G5, H1.1, H1.2, H2, H3, H4, I1.3, I6.2.1, I6.2.2, I6.2.4, J2.1, J2.2.3, J2.4.1, J4.5.1, J6.3, M1, 1.1, 1.1.4 |
| $F_{ya}$           | Average yield stress of section  | A3.3.2   |
| $F_{yc}$           | Tensile yield stress of corners  | A3.3.2   |
| $F_{yf}$           | Weighted average tensile yield stress of flat portions   | A3.3.2, K2.3.2   |
| $F_{ys}$           | Yield stress of stiffener steel  | F5.1, F5.2   |
| $F_{yv}$           | Tensile yield stress of virgin steel specified by Section A3 or established in accordance with Section K2.3.3  | A3.3.2   |
| $F_{y2}$           | Yield stress of member not in contact with <i>PAF</i> head or washer   | J5, J5.3.3   |
| $\bar{F}$          | Story shear, in the direction of translation being considered, produced by the lateral forces using <i>LRFD</i> , <i>LSD</i> , or 1.6 times <i>ASD</i> load combinations | C1.2.1.1   |
| $f$                | Stress in compression element computed on basis of effective design width  | 1.1, 1.1.1, 1.1.3, 1.1.4   |
| $f$                | Uniform compressive stress acting on flat element  | 1.4.1, 1.4.1.1, 1.4.1.2, 1.4.2   |
| $f'$               | Stress used in Section 1.3(a) for determining effective width of edge stiffener  | 1.3  |
| $f_{av}$           | Average computed stress in full unreduced flange width   | L3   |
| $f_{bending}$      | Bending stress at location in cross section where combined bending and torsion stress is maximum   | H4   |
| $f_{bending\_max}$ | Bending stress at extreme fiber, taken on same side of neutral axis as $f_{bending}$   | H4   |

## SYMBOLS

| Symbol               | Definition   | Section  |
|----------------------|--|--|
| $f_c$                | Compressive <i>stress</i> in cover plate or sheet based on <i>ASD</i> , <i>LRFD</i> or <i>LSD</i> load combinations  | I1.3   |
| $f'_c$               | Specified compressive strength of concrete   | J7.2.2   |
| $f_d$                | Computed compressive <i>stress</i> in element being considered. Calculations are based on effective section at load for which deflections are determined.  | 1.1, 1.1.1, 1.1.4, 1.3   |
| $f_d$                | Uniform compressive <i>stress</i> acting on flat element. Calculations are based on effective section at load for which deflections are determined.  | 1.4.1, 1.4.1.1, 1.4.1.2, 1.4.2   |
| $f_{d1}, f_{d2}$     | Computed <i>stresses</i> $f_1$ and $f_2$ as shown in Figure 1.1.2-1. Calculations are based on effective section at load for which serviceability is determined.                                       | 1.1.2  |
| $f_{d1}, f_{d2}$     | Computed <i>stresses</i> $f_1$ and $f_2$ in unstiffened element, as defined in Figures 1.2.2-1 to 1.2.2-3. Calculations are based on effective section at load for which serviceability is determined. | 1.2.2  |
| $f_{\text{torsion}}$ | Torsional warping <i>stress</i> at location in cross-section where combined bending and torsion stress effect is maximum   | H4   |
| $f_v$                | Required <i>shear stress</i> on a bolt   | J3.4   |
| $f_1, f_2$           | <i>Web stresses</i> defined by Figure 1.1.2-1  | 1.1.2, 1.1.3   |
| $f_1, f_2$           | <i>Stresses</i> at the opposite ends of the <i>web</i>   | 2.3.3.3  |
| $f_1, f_2$           | <i>Stresses</i> on unstiffened element defined by Figures 1.2.2-1 to 1.2.2-3   | 1.2.2  |
| G                    | Shear modulus of steel, 11,300 ksi (78,000 MPa or 795,000 kg/cm <sup>2</sup> )   | E2.2, F2.1.1, F2.1.4, 2.3.1.1, 2.3.1.3, 2.3.2.1.2, 2.3.2.1.4, 2.3.4.1.1, 2.3.4.1.3 |
| g                    | Vertical distance between two rows of <i>connections</i> nearest to top and bottom <i>flanges</i>  | I1.1   |
| g                    | Transverse center-to-center spacing between fastener gage lines  | J6.2   |
| H                    | Height of story  | C1.2.1.1   |
| HRC <sub>p</sub>     | Rockwell C hardness of <i>PAF</i> steel  | J5, J5.2.1   |
| h                    | Depth of flat portion of <i>web</i> measured along plane of <i>web</i> (disregard intermediate stiffeners)   | B4.1, 2.3.5  |
| h                    | Flat depth of <i>web</i>   | F2.4.1, G2.1, G2.3, G3, G4, G5, G6, H3, 1.1.3                                      |
| h                    | Centerline dimension of depth  | 2.3.1.3  |
| h                    | Width of elements adjoining stiffened element  | 1.4.1  |
| h                    | Height of lip  | J2.6   |
| h <sub>ET</sub>      | Embedment depth of <i>PAF</i> in concrete  | J7.2.2   |

## SYMBOLS

| Symbol                 | Definition  | Section   |
|------------------------|---|---|
| $h_o$                  | Out-to-out depth of <i>web</i>  | 1.1.2, 2.3.1.3, 2.3.3.3                               |
| $h_o$                  | Overall depth of unstiffened C-section member as defined in Figure 1.2.2-3  | 1.2.2   |
| $h_{st}$               | Nominal seam height   | J2.4.1  |
| $h_{wc}$               | Coped flat <i>web</i> depth   | J6.1  |
| $h_{xf}$               | x distance from centroid of <i>flange</i> to <i>flange/web</i> junction   | 2.3.1.3, 2.3.3.3                                      |
| $h_{yf}$               | y distance from centroid of <i>flange</i> to shear center of <i>flange</i>  | 2.3.1.3   |
| $I_a$                  | Adequate moment of inertia of stiffener, so that each component element will behave as a stiffened element  | 1.3   |
| $I_{avg}$              | Weighted average moment inertia about axis of <i>buckling</i>   | 2.3.2.1.1   |
| $I_E$                  | Earthquake importance factor of the structure, as defined in NBCC   | A3.2.1.1  |
| $I_{eff}$              | Effective moment of inertia   | L1  |
| $I_g$                  | Gross moment of inertia   | L2  |
| $I_g$                  | Moment of inertia of gross cross-section about axis of <i>buckling</i>  | 2.3.2.1.1   |
| $I_{net}$              | Moment of inertia of net cross-section about axis of <i>buckling</i>  | 2.3.2.1.1   |
| $I_s$                  | Unreduced moment of inertia of stiffener about its own centroidal axis parallel to element to be stiffened  | 1.3   |
| $I_s$                  | Actual moment of inertia of a pair of attached transverse <i>web</i> stiffeners, or of a single transverse <i>web</i> stiffener, with reference to an axis in the plane of the <i>web</i> | G4.1  |
| $I_{smin}$             | Minimum moment of inertia of shear stiffener(s) with respect to an axis in plane of <i>web</i>  | G4.1  |
| $I_{sp}$               | Moment of inertia of stiffener about centerline of flat portion of element  | 1.4.1, 1.4.1.1, 1.4.1.2                               |
| $I_x, I_y$             | Moment of inertia of full unreduced section about x- and y-axis, respectively   | C2.2.1, F2.1.4, I6.4.1, 2.3.1.1                       |
| $I_{x,avg}, I_{y,avg}$ | Weighted average of moment of inertia about x- and y-axis, respectively   | 2.3.2.1.1, 2.3.2.1.2, 2.3.2.1.4, 2.3.4.1.1, 2.3.4.1.3 |
| $I_{xf}$               | x-axis moment of inertia of the <i>flange</i>   | 2.3.1.3, 2.3.3.3                                      |
| $I_{xy}$               | Product of inertia of full unreduced section about centroidal axes parallel and perpendicular to the <i>purlin web</i>  | C2.2.1, I6.4.1  |
| $I_{xyf}$              | Product of inertia of <i>flange</i> about major and minor centroidal axes   | 2.3.1.3, 2.3.3.3                                      |

## SYMBOLS

| Symbol        | Definition   | Section  |
|---------------|--|--|
| $I_{yc}$      | Moment of inertia of compression portion of section about centroidal axis of entire section parallel to <i>web</i> , using full unreduced section  | F2.1.1, F2.1.3   |
| $I_{yf}$      | y-axis moment of inertia of <i>flange</i>  | 2.3.1.3, 2.3.3.3   |
| $i$           | Index of stiffener   | 1.4.1, 1.4.1.2   |
| $i$           | Index of each <i>purlin</i> line   | I6.4.1   |
| $i$           | Index of tests   | K2.1.1   |
| $J$           | Saint-Venant torsion constant  | E2.2, F2.1.1, F2.1.4, 2.3.1.1  |
| $J_{avg}$     | Weighted average of Saint-Venant Torsion constant  | 2.3.2.1.1, 2.3.2.1.2, 2.3.2.1.4, 2.3.4.1.1, 2.3.4.1.3                                      |
| $J_f$         | Saint-Venant torsion constant of compression <i>flange</i> , plus edge stiffener about an x-y axis located at the centroid of the <i>flange</i>  | 2.3.1.3  |
| $J_g$         | Moment of inertia of gross cross-section about axis of <i>buckling</i>   | 2.3.2.1.1  |
| $J_{net}$     | Moment of inertia of net cross-section about axis of <i>buckling</i>   | 2.3.2.1.1  |
| $j$           | Index for each anchorage device  | I6.4.1   |
| $K$           | <i>Effective length factor</i>   | A1.3, E2.1, 2.3.2.1.1  |
| $K'$          | Constant   | C2.2.1   |
| $K_a$         | Lateral stiffness of anchorage device  | I6.4.1   |
| $K_{eff,i,j}$ | Effective lateral stiffness of $j$ th anchorage device with respect to $i$ th <i>purlin</i>  | I6.4.1   |
| $K_{req}$     | Required stiffness   | I6.4.1   |
| $K_{sys}$     | Lateral stiffness of roof system, neglecting anchorage devices   | I6.4.1   |
| $K_t$         | <i>Effective length factor</i> for twisting  | E2.2, F2.1.1, 2.3.1.1, 2.3.2.1.4, 2.3.4.1.1  |
| $K_{total,i}$ | Effective lateral stiffness of all elements resisting force $P_i$  | I6.4.1   |
| $K_x$         | <i>Effective length factor</i> for <i>buckling</i> about x-axis  | C1.1.2, C1.2.1.1, C1.3.2, E2.2, F2.1.2, 2.3.1.1, 2.3.2.1.4                                 |
| $K_y$         | <i>Effective length factor</i> for <i>buckling</i> about y-axis  | C1.1.2, C1.2.1.1, C1.3.2, F2.1.1, F2.1.3, F2.1.4, 2.3.1.1, 2.3.2.1.4, 2.3.4.1.1, 2.3.4.1.3 |
| $KL$          | <i>Effective length</i>  | E2.1.1   |
| $(KL/r)_o$    | Overall slenderness ratio of entire section about built-up member axis   | I1.2   |
| $K_1$         | <i>Effective length factor</i> for flexural <i>buckling</i> in the plane of bending, $K_y$ or $K_x$ , as applicable, calculated based on the assumption of no lateral translation at member ends | C1.2.1.1   |

## SYMBOLS

| Symbol                | Definition   | Section   |
|-----------------------|--|---|
| $k$                   | Plate <i>buckling</i> coefficient  | 1.1, 1.1.2, 1.1.4, 1.2.2, 1.3, 1.4.1, 1.4.2, 2.3.1.2, 2.3.3.2 |
| $k_{af}$              | Reduction factor   | I6.2.4  |
| $k_d$                 | Plate <i>buckling</i> coefficient for <i>distortional buckling</i>   | 1.4.1, 1.4.1.1, 1.4.1.2                                       |
| $k_f$                 | Flexural <i>stiffness</i> in the plane of bending as modified in Section C1.2.1.3  | C1.2.1.1  |
| $k_{loc}$             | Plate <i>buckling</i> coefficient for local sub-element <i>buckling</i>  | 1.4.1, 1.4.1.1, 1.4.1.2                                       |
| $k_v$                 | <i>Shear buckling</i> coefficient  | G2.1, G2.3, G4.1, 2.3.5                                       |
| $k_\phi$              | Rotational <i>stiffness</i>  | 2.3.1.3, 2.3.3.3  |
| $k_{\phi fe}$         | Elastic rotational <i>stiffness</i> provided by <i>flange</i> to <i>flange/web</i> juncture  | 2.3.1.3, 2.3.3.3, 2.3.5                                       |
| $\tilde{k}_{\phi fg}$ | Geometric rotational <i>stiffness</i> demanded by <i>flange</i> from <i>flange/web</i> juncture                                    | 2.3.1.3, 2.3.3.3  |
| $k_{\phi we}$         | Elastic rotational <i>stiffness</i> provided by <i>web</i> to <i>flange/web</i> juncture   | 2.3.1.3, 2.3.3.3  |
| $\tilde{k}_{\phi wg}$ | Geometric rotational <i>stiffness</i> demanded by the <i>web</i> from the <i>flange/web</i> juncture                               | 2.3.1.3, 2.3.3.3  |
| $L$                   | Full span for simple beams, or distance between inflection point for continuous beams, or twice member length for cantilever beams | B4.3  |
| $L$                   | Span length  | I1.1, I6.4.1  |
| $L$                   | Length of weld   | J2.1, J2.6  |
| $L$                   | Length of longitudinal weld or length of <i>connection</i>   | J6.2  |
| $L$                   | Length of seam weld not including circular ends  | J2.3.2.1  |
| $L$                   | Length of fillet weld  | J2.5  |
| $L$                   | <i>Unbraced length</i> of member   | C1.2.1.1, E2.1, 2.3.2.1.1, 2.3.2.1.1                          |
| $L$                   | Minimum of $L_{crd}$ and $L_m$   | 2.3.1.3, 2.3.3.3, 2.3.5                                       |
| $L_b$                 | Distance between braces on individual concentrically loaded compression member to be braced  | C2.3  |
| $L_{br}$              | Unsupported length between brace points or other restraints which restrict <i>distortional buckling</i> of element                 | 1.4.1, 1.4.1.1, 1.4.1.2                                       |
| $L_{crd}$             | Critical unbraced length of <i>distortional buckling</i>   | 2.3.1.3, 2.3.2.3, 2.3.3.3, 2.3.4.3, 2.3.5                     |
| $L_g$                 | Segment length without holes   | 2.3.2.1.1   |
| $L_h$                 | Length of hole   | G3, G6, 1.1.1, 1.1.3, 2.3.2.3, 2.3.4.3                        |
| $L_m$                 | Distance between discrete restraints that restrict <i>distortional buckling</i>  | 2.3.1.3, 2.3.3.3  |

## SYMBOLS

| Symbol           | Definition   | Section                                  |
|------------------|--|--|
| $L_m$            | Distance between discrete restraints that restrict <i>shear buckling</i>   | 2.3.5                                    |
| $L_{net}$        | Length of holes or net section regions   | 2.3.2.1.1                                |
| $L_o$            | Overhang length measured from the edge of bearing to the end of member   | G5                                       |
| $L_{st}$         | Length of bearing stiffener  | F5.1                                     |
| $L_t$            | <i>Unbraced length</i> of compression member for twisting  | E2.2, F2.1.1, 2.3.1.1, 2.3.4.1.1         |
| $L_u$            | Limit of unbraced length below which <i>lateral-torsional buckling</i> is not considered   | F2.1.4                                   |
| $L_w$            | Length of <i>top arc seam sidelap weld</i>   | J2.4.1                                   |
| $L_x$            | <i>Unbraced length</i> of compression member for bending about x-axis  | E2.2, 2.3.1.1, 2.3.2.1.4                 |
| $L_x$            | <i>Unbraced length</i> of member for bending about x-axis  | F2.1.2                                   |
| $L_y$            | <i>Unbraced length</i> of compression member for bending about y-axis  | 2.3.1.1, 2.3.2.1.4, 2.3.4.1.1, 2.3.4.1.3 |
| $L_y$            | <i>Unbraced length</i> of member for bending about y-axis  | F2.1.1                                   |
| $L_0$            | Length at which <i>local buckling stress</i> equals <i>flexural buckling stress</i>  | E2.1.1                                   |
| $l$              | Distance from concentrated load to a brace   | C2.2.1                                   |
| $M$              | Bending moment   | L1, L2                                   |
| $M_a$            | <i>Available flexural strength [factored resistance]</i> when bending alone is considered, determined in accordance with Section F3  | H2                                       |
| $M_{a/o}$        | <i>Available flexural strength [factored resistance]</i> for globally braced member, determined in accordance (1) and (2) in Section H2  | H2                                       |
| $M_{a/o}$        | <i>Available flexural strength [factored resistance]</i> for globally braced member, determined in accordance with Section F3 with $F_n = F_y$ or $M_{ne} = M_y$                       | H3                                       |
| $M_{a/o}$        | <i>Available flexural strength [factored resistance]</i> for globally braced member, determined in accordance with Section H2  | H2                                       |
| $M_{a/o}$        | <i>Available flexural strength [factored resistance]</i> about centroidal x-axis in absence of axial load, determined in accordance with Section F3 with $F_n = F_y$ or $M_{ne} = M_y$ | H3                                       |
| $M_{ax}, M_{ay}$ | <i>Available flexural strengths [resistances]</i> about centroidal axes, determined in accordance with Chapter F   | H1.1, H1.2                               |

## SYMBOLS

| Symbol                   | Definition  | Section  |
|--------------------------|---|--|
| $M_{axt}, M_{ayt}$       | Available flexural strengths [resistances] about centroidal axes  | H1.1   |
| $M_{cr}$                 | $M_{cre}$ – global (lateral-torsional), $M_{cr\ell}$ – local, or $M_{crd}$ – <i>distortional</i> elastic buckling moment about the axis of bending              | 2.1  |
| $M_{crd}$                | <i>Distortional</i> buckling moment   | F4.1, F4.2, F4.3, I6.1.2.3, 2.1, 2.3.3.3   |
| $M_{cre}$                | Global buckling moment  | 2.1, 2.3.4.1   |
| $M_{cre}$                | Lateral-torsional buckling moment   | I6.1.2.1, 2.3.4.1.1  |
| $M_{cr\ell}$             | Critical elastic local buckling moment  | F3.2.1, F3.2.3, I6.1.2.2, 2.1, 2.3.3.2   |
| $M_d$                    | Nominal flexural strength [resistance], $M_{n\ell}$ , defined in Chapter F with <i>Direct Strength Method</i> , but with $M_y$ replaced by $M$ in all equations | L2   |
| $M_{d2}$                 | Nominal flexural strength [resistance] of <i>distortional</i> buckling at $\lambda_2$   | F4.2   |
| $M_m$                    | Mean value of material factor   | I6.3.1, K2.1.1   |
| $M_{max}, M_A, M_B, M_C$ | Absolute value of moments in unbraced segment, used for determining $C_b$   | F2.1.1   |
| $M_n$                    | Nominal flexural strength [resistance]  | F1, I6.1.2, I6.1.3, I6.2.1, I6.2.2   |
| $M_{nd}$                 | Nominal flexural strength [resistance] for <i>distortional</i> buckling   | F4, F4.1, F4.2, F4.3, I6.1.2, I6.1.2.3   |
| $M_{ne}$                 | Nominal flexural strength [resistance] for yielding and global (lateral-torsional) buckling   | F2, F2.1, F2.3, F2.4, F2.4.1, F2.4.2, F3.2.1, F3.2.3, H2, H3, H4, I6.1.2, I6.1.2.1, I6.2.1, I6.2.2 |
| $M_{n\ell}$              | Nominal flexural strength [resistance] for local buckling   | F3, F3.1, F3.2.1, F3.2.2, F3.2.3, I6.1.2, I6.1.2.2   |
| $M_{n\ell o}$            | Nominal flexural strength [resistance] for local buckling only, as determined from Section F3 with $F_n = F_y$ or $M_{ne} = M_y$                                | H3, I6.2.1, I6.2.2   |
| $M_p$                    | Member plastic moment   | F2.4.2, F3.2.3, F4.3,  |
| $M_y$                    | Member yield moment ( $= S_{fy} F_y$ )  | F2.1, F2.4.2, F3.2.3, F4.1, F4.2, F4.3, H2, H3, H4, I6.2.1, I6.2.2                                 |
| $M_{yc}$                 | Moment at which yielding initiates in compression (after yielding in tension)   | F3.2.3, F4.3   |
| $M_{ynet}$               | Member yield moment of net cross-section  | F4.2   |
| $M_{yt3}$                | Yield moment at maximum tensile strain  | F3.2.3, F4.3   |
| $M_1, M_2$               | Smaller and larger end moments in an unbraced segment, respectively   | F2.1.2, 2.3.3.3  |

## SYMBOLS

| Symbol                 | Definition  | Section                 |
|------------------------|---|-------------------------|
| $\bar{M}$              | Required second-order flexural strength [moment due to factored loads] using LRFD, LSD, or 1.6 times ASD load combinations, as applicable   | C1.1.1.1, C1.2.1.1      |
| $\bar{M}$              | Required flexural strengths [moments due to factored loads] in accordance with ASD, LRFD, or LSD load combinations  | H2                      |
| $\bar{M}$              | Required flexural strength [moment due to factored loads] at, or immediately adjacent to, the point of application of the concentrated load or reaction $\bar{P}$ determined in accordance with ASD, LRFD, or LSD load combinations | H3                      |
| $\bar{M}_{lt}$         | Moment from first-order elastic analysis using LRFD, LSD, or ASD load combinations, as applicable, due to lateral translation of the structure only   | C1.2.1.1                |
| $\bar{M}_{nt}$         | Moment from first-order elastic analysis using LRFD, LSD, or ASD load combinations, as applicable, with the structure restrained against lateral translation  | C1.2.1.1                |
| $\bar{M}_x, \bar{M}_y$ | Required flexural strengths [moments due to factored loads] with respect to centroidal axes in accordance with ASD, LRFD, or LSD load combinations  | E3.1, H1.1, H1.2        |
| $\bar{M}_z$            | Torsional moment of force about shear center  | C2.2.1                  |
| m                      | Degrees of freedom  | K2.1.1                  |
| m                      | Term for determining tensile yield point of corners   | A3.3.2                  |
| m                      | Distance from shear center to mid-plane of web of C-section   | C2.2.1, I1.1, I6.4.1    |
| $m_f$                  | Modification factor for type of bearing connection  | J3.3.1                  |
| N                      | Bearing length  | G5, G6, H3              |
| N                      | Number of stress range fluctuations in design life  | M3                      |
| $N_a$                  | Number of anchorage devices along a line of anchorage   | I6.4.1                  |
| $N_i$                  | Notional load applied at level i  | C1.1.1.2                |
| $N_p$                  | Number of purlin lines on roof slope  | I6.4.1                  |
| n                      | Coefficient   | 1.3                     |
| n                      | Number of stiffeners on critical cross-section  | J6.1                    |
| n                      | Number of stiffeners in element   | 1.4.1, 1.4.1.1, 1.4.1.2 |
| n                      | Number of equally spaced intermediate brace locations   | C2.3                    |
| n                      | Number of anchors in test assembly with same tributary area (for anchor failure), or number of panels with identical spans and loading to failed span (for non-anchor failure)  | I6.3.1                  |

## SYMBOLS

| Symbol               | Definition   | Section                        |
|----------------------|--|--------------------------------|
| n                    | Number of fasteners on critical cross-section  | J6.1                           |
| n                    | Number of threads per inch   | M4                             |
| n                    | Total number of tests  | K2.1.1                         |
| n <sub>b</sub>       | Number of fasteners along failure path being analyzed  | J6.1, J6.2                     |
| n <sub>f</sub>       | Number of intermediate stiffeners in stiffened compression element   | B4.1                           |
| n <sub>fe</sub>      | Number of intermediate stiffeners in edge stiffener  | B4.1                           |
| n <sub>w</sub>       | Number of intermediate stiffeners in stiffened element under stress gradient (e.g. <i>web</i> )  | B4.1                           |
| P                    | Professional factor  | B4.2                           |
| P <sub>a</sub>       | Available axial strength [factored resistance], determined in accordance with Chapter E  | H1.2                           |
| P <sub>a</sub>       | Available strength [factored resistance] for concentrated load or reaction in absence of bending moment, determined in accordance with Section G5 and G6, as applicable    | H3                             |
| P <sub>at</sub>      | Available tensile strength [resistance] of arc spot weld   | J2.2.3, J2.2.4                 |
| P <sub>av</sub>      | Available shear strength [resistance] of arc spot weld   | J2.2.2.1, J2.2.2.2, J2.2.4     |
| P <sub>av</sub>      | Available shear strength [resistance] of arc seam weld   | J2.3.2.1, J2.3.2.2             |
| P <sub>av</sub>      | Available shear strength [resistance] of a flare groove weld   | J2.6                           |
| P <sub>av</sub>      | Available resistance weld shear strength [resistance]  | J2.7                           |
| P <sub>cr</sub>      | P <sub>cre</sub> – global (flexural, torsional, or flexural-torsional), P <sub>crℓ</sub> – local, or P <sub>crd</sub> – distortional elastic buckling force in compression | 2.1                            |
| P <sub>crd</sub>     | Distortional buckling force (load)   | E4.1, I6.1.1.3, 2.1, 2.3.1.3   |
| P <sub>cre</sub>     | Global buckling force  | I6.1.1.1, 2.3.1.1, 2.3.2.1     |
| P <sub>crℓ</sub>     | Local buckling force (load)  | E3.2.2, I6.1.1.2, 2.1, 2.3.1.2 |
| P <sub>d2</sub>      | Nominal axial strength [resistance] of distortional buckling at λ <sub>d2</sub>  | E4.2                           |
| P <sub>e1</sub>      | Elastic critical buckling strength of the member in the plane of bending, calculated based on the assumption of no lateral translation at member ends                      | C1.2.1.1                       |
| P <sub>e,story</sub> | Elastic critical buckling strength for the story in the direction of translation being considered, determined by sidesway buckling analysis or taken as Eq. C1.2.1.1-7     | C1.2.1.1                       |
| P <sub>i</sub>       | Lateral force introduced into system at <i>i</i> th purlin   | I6.4.1                         |

## SYMBOLS

| Symbol      | Definition  | Section  |
|-------------|---|--|
| $P_{Lj}$    | Lateral force to be resisted by the $j$ th anchorage device   | I6.4.1   |
| $P_m$       | Mean value of tested-to-predicted load ratios   | B4.2   |
| $P_m$       | Mean value of professional factor   | K2.1.1   |
| $P_{mf}$    | Total vertical <i>load</i> in columns in the story that are part of moment frames, if any, in the direction of translation being considered                         | C1.2.1.1   |
| $P_n$       | <i>Nominal web crippling strength [resistance]</i>  | G5   |
| $P_n$       | <i>Nominal strength [resistance] for concentrated load or reaction in absence of bending moment, determined in accordance with Section G5 and G6, as applicable</i> | H3   |
| $P_n$       | <i>Nominal axial strength [resistance] of member</i>  | E1, I6.1.1, I6.2.4   |
| $P_n$       | <i>Nominal axial strength [resistance] of bearing stiffener</i>   | F5.1, F5.2   |
| $P_n$       | <i>Nominal strength [resistance] of groove weld</i>   | J2.1   |
| $P_n$       | <i>Nominal fillet weld strength [resistance]</i>  | J2.5   |
| $P_n$       | <i>Nominal flare groove weld strength [resistance]</i>  | J2.5   |
| $P_n$       | <i>Nominal bolt strength [resistance]</i>   | J3.4   |
| $P_{nb}$    | <i>Nominal bearing strength [resistance]</i>  | J3.3.1, J3.3.2   |
| $P_{nb}$    | <i>Nominal bearing and tilting strength [resistance] per PAF</i>  | J5, J5.3.2   |
| $P_{nc}$    | <i>Nominal web crippling strength [resistance] of C- or Z-section with overhang(s)</i>  | G5   |
| $P_{nd}$    | <i>Nominal axial strength for distortional buckling</i>   | E4, E4.1, E4.2, I6.1.1, I6.1.1.3                             |
| $P_{ne}$    | <i>Nominal axial strength [resistance] for overall buckling</i>   | E2, E2.2, E3.1, E3.2.1, H1.2, I6.1.1, I6.1.1.1               |
| $P_{n\ell}$ | <i>Nominal axial strength [resistance] for local buckling</i>   | E2.2, E3, E3.1, E3.2, E3.2.1, E3.2.2, H1.2, I6.1.1, I6.1.1.2 |
| $P_{nos}$   | <i>Nominal pull-out strength [resistance] in shear per PAF</i>  | J5, J7.2.2   |
| $P_{not}$   | <i>Nominal pull-out strength [resistance] of sheet per screw</i>  | J4, J4.4.1, J4.5.2   |
| $P_{not}$   | <i>Nominal pull-out strength [resistance] in tension per PAF</i>  | J5, J5.2.2   |
| $P_{nov}$   | <i>Nominal pull-over strength [resistance] of sheet per screw</i>   | J4, J4.4.2, J4.5.1   |
| $P_{nov}$   | <i>Nominal pull-over strength [resistance] per PAF</i>  | J5, J5.2.3   |
| $P_{nr}$    | <i>Nominal block shear rupture strength [resistance]</i>  | J6.3   |
| $P_{nt}$    | <i>Nominal tensile rupture strength [resistance]</i>  | J6.2   |
| $P_{ntp}$   | <i>Nominal tensile strength [resistance] of PAF</i>   | J5, J5.2.1   |

## SYMBOLS

| Symbol             | Definition   | Section                    |
|--------------------|--|----------------------------|
| $P_{nts}$          | Nominal tension strength [resistance] of screw as reported by manufacturer or determined by independent laboratory testing   | J4, J4.4.3, J4.5.3         |
| $P_{nv}$           | Nominal shear strength [resistance] of arc spot weld   | J2.2.2.1, J2.2.2.2         |
| $P_{nv}$           | Nominal shear strength [resistance] of arc seam weld   | J2.3.2.1, J2.3.2.2         |
| $P_{nv}$           | Nominal shear strength [resistance] of top arc seam sidelap weld   | J2.4.1                     |
| $P_{nv}$           | Nominal shear strength [resistance] of a flare groove weld   | J2.6                       |
| $P_{nv}$           | Nominal resistance weld shear strength [resistance]  | J2.7                       |
| $P_{nv}$           | Nominal shear strength [resistance] of sheet per screw   | J4, J4.3.1, J4.5.1, J4.5.2 |
| $P_{nv}$           | Nominal shear strength [resistance] per PAF  | J5                         |
| $P_{nv}$           | Nominal shear rupture strength [resistance]  | J6.1                       |
| $P_{nv}$           | Nominal shear strength [resistance] of PAF   | J5, J5.3.1                 |
| $P_{nvs}$          | Nominal shear strength [resistance] of screw as reported by manufacturer or determined by independent laboratory testing   | J4, J4.3.2, J4.5.3         |
| $P_{nv1}, P_{nv2}$ | Nominal shear strength [resistance] corresponding to connected thicknesses $t_1$ and $t_2$   | J2.5                       |
| $P_s$              | Concentrated load or reaction based on critical load combinations for ASD, LRFD, and LSD   | I1.1                       |
| $P_{wc}$           | Nominal web crippling strength [resistance] for C-section flexural member  | F5.2                       |
| $P_y$              | Member axial yield strength  | C1.1.1.3, E4.1, E4.2       |
| $P_{ynet}$         | Member yield strength on net cross-section   | E3.2.2, E4.2               |
| $\bar{P}$          | Design concentrated load [factored load] within a distance of 0.3a on each side of a brace, plus 1.4(1-l/a) times each required concentrated load located farther than 0.3a but not farther than 1.0a from the brace. The design concentrated load [factored load] is the applied load, determined in accordance with the most critical ASD, LRFD, or LSD load combinations, depending on the design method used | C2.2.1                     |
| $\bar{P}$          | Required compressive axial strength [compressive axial force due to factored loads], determined as required in Section C1, in accordance with ASD, LRFD, or LSD load combinations  | H1.2                       |
| $\bar{P}$          | Required second-order axial strength [compressive force due to factored loads] using LRFD, LSD, or ASD load combinations, as applicable  | C1.1.1.3, C1.2.1.1         |

## SYMBOLS

| Symbol                       | Definition  | Section        |
|------------------------------|---|----------------|
| $\bar{P}$                    | Required strength [force due to factored loads] for concentrated load or reaction in presence of bending moment determined in accordance with ASD, LRFD or LSD load combinations  | H3             |
| $\bar{P}_{lt}$               | Axial force from first-order elastic analysis using LRFD, LSD, or ASD load combinations, as applicable, due to lateral translation of the structure only  | C1.2.1.1       |
| $\bar{P}_{L1}, \bar{P}_{L2}$ | Lateral bracing forces  | C2.2.1         |
| $\bar{P}_{nt}$               | Axial force from first-order elastic analysis using LRFD, LSD, or ASD load combinations, as applicable, with the structure restrained against lateral translation   | C1.2.1.1       |
| $\bar{P}_{ra}$               | Required compressive axial strength [compressive axial force due to factored loads] of individual concentrically loaded compression member to be braced, which is calculated in accordance with ASD, LRFD, or LSD load combinations depending on the design method used | C2.3           |
| $\bar{P}_{rb}$               | Required brace strength [brace force due to factored loads] to brace a single compression member with an axial load $\bar{P}_{ra}$  | C2.3           |
| $\bar{P}_{story}$            | Total vertical load supported by the story using LRFD, LSD, or ASD load combinations, as applicable, including loads in columns that are not part of the lateral force-resisting system   | C1.2.1.1       |
| $\bar{P}_x, \bar{P}_y$       | Components of design load [factored load] $\bar{P}$ parallel to the x- and y-axis, respectively   | C2.2.1         |
| p                            | Pitch (mm per thread for SI units and cm per thread for MKS units)  | M4             |
| $Q_i$                        | Load effect   | K2.1.1         |
| q                            | Design load [factored load] on beam for determining longitudinal spacing of connections   | I1.1           |
| $q_s$                        | Reduction factor  | G3             |
| R                            | Required allowable strength for ASD   | B3.2.1         |
| R                            | Modification factor for distortional plate buckling coefficient   | 1.4.1          |
| R                            | Reduction factor  | E3.1.1.1       |
| R                            | Reduction factor  | H4, I6.1.3     |
| R                            | Reduction factor  | I6.2.1         |
| R                            | Reduction factor determined in accordance with AISI S908  | I6.2.2, I6.2.4 |

## SYMBOLS

| Symbol      | Definition  | Section   |
|-------------|---|---|
| R           | Coefficient   | E3.1.1.1  |
| R           | Inside bend radius  | B4.1, G5, H3  |
| R           | Radius of outside bend surface  | J2.6  |
| $R_a$       | <i>Available strength [factored resistance]</i>   | B3.2  |
| $R_a$       | <i>Allowable design strength</i>  | B3.2.1, K2.1.2  |
| $R_a$       | <i>Design strength</i>  | B3.2.2  |
| $R_a$       | <i>Factored resistance</i>  | B3.2.3  |
| $R_b$       | Reduction factor  | A3.1.3  |
| $R_c$       | Reduction factor  | G6  |
| $R_f$       | Effect of <i>factored loads</i>   | B3.2.3  |
| $R_I$       | $I_s/I_a$   | 1.3   |
| $R_n$       | <i>Nominal strength [resistance]</i>  | A1.3, B3.2.1, B3.2.2, B3.2.3                          |
| $R_n$       | <i>Nominal rupture strength [resistance]</i>  | J6  |
| $R_n$       | Average value of all test results   | K2.1.1, K2.1.2  |
| $R_{n,i}$   | Calculated <i>nominal strength [resistance]</i> of test i per <i>rational engineering analysis</i> model                                | K2.1.1  |
| $R_r$       | Reduction factor  | E2.1.1  |
| $R_t$       | <i>Tested strength [resistance]</i>   | K2.1.1  |
| $R_{t,i}$   | <i>Tested strength [resistance]</i> of test i   | K2.1.1  |
| $R_u$       | <i>Required strength</i> for LRFD   | B3.2.2  |
| $R_1, R_2$  | Radius of outside bend surface  | J2.6  |
| $\bar{R}$   | <i>Required strength [effect due to factored loads]</i>   | B3.2  |
| r           | Correction factor   | I6.2.1,   |
| r           | Radius of gyration of full unreduced cross-section about axis of <i>buckling</i>  | E2.1, E2.1.1  |
| $r_i$       | Minimum radius of gyration of <i>full unreduced cross-sectional area</i> of an individual shape in a built-up member                    | I1.2  |
| $r_o$       | Polar radius of gyration of cross-section about shear center  | E2.2, F2.1.1, 2.3.1.1                                 |
| $r_{o,avg}$ | Weighted average of polar radius of gyration about shear center   | 2.3.2.1.1, 2.3.2.1.2, 2.3.2.1.4, 2.3.4.1.1, 2.3.4.1.2 |
| $r_{o,g}$   | Polar radius gyration about shear center of gross cross-section   | 2.3.2.1.1   |
| $r_{o,net}$ | Polar radius gyration about shear center of net cross-section   | 2.3.2.1.1   |
| $r_x, r_y$  | Radius of gyration of cross-section about centroidal principal axes   | E2.2, F2.1.1, 2.3.1.1                                 |
| S           | $1.28\sqrt{E/f}$  | 1.3   |
| $S_a(T)$    | 5 percent damped spectral response acceleration, expressed as a ratio to gravitational acceleration, for a period T, as defined in NBCC | A3.2.1.1  |

## SYMBOLS

| Symbol     | Definition   | Section   |
|------------|--|---|
| $S_e$      | Effective section modulus calculated relative to extreme compression or tension fiber at $F_y$   | F2.4.1  |
| $S_e$      | Effective section modulus calculated at extreme fiber compressive <i>stress</i> of $F_n$   | F3.1, F3.1.1, F3.1.2, 1.2.2   |
| $S_{et}$   | Effective section modulus calculated at extreme fiber tension <i>stress</i> of $F_y$   | F3.1  |
| $S_f$      | Elastic section modulus of full unreduced section relative to extreme compression fiber  | F2.1, F2.1.1, F2.1.3, F2.1.4, F2.3, F2.4.2, F4.1, 2.1, 2.3.3.2, 2.3.4.1, 2.3.4.1.1, 2.3.4.1.2, 2.3.4.1.3, 2.3.4.2 |
| $S_{fnet}$ | Net section modulus referenced to the extreme fiber in first yield   | 2.3.4.2   |
| $S_{ft}$   | Section modulus of full unreduced section relative to extreme tension fiber about appropriate axis   | H1.1  |
| $S_{fy}$   | Elastic section modulus of full unreduced cross-section relative to extreme fiber in first yielding  | F2.1, F4.1  |
| $s$        | Center-to-center hole spacing  | 1.1.1   |
| $s$        | Center-to-center spacing of connectors in line of compression <i>stress</i>  | 1.1.4   |
| $s$        | Spacing in line of <i>stress</i> of welds, rivets, or bolts connecting a compression cover plate or sheet to a non-integral stiffener or other element | I1.3  |
| $s$        | Sheet width divided by number of bolt holes in cross-section being analyzed  | J6.2  |
| $s$        | Longitudinal <i>connection</i> spacing   | I1.1  |
| $s'$       | Longitudinal center-to-center spacing of any consecutive holes   | J6.2  |
| $s_c$      | Standard deviation of $R_{t,i}$ divided by $R_{n,i}$ for all of the test results   | K2.1.1  |
| $s_{end}$  | Clear distance from the hole at ends of member   | 1.1.1   |
| $s_{max}$  | Maximum permissible longitudinal spacing of welds or other connectors joining two C-sections to form an I-section                                      | I1.1  |
| $s_t$      | Standard deviation of all of the test results  | K2.1.1  |
| $T_a$      | <i>Available tensile axial strength [factored resistance]</i> determined in accordance with Chapter D  | H1.1  |
| $T_n$      | <i>Nominal tensile strength [resistance]</i>   | D1, D2, D3  |
| $T_r$      | <i>Required strength [force due to factored loads]</i> for connection in tension   | I1.1  |
| $T_s$      | <i>Available strength [factored resistance]</i> of connection in tension (Chapter J)   | I1.1  |

## SYMBOLS

| Symbol    | Definition  | Section  |
|-----------|---|--|
| $\bar{T}$ | Required tensile axial strength [tensile force due to factored loads] in accordance with ASD, LRFD, or LSD load combinations                              | H1.1   |
| $\bar{T}$ | Required tension strength [tensile force due to factored loads] per connection fastener determined in accordance with ASD, LRFD, or LSD load combinations | J2.2.4, J4.5.1, J4.5.2, J4.5.3   |
| t         | Base steel thickness of any element or section  | A3.1.3, B4.1, E3.1.1.1, F2.3, F2.4.1, F3.1.1, F5.1, G2.1, G2.3, G3, G4.1, G5, G6, I1.3, I6.2.3, I6.2.4, I6.4.1, J2.2.2.2, J2.2.3, J2.2.4, J2.3.2.2, J2.4.1, J3.3.1, J3.3.2, J6.1, J6.2, L3, 1.1, 1.1.1, 1.1.3, 1.1.4, 1.2.2, 1.3, 1.4.1, 1.4.1.1, 1.4.1.2, 2.3.1.2, 2.3.1.3, 2.3.2.3, 2.3.3.2, 2.3.3.3, 2.3.4.3, 2.3.5 |
| t         | Total combined base steel thickness (exclusive of coatings) of sheets involved in shear transfer above plane of maximum shear transfer                    | J2.2.2.1, J2.3.2.1   |
| t         | Lesser value of $t_1$ and $t_2$   | J2.5   |
| t         | Thickness of thinnest outside sheet   | J2.7   |
| t         | Thickness of coped web  | J6.1   |
| t         | Thickness of welded member as illustrated in Figures J2.6-1 to J2.6-3   | J2.6   |
| $t_c$     | Lesser of depth of penetration and $t_2$  | J4, J4.4.1, J4.5.2   |
| $t_e$     | Effective throat dimension of groove weld   | J2.1   |
| $t_i$     | Thickness of uncompressed glass fiber blanket insulation  | I6.2.1   |
| $t_r$     | Modified thickness  | 2.3.2.3, 2.3.4.3   |
| $t_s$     | Thickness of stiffener steel  | F5.1   |
| $t_w$     | Effective throat of weld  | J2.5, J2.6   |
| $t_w$     | Steel washer thickness  | J4.4.2, J5, J5.2   |
| $t_{wf}$  | Effective throat of groove weld that is filled flush to surface, determined in accordance with Table J2.6-1   | J2.6   |
| $t_1$     | Thickness of member in contact with screw head or washer  | J4, J4.3.1, J4.4, J4.4.2, J4.5.1   |
| $t_1$     | Thickness of member in contact with PAF head or washer  | J5, J5.2.3, J5.3.2   |
| $t_2$     | Thickness of member not in contact with screw head  | J5, J5.2.2, J5.3.2, J5.3.3   |

## SYMBOLS

| Symbol                 | Definition  | Section                        |
|------------------------|---|--------------------------------|
| $t_2$                  | Thickness of member not in contact with <i>PAF</i> head or washer   | J4, J4.3.1, J4.5.1, J4.5.2     |
| $t_1, t_2$             | Based thicknesses connected with fillet weld  | J2.5                           |
| $U_{bs}$               | Nonuniform block shear factor   | J6.3                           |
| $U_{s1}$               | Shear lag factor determined in Table J6.2-1   | J6.2                           |
| $V_a$                  | Available shear strength [factored resistance] when shear alone is considered, determined in accordance with Chapter G  | H2                             |
| $V_{cr}$               | Shear buckling force  | G2.1, G2.2, G2.3, 2.1, 2.3.5   |
| $V_F$                  | Coefficient of variation of fabrication factor  | I6.3.1, K2.1.1                 |
| $V_M$                  | Coefficient of variation of material factor   | I6.3.1, K2.1.1                 |
| $V_n$                  | Nominal shear strength [resistance]   | G2, G2.1, G2.2, G4.1           |
| $V_P$                  | Coefficient of variation of tested-to-predicted load ratios   | B4.2, I6.3.1                   |
| $V_P$                  | Coefficient of variation of test results, but not less than 0.065   | K2.1.1                         |
| $V_Q$                  | Coefficient of variation of load effect   | I6.3.1, K2.1.1                 |
| $V_y$                  | Yield shear force of cross-section  | G2.1, G2.2                     |
| $\bar{V}$              | Required shear strength [shear force due to factored loads] per connection fastener, determined in accordance with ASD, LRFD, or LSD load combinations  | J2.2.4, J4.5.1, J4.5.2, J4.5.3 |
| $\bar{V}$              | Required shear strength [shear force due to factored loads] in accordance with ASD, LRFD, or LSD load combinations  | H2                             |
| $W_{pi}$               | Total required vertical load supported by <i>i</i> th purlin in a single bay  | I6.4.1                         |
| $\bar{W}$              | Design load [factored load] (applied load determined in accordance with the most critical ASD, LRFD, or LSD load combinations, depending on the design method used) within a distance of 0.5a on each side of the brace | C2.2.1                         |
| $\bar{W}_x, \bar{W}_y$ | Components of required strength [factored load] $\bar{W}$   | C2.2.1                         |
| $w$                    | Flat width of compression flange  | A3.1.3, B4.3                   |
| $w$                    | Flat width of unstiffened element, where $w/t \leq 60$  | 1.2.2                          |
| $w$                    | Flat width of stiffened compression element (disregard intermediate stiffeners)   | B4.1                           |
| $w$                    | Flat width of element   | F2.4.1, 1.1, 2.3.1.2, 2.3.3.2  |
| $w$                    | Stiffened and unstiffened element of bearing stiffener  | F5.1                           |
| $w$                    | Flat width of element measured between  | 1.1.4                          |

## SYMBOLS

| Symbol      | Definition   | Section               |
|-------------|--|-----------------------|
|             | longitudinal <i>connection</i> lines and exclusive of radii at stiffeners  |                       |
| $w$         | Flat width of narrowest unstiffened compression element tributary to <i>connections</i>  | I1.3                  |
| $w'$        | Equivalent flat width for determining effective width of edge stiffener  | 1.1.4                 |
| $w_f$       | Width of <i>flange</i> projection beyond <i>web</i> for I-beams and similar sections, or half distance between <i>webs</i> for box- or U-type sections   | B4.3, L3              |
| $w_f$       | Face width of weld   | J2.6                  |
| $w_i$       | Required distributed gravity load supported by the $i^{\text{th}}$ <i>purlin</i> per unit length (determined from the critical ASD, LRFD, or LSD load combination depending on the design method used) | I6.4.1                |
| $w_o$       | Out-to-out width   | 1.1.1                 |
| $w_1$       | Transverse spacing between first and second line of fasteners in compression element   | 1.1.4                 |
| $w_1, w_2$  | Leg of weld  | J2.5, J2.6            |
| $x$         | Fastener distance for Z- and C-Sections determined by Eqs. I6.2.3-5 and I6.2.3-6   | I6.2.3                |
| $x$         | Non-dimensional fastener location  | I6.2.3                |
| $x$         | Nearest distance between <i>web</i> hole and edge of bearing   | G6                    |
| $x_o$       | Distance from centroid to shear center in principal x-axis direction   | E2.2, F2.1.1, 2.3.1.1 |
| $x_{o,avg}$ | Weighted average distance from centroid to shear center to in principal x-axis direction   | 2.3.2.1.1, 2.3.2.1.4  |
| $x_{o,g}$   | Distance from gross cross-section centroid to gross cross-section shear center in principal x-axis direction   | 2.3.2.1.1             |
| $x_{o,net}$ | Distance from net cross-section centroid to net cross-section shear center in principal x-axis direction   | 2.3.2.1.1             |
| $x_{of}$    | $x$ distance from centroid of <i>flange</i> to shear center of <i>flange</i>   | 2.3.1.3, 2.3.3.3      |
| $\bar{x}$   | Distance from shear plane to centroid of cross-section   | J6.2                  |
| $Y$         | Yield stress of <i>web</i> steel divided by yield stress of stiffener steel  | G4.1                  |
| $Y_i$       | Gravity load applied at level $i$ from the LRFD, LSD load combinations, or ASD load combinations, as applicable  | C1.1.1.2              |

## SYMBOLS

| Symbol             | Definition   | Section                            |
|--------------------|--|------------------------------------|
| $y_o$              | Distance from centroid to shear center in principal y-axis direction   | 2.3.1.1                            |
| $y_{o,avg}$        | Weighted average distance from centroid to shear center in principal y-axis direction                        | 2.3.2.1.1, 2.3.2.1.4               |
| $y_{o,g}$          | Distance from gross cross-section centroid to gross cross-section shear center in principal y-axis direction | 2.3.2.1.1                          |
| $y_{o,net}$        | Distance from net cross-section centroid to net cross-section shear center in principal y-axis direction     | 2.3.2.1.1                          |
| $y_{of}$           | y distance from centroid of <i>flange</i> to shear center of <i>flange</i>                                   | 2.3.1.3                            |
| $Z_f$              | Plastic section modulus  | F2.4.2                             |
| $\alpha$           | Coefficient for <i>purlin</i> directions   | I6.4.1                             |
| $\alpha$           | Coefficient for conversion of units  | I6.2.3, J3.3.2, M3                 |
| $\alpha$           | Coefficient for strength increase due to overhang  | G5                                 |
| $\alpha$           | Coefficient  | I1.3, C1.1.1.2, C1.1.1.3, C1.2.1.1 |
| $\alpha_b$         | Coefficient  | J5.3.2                             |
| $\alpha_w$         | Coefficient differentiating <i>PAF</i> types   | J5.2.3                             |
| $\beta$            | Coefficient  | E2.2                               |
| $\beta$            | Variable used in Section 1.4.1.1   | 1.4.1.1                            |
| $\beta$            | $1-(x_{o,avg}/r_{o,avg})^2$  | 2.3.2.1.2                          |
| $\beta$            | A value accounting for moment gradient   | 2.3.3.3                            |
| $\beta_o$          | Target reliability index   | I6.3.1                             |
| $\beta_{rb}$       | Minimum required brace stiffness to brace a single compression member  | C2.3                               |
| $\gamma, \gamma_i$ | Coefficients   | 1.4.1.1, 1.4.1.2                   |
| $\gamma_i$         | <i>Load factor</i>   | K2.1.1                             |
| $\delta, \delta_i$ | Coefficients   | 1.4.1.1, 1.4.1.2                   |
| $\varepsilon$      | Coefficient  | 2.3.5                              |
| $\eta$             | Variable   | J2.6                               |
| $\theta$           | Angle between plane of <i>web</i> and plane of bearing surface   | G5                                 |
| $\theta$           | Angle between vertical and plane of <i>purlin web</i>  | I6.4.1                             |
| $\theta$           | Angle between an element and its edge stiffener  | 2.3.1.3                            |

## SYMBOLS

| Symbol                                       | Definition   | Section   |
|--|--|---|
| $\lambda, \lambda_c$                         | Slenderness factors  | E2, F2.4.1, 1.1, 1.1.1, 1.2.2, 1.4.1  |
| $\lambda_\ell$                               | Slenderness factor of <i>local buckling</i> for column or beam   | E3.2.1, F3.2.1, F3.2.3  |
| $\lambda_d$                                  | Slenderness factor of <i>distortional buckling</i> for column or beam  | E4.1, E4.2, F4.1, F4.2, F4.3  |
| $\lambda_{dp}$                               | <i>PAF</i> point length  | J5, J5.2.2, J5.3.2  |
| $\lambda_{d1}, \lambda_{d2}$                 | Slenderness factors of column or beam  | E4.2  |
| $\lambda_t$                                  | Slenderness factor   | 1.1.4   |
| $\lambda_v$                                  | Slenderness factor   | G2.1, G2.2  |
| $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ | Parameters used in determining compression strain factor   | F2.4.1  |
| $\mu$  | Poisson's ratio of steel = 0.30  | 1.1, 1.4.1, 2.3.1.2, 2.3.1.3, 2.3.3.2, 2.3.3.3, 2.3.5   |
| $\xi_{web}$                                  | <i>Stress gradient in web</i>  | 2.3.3.3   |
| $\rho$                                       | Local reduction factor   | 1.1   |
| $\rho$                                       | Reduction factor   | 1.1.4, 1.2.2, 1.4.1   |
| $\rho_m$                                     | Reduction factor   | 1.1.4   |
| $\rho_t$                                     | Reduction factor   | 1.1.4   |
| $\sigma_{ex}$                                | $(\pi^2 E)/(K_x L_x / r_x)^2$ or $(\pi^2 E)/(L/r_x)^2$   | E2.2, F2.1.1, 2.3.1.1   |
| $\sigma_{ex}$                                | Elastic <i>flexural buckling stress</i> based on weighted average moment of inertia about principal x-axis                             | 2.3.2.1.2, 2.3.2.1.4  |
| $\sigma_{ey}$                                | $(\pi^2 E)/(K_y L_y / r_y)^2$ or $(\pi^2 E)/(L/r_y)^2$   | F2.1.1, F2.1.3, 2.3.1.1   |
| $\sigma_{ey}$                                | Elastic <i>flexural buckling stress</i> based on weighted average moment of inertia about principal y-axis                             | 2.3.2.1.4, 2.3.4.1.1  |
| $\sigma_{ey}$                                | Elastic <i>flexural buckling stress</i> based on weighted average moment of inertia about the centroidal y-axis parallel to <i>web</i> | 2.3.4.1.2   |
| $\sigma_t$                                   | <i>Torsional buckling stress</i>   | E2.2, E2.3, F2.1.1, F2.1.3, 2.3.1.1, 2.3.2.1.3  |
| $\sigma_t$                                   | <i>Torsional buckling stress</i> based on weighted average cross-section properties  | 2.3.2.1.2, 2.3.2.1.4, 2.3.4.1.1, 2.3.4.1.2  |
| $\tau_b$                                     | Parameter for reduced stiffness using <i>second-order analysis</i>   | C1.1.1.3  |
| $\phi$                                       | <i>Resistance factor</i>   | A1.2, A1.3, B3.2.2, B3.2.3, B4.1, B4.2, C2.3, G2, I6.2.3, I6.2.4, I6.3.1, I6.4.1, I6.4.2, J2.1, J2.2.2.1, J2.2.2.2, J2.2.3, J2.3.2.1, J2.3.2.2, J2.4.1, |

## SYMBOLS

| Symbol        | Definition   | Section  |
|---------------|--|--|
| $\phi_b$      | Resistance factor for bending strength   | J2.5, J2.6, J2.7, J3.3.1, J3.3.2, J3.4, J4, J4.3.2, J4.4.3, J4.5.1, J4.5.2, J4.5.3, J5, J5.2.1, J5.2.2, J5.2.3, J5.3.1, J5.3.2, J5.3.3, J6, J7.2.2, K2.1.1, K2.1.2<br>F1, F2, F2.3, F3, F4, H1.1, I6.1.2, I6.2.1, I6.2.2   |
| $\phi_c$      | Resistance factor for concentrically loaded compression strength   | E1, E2, E3, E4, F5.1, F5.2, I6.1.1   |
| $\phi_t$      | Resistance factor for tension strength   | D1, D2, D3   |
| $\phi_v$      | Resistance factor for shear strength   | G2   |
| $\phi_w$      | Resistance factor for web crippling strength   | G5   |
| $\phi$        | Coefficient  | 2.3.5  |
| $\omega_i$    | Coefficient  | 1.4.1.2  |
| $\psi$        | $ f_2/f_1 $  | F2.4.1, 1.1.2, 1.2.2   |
| $\Delta_F$    | Inter-story drift from <i>first-order elastic analysis</i> in the direction of translation being considered, due to story shear, $\bar{F}$ , computed using the <i>stiffness</i> as required by Section C1.2.1.3 | C1.2.1.1   |
| $\Delta_{tf}$ | Lateral displacement of <i>purlin top flange</i> at the line of restraint  | I6.4.1   |
| $\Omega$      | Safety factor  | A1.2, A1.3, B3.2.1, B4.1, B4.2, C2.3, G2, I6.2.3, I6.2.4, I6.3.1, I6.4.1, I6.4.2, J2.1, J2.2.2.1, J2.2.2.2, J2.2.3, J2.3.2.1, J2.3.2.2, J2.4.1, J2.5, J2.6, J2.7, J3.3.1, J3.3.2, J3.4, J4, J4.3.2, J4.4.3, J4.5.1, J4.5.2, J4.5.3, J5, J5.2.1, J5.2.2, J5.2.3, J5.3.1, J5.3.2, J5.3.3, J6, J7.2.2, K2.1.2<br>F1, F2, F2.3, F3, F4, H1.1, I6.1.2, I6.2.1, I6.2.2 |
| $\Omega_b$    | Safety factor for bending strength   | F1, F2, F2.3, F3, F4, H1.1, I6.1.2, I6.2.1, I6.2.2   |
| $\Omega_c$    | Safety factor for concentrically loaded compression strength   | A3.2.1, E1, E2, E3, E4, F5.1, F5.2, I6.1.1   |
| $\Omega_t$    | Safety factor for tension strength   | D1, D2, D3   |
| $\Omega_v$    | Safety factor for shear strength   | G2   |
| $\Omega_w$    | Safety factor for web crippling strength   | G5   |

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**COLD-FORMED STEEL STRUCTURAL MEMBERS**

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## NORTH AMERICAN SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS

### A. GENERAL PROVISIONS

This chapter addresses the scope and applicability of the *Specification*, lists the definitions of the terminology used, summarizes referenced specifications, codes, and standards, and provides requirements for materials.

This chapter is organized as follows:

A1 Scope, Applicability, and Definitions

A2 Referenced Specifications, Codes, and Standards

A3 Material

#### A1 Scope, Applicability, and Definitions

##### A1.1 Scope

This *Specification* applies to the design of *structural members* cold-formed to shape from carbon or low-alloy steel sheet, strip, plate, or bar not more than 1 in. (25.4 mm) in *thickness* and used for *load-carrying* purposes in

- (a) Buildings, and
- (b) Structures other than buildings provided allowances are made for dynamic effects.

##### A1.2 Applicability

This *Specification* includes Symbols, Chapters A through M, Appendices A and B, and Appendices 1 and 2 that shall apply as follows:

- Chapters A through M, Appendices 1 and 2—the United States, Mexico, and Canada,
- Appendix A—the United States and Mexico, and
- Appendix B—Canada.

The symbol  $\Rightarrow^x$  is used to point out that additional provisions that are specific to a certain country are provided in the corresponding appendices indicated by the letter(s) “x.”

This *Specification* includes design provisions for *Allowable Strength Design (ASD)*, *Load and Resistance Factor Design (LRFD)*, and *Limit States Design (LSD)*. These design methods shall apply as follows:

- *ASD* and *LRFD*—the United States and Mexico, and
- *LSD*—Canada.

In this *Specification*, bracketed terms are equivalent terms that apply particularly to *LSD*.

The *nominal strength* [*resistance*] and stiffness of cold-formed steel components such as elements, members, assemblies, *connections*, and details shall be determined in accordance with the provisions in Chapters B through M, Appendices A and B, and Appendices 1 and 2 of the *Specification*.

Where the composition or configuration of the components is such that calculation of *available strength* [*factored resistance*] or stiffness cannot be made in accordance with these provisions (excluding those in Chapter K), structural performance shall be established from

one of the following:

- (a) *Available strength [factored resistance]* or stiffness by tests only. Specifically, the *available strength [factored resistance]* is determined from tested *nominal strength [resistance]* by applying the *safety factors* or the *resistance factors* evaluated in accordance with Section K2.1.1(a);
- (b) *Available strength [factored resistance]* by *rational engineering analysis* with *confirmatory* tests. Specifically, the *available strength [factored resistance]* is determined from the calculated *nominal strength [resistance]* by applying the *safety factors* or *resistance factors* evaluated in accordance with Section K2.1.1(b);
- (c) *Available strength [factored resistance]* or stiffness by *rational engineering analysis* based on appropriate theory and engineering judgment. Specifically, the *available strength [factored resistance]* is determined from the calculated *nominal strength [resistance]* by applying the following *safety factors* or *resistance factors*:

For members

$$\Omega = 2.00 \text{ (ASD)}$$

$$\phi = 0.80 \text{ (LRFD)}$$

$$= 0.75 \text{ (LSD)}$$

For connections

$$\Omega = 3.00 \text{ (ASD)}$$

$$\phi = 0.55 \text{ (LRFD)}$$

$$= 0.50 \text{ (LSD)}$$

When *rational engineering analysis* is used in accordance with Section A1.2(b) or A1.2(c) to determine the *nominal strength [resistance]* for a *limit state* already provided in this *Specification*, the *safety factor* shall not be less than the applicable *safety factor* ( $\Omega$ ), nor shall the *resistance factor* exceed the applicable *resistance factor* ( $\phi$ ) for the prescribed *limit state*.

### A1.3 Definitions

In this *Specification*, “shall” is used to express a mandatory requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the *Specification*; and “is permitted” is used to express an option or that which is permissible within the limits of the *Specification*. In standards developed by the CSA Group, “is permitted” is expressed by “may.”

The following terms are italicized when they appear in the *Specification*. Definitions listed under the *ASD* and *LRFD* Terms sections shall apply to the USA and Mexico, while definitions listed under the *LSD* Terms section shall apply in Canada.

Terms designated with \* are usually qualified by the type of *load* effect; for example, *nominal tensile strength*, *available compressive strength*.

Terms designated with + are common AISC-AISI terms that are coordinated between the two standards developers.

### General Terms

*Applicable Building Code*<sup>+</sup>. Building code under which the structure is designed.

*Bearing*<sup>+</sup>. In a *connection*, *limit state* of shear forces transmitted by the mechanical fastener to the *connection* elements.

*Bearing (Local Compressive Yielding)*<sup>+</sup>. *Limit state* of local compressive *yielding* due to the action