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SUMMARY OF MAJOR CHANGES AND IMPROVEMENTS IN THE 2001 NORTH AMERICAN SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS

The 2001 edition of the *North American Specification for the Design of Cold-Formed Steel Structural Members* will soon be issued in Canada, Mexico and the United States. This first edition of the North American Specification was developed on the basis of the 1996 AISI Specification with the 1999 Supplement, the 1994 Canadian Standards Association (CSA) Standard S136, and subsequent developments. It includes a main document applicable to all three countries with Appendix A for US, Appendix B for Canada and Appendix C for Mexico. A hand point symbol with appendix letters A, B and C is used in the main document to point out that additional provisions are provided in the corresponding applications.

Three design methods (ASD, LRFD, and LSD) were included in this new North American Specification. ASD and LRFD methods are used only in the US and Mexico, and LSD is used only in Canada. The equivalent terms for LSD were included in the brackets for the convenience of LSD users. The factors of safety and resistance factors were listed in the corresponding design provisions.

This Technical Bulletin presents a brief summary of major changes made in the North American Specification as compared with the 1996 AISI Specification with the 1999 Supplement. All section numbers shown below are those used in the North American Specification. The reasoning behind and the justification for the revisions and additions are discussed in the Commentary on the North American Specification.

A. General Provisions

A1.1 Scope and Limits of Applicability

This Section was completely revised except for the first paragraph. It specifies that the Allowable Strength Design (ASD) and Load and Resistance Factor Design (LRFD) methods are used in the United States and Mexico, while the Limit Sates Design (LSD) method is used in Canada according to Chapters A through G, and Appendices A through C for a specific country. For those special cases where the design strength and/or stiffness cannot be so determined, it can be established either by tests or by rational engineering analysis on the basis of the given factor of safety and resistance factor.

A1.2 Terms

This Section was revised to include General Terms, ASD and LRFD Terms (USA and Mexico), and LSD Terms (Canada).

A1.3 Units of Symbols and Terms

This Section was revised to use U.S. customary units, SI units, and MKS units.

(Section A2, Non-Conforming Shapes and Construction, of the 1996 AISI Specification was deleted in the North American Specification.)

A2.1 Applicable Steels

The Section number was changed from A3.1 to A2.1. The ASTM A1008 and A1011 Standards in the North American Specification replaced the ASTM A570, A607, A611, and A715 Standards in the 1996 AISI Specification and the 1999 Supplement. ASTM A1003 Standard was added to the list of Section A2.1.

A2.2 Other Steels

The Section number was changed from A3.2 to A2.2. Editorial changes were made in the text for section numbers. This section was moved to Appendix A for use in the United States.

A2.3 Ductility

The Section number was changed from A3.3 to A2.3. Editorial revisions were made for the use of the LSD method and the MKS unit. The ASTM Standards were updated according to the revisions of Section A2.1.

A2.4 Delivered Minimum Thickness

The Section number was changed from A3.4 to A2.4.

A3 Loads

The Section number was changed from A4 to A3. The design requirements for loads and load combinations are presented in Section A3 of Appendix A for use in the United States. The definitions of symbols were deleted. Section A4.2 of the 1996 AISI Specification for ponding was deleted.

A4 Allowable Strength Design

The Section number was changed from A5 to A4 with a title change from "Allowable Stress Design" to "Allowable Strength Design."

A4.1 Design Basis

The Section number was changed from A5.1 to A4.1. The term "Allowable Stress Design" was changed to "Allowable Strength Design." Other editorial revisions were also made in this Section.

A4.1.1 ASD Requirements

The Section number was changed from A5.1.1 to A4.1.1 with a title change from "ASD Strength Requirements" to "ASD Requirements."

A4.1.2 Load Combinations for ASD

This Section was completely rewritten by deferring loads and load combinations to applicable building codes and ASCE 7. It replaces the design requirements previously covered in Sections A5.1.2, A5.1.3 and A5.1.4 of the 1996 AISI Specification. This newly revised Section A4.1.2 is included in Appendix A for use in the United States.

A5 Load and Resistance Factor Design
The Section number was changed from A6 to A5.

A5.1 Design Basis
The Section number was changed from A6.1 to A5.1. Editorial revisions were also made in this section.

A5.1.1 LRFD Requirements
The Section number was changed from A6.1.1 to A5.1.1 with a title change from "LRFD Strength Requirements" to "LRFD Requirements."

A5.1.2 Load Factors and Load Combinations for LRFD
This Section was completely rewritten by deferring loads and load combinations to applicable codes and ASCE 7. It replaces the design requirements previously covered in Sections A6.1.2 and A6.1.3 of the 1996 AISI Specification. It is included in Appendix A for use in the United States.

A9 Referenced Documents
The first paragraph was revised with a reference to Appendix A for documents applicable to the United States. ASCE 7, AISC ASD Specification, AISC LRFD Specification, AWS D1.3-98, AWS C1.1-66, and AWS C1.3-70 Standards were moved to Section A9a of Appendix A. ASME B46.1-85 was added. All ASTM standards were updated. ASTM A1008 and A1011 Standards replaced the ASTM A570, A607, A611, and A715 Standards. ASTM A1003 Standard was added to the list.

B. ELEMENTS

B1.1(a) Maximum Flat-Width-to-Thickness Ratios
In Item (1), definitions of I_s and I_a were added.

B1.1(b) Flange Curling
The footnote for flange curling was changed to a note in the text.

B2 Effective Widths of Stiffened Elements
In this Section, the term "Load Capacity Determination" was changed to "Strength Determination," and the term "Deflection Determination" was changed to "Serviceability Determination."

B2.1 Uniformly Compressed Stiffened Elements
Equation E2.1-4 for computing the slenderness factor λ was changed with an addition of Equation E2.1-5 for F_{cr}. Minor editorial revision was made for the definition of "*f*."

B2.3 Webs and other Stiffened Elements under Stress Gradient
A list of symbols and definitions were added to the first paragraph of this Section. The design requirements were revised to adopt a two-part approach for the effective width of webs based on the ratio of overall web width to overall flange width. The stress ratio ψ is defined as an

absolute value and some signs for ψ were changed in several related equations.

B2.4 C-Section Webs with Holes under Stress Gradient
Condition "$d_o/h < 0.7$" was revised to "$d_o/h \leq 0.7$."

B3 Effective Widths of Unstiffened Elements
In this Section, the term "Load Capacity Determination" was changed to "Strength Determination, " and the term "Deflection Determination" was changed to "Serviceability Determination."

B4 Effective Widths of Elements with One Intermediate Stiffener or an Edge Stiffener
In this Section, the term "Deflection Determination" was changed to "Serviceability Determination."

B4.1 Uniformly Compressed Elements with One Intermediate Stiffener
The design requirements for the case of $b_o/t > S$ were changed to eliminate the discontinuity. A new equation (Eq. B4.1-4) for determining "n" was added.

B4.2 Uniformly Compressed Elements with an Edge Stiffener
The limiting *w/t* was changed from S/3 to 0.328S. Design equations were changed for the case of $w/t > 0.328S$ by adopting an equation for "n," which eliminated a discontinuity that existed in the previous design expressions.

B5 Effective Widths of Stiffened Elements with Multiple Intermediate Stiffeners or Edge Stiffened Elements with Intermediate Stiffeners
This Section was completely revised to reflect recent research findings for flexural members with intermediate stiffeners in the compression flange. It includes two new subsections to cover sub-element local buckling and distortional buckling. Section B5.1 deals with the effective widths of uniformly compressed stiffened elements with multiple intermediate stiffeners, while Section B5.2 deals with edge stiffened elements with intermediate stiffeners.

(Section B6 – Stiffeners of the 1996 AISI Specification was changed to Section C3.6 of the North American Specification. See Chapter C on Members)

C. MEMBERS

C2 Tension Members
This Section was moved to Appendix A for use in the United States.

C3.1 Bending
The title of this Section was simplified. In the first paragraph, reference is made to Appendix A for use in the United States. The footnote for torsional effects was added as the second paragraph of this Section.

C3.1.1 Nominal Section Strength [Resistance]
In Subsection (b) for Procedure II, Condition (4) was revised to read "The shear force does

not exceed 0.35 F_y times the web area, *ht*, for ASD, and 0.60 F_y *ht* for LRFD."

C3.2.1 Lateral-Torsional Buckling Strength [Resistance] of Open Cross Section Members

The footnote for the applicability of design provisions was added as the first paragraph of this Section.

In Subsection (a), C_b and C_{TF} are not required to be unity (1.0) for members subject to combined axial load and bending moment in the North American Specification.

In Subsection (b), Eq. C3.1.2.1-14 is now permitted for doubly-symmetric I-sections and singly-symmetric C-sections. The unbraced length "L" in Eqs. C3.1, 2.1-14 and C3.1.2-15 was clarified as "L_y."

C3.1.2.2 Lateral-Torsional Buckling Strength [Resistance]of Closed Box Members

The unbraced length "L" in Eq.C3.1.2.2-2 was clarified as "L_y."

C3.1.4 Beams Having One Flange Fastened to a Standing Seam Roof System

This Section was moved to Appendix A for use in the United States.

C3.1.5 Strength [Resistance] of Standing Seam Roof Panel Systems

In the last line of this Section, the resistance factor was revised from "0.5" to "0.8" for the number of physical test assemblies less than 3.

C3.2 Shear

The title of this Section was simplified.

C3.2.1 Shear Strength [Resistance] of Webs without Holes

The format for the nominal shear strength was revised to be $V_n = A_w F_v$. Equations are given for F_v governed by shear yielding, inelastic shear buckling and elastic shear buckling. The factor of safety for ASD was revised to 1.60 and the resistance factor for LRFD was changed to 0.95 for all cases.

C3.2.2 Shear Strength [Resistance] of C-Section Webs with Holes

Condition "$d_o/h < 0.7$" was revised to "$d_o/h \leq 0.7$"

C3.3.1 ASD Method

For beams with unreinforced webs, the design provisions were revised to specify that the required allowable flexural strength, *M*, and the required allowable shear strength, *V*, shall not exceed M_n/Ω_b and V_n/Ω_v, respectively.

C3.3.2 LRFD and LSD Methods

For beams with unreinforced webs, the design provisions were revised to specify that the required flexural strength [factored moment], M_u, and the required shear strength [factored shear], V_u, shall not exceed $\phi_b M_n$ and $\phi_v V_n$, respectively.

C3.4 Web Crippling

The title of this Section was simplified. This Section was completely revised to use a unified web crippling strength equation with variable coefficients on the basis of the type of cross

section and the fastened condition at support. The web crippling coefficients, factors of safety for ASD, and resistance factors for LRFD are presented in five separate tables for built-up sections, single web channel and C-sections, single web Z-sections, single hat sections, and multi-web deck sections, either fastened or unfastened to support.

C3.5.1 ASD Method

In Subsection (c), the interaction equation for the support point of two nested Z-sections was modified according to the new web crippling equation. In addition, it is specified that the moment, M, and the concentrated load or reaction, P, shall not exceed M_{no}/Ω_b and P_n/Ω_w, respectively.

C3.5.2 LRFD and LSD Methods

In subsection (c), the interaction equation for two nested Z-shapes was modified according to the new web crippling equation. In addition, it is specified that the moment, M_u, and the concentrated load or reaction, P_u, shall not exceed $\phi_b M_{no}$ and $\phi_w P_n$, respectively, for the LRFD method.

C3.6 Stiffeners

This Section was previously included in Chapter B of the 1996 AISI Specification as Section B6. It was moved to Section C3.6 for the design of flexural members.

C3.6.3 Non-Conforming Stiffeners

This Section was revised to permit the use of rational engineering analysis with some minor changes on section numbers.

C4.1 Sections Not Subject to Torsional or Torsional-Flexural Buckling

The footnote for the effective length factor was moved to the text as a new note.

C4.2 Doubly or Singly-Symmetric Sections Subject to Torsional or Torsional-Flexural Buckling

A new paragraph was added at the end of this Section for singly-symmetric unstiffened angle sections, for which the effective area (A_e) at stress F_y is equal to the full unreduced cross-sectional area (A).

C4.3 Point-Symmetric Sections

This is a new Section for the design of point-symmetric sections.

C4.4 Nonsymmetric Sections

This Section was renumbered from “C4.3” in the 1996 AISI Specification to “C4.4” in the North American Specification.

C4.5 Built-Up Members

This is a new Section for built-up members. It replaces Section D1.1(a) of the 1996 AISI Specification.

C4.6 Compression Members Having One Flange Through-Fastened to Deck or Sheathing

This Section was renumbered from "Section C4.4" of the 1996 AISI Specification to "Section C4.6" of the North American Specification. Minor revisions were made in conditions (5), (6), and (8). The footnote for Condition (8) in the 1996 AISI Specification was added to the text as a new Note.

C5.2.1 ASD Method

In the first paragraph, an additional requirement was added to specify that each individual ratio in Eqs. C5.2.1-1 and C5.2.1-3 shall not exceed unity.

For the definition of M_y, the design requirements for singly-symmetric unstiffened angle sections were revised in the North American Specification.

C5.2.2 LRFD and LSD Methods

In the first paragraph, an additional requirement was added to specify that each individual ratio in Eqs. C5.2.2-1 and C5.2.2-3 shall not exceed unity.

For the definition of M_{uy}, the design requirements for singly-symmetric unstiffened angle sections were revised in the North American Specification.

C6 Closed Cylindrical Tubular Members

The term "Cylindrical Tubular Members" was changed to "Closed Cylindrical Tubular Members" in the title and the text.

C6.1 Bending

Definitions of "D" and "t" were added.

C6.2 Compression

Equation C6.2-5 for determining A_e was simplified with the revision of Eq. C6.2-6 for determining "R." Definitions of "D" and "t" were added.

D. Structural Assemblies

D1.1 I-Sections Composed of Two C-Sections

In Subsection (a), new requirements for built-up compression members composed of two C-sections are given in Section C4.5.

In Subsection (b), the equations for determining "m" (Eqs. D1.1-3 and D1.1-4 of the 1996 AISI Specification) and the definitions of w_f, d, D, and I_x were moved to the Commentary.

D3.2 C-Section and Z-Section Beams

The footnote in the 1996 AISI Specification was added to the text as a new Note.

D3.2.2 Neither Flange Connected to Sheathing

The equation for determining K' for Z-sections (Eq. D3.2.2-2) was revised from "$K' = I_{xy}/I_x$" to "$K' = I_{xy}/2I_x$." The direction of the applied brace force for Z-sections is also specified in the new requirement.

Other editorial changes were also made in the text.

D4 Wall Studs and Wall Stud Assemblies

Minor editorial changes were made in the text. The limits for yield strength, section depth, section thickness, overall length, and stud spacing previously included in Subsection (b) were moved to Section D4.1.

D4.1 Compression

The title of this Section as simplified. Limits for using the equations provided in Conditions (a), (b), and (c) of this Section were added from Section D4. Editorial revisions were made for several symbols not previously defined in this Section.

D4.2 Bending

The title of this Section was simplified. The definitions of M_{nxo} *and* M_{nyo} were revised to directly refer to Section C3.1.1.

E. Connections and Joints

E2 Welded Connections

This Section was revised by moving some of the design provisions to Section E2a of Appendix A for use in the United States.

E2.1 Groove Welds in Butt Joints

For the ASD method, the factors of safety for tension, compression, and shear were reduced.

E2.2 Arc Spot Welds

All figures in the Specification use numbers at the end instead of letters

E2.2.1 Shear

Some factors of safety for ASD and resistance factors for LRFD were revised for Subsections (a) and (b).

The definition of "d_a" for multiple sheets not more than four lapped sheets over a supporting member was changed from *(d - 2t)* to *(d - t)*.

For the ASD method, the factors of safety for Eq. E2.2.1-6a were revised.

Minor editorial revisions were also made.

E2.2.2 Tension

In the North American Specification, Eq. E2.2.2-2 was modified to replace Eqs. E2.2.2-2 and E2.2.2–3 of the 1996 AISI Specification. Different factors of safety and resistance factor are used for applications other than panels and decks. A new limitation for the value of $t d_a F_u$ was added.

E2.3 Arc Seam Welds

For the ASD method, the factor of safety was increased slightly. The definition of "d_a" was revised for a double sheet in the North American Specification. All figures in the Specification use numbers at the end instead of letters.

E2.4 Fillet Welds

Several factors of safety and resistance factors were revised. This Section was revised to require a weld strength check when the plate thickness is greater than 0.10 in. i.e., the thickness limit of "$t > 0.15$ in." was changed to "$t > 0.10$ in." All figures in the Specification use numbers at the end instead of letters.

E2.5 Flare Groove Welds

Several factors of safety and one resistance factor were revised. All figures in the Specification use numbers at the end instead of letters. Thickness limit for weld strength check was revised to "$t > 0.10$ in."

E2.6 Resistance Welds

For the ASD method, the factor of safety was increased slightly. Equations E2.6-5 and E2.6-6 for the MKS unit were added.

E2.7 Fracture in Net Section of Members Other Than Flat Sheets (Shear Lag)

The title of this Section was changed from "Shear Lag Effect in Welded Connections of Members Other Than Flat Sheets."

E3 Bolted Connections

The design provisions for the thickness of the thinnest connected part exceeding 3/16 in., the maximum size of holes and other requirements were moved to Section E3a of Appendix A for use in the United States.

E3.1 Shear, Spacing and Edge Distance

This Section was moved to Appendix A for use in the United States. Minor editorial revisions were made for spacing and edge distance.

E3.2 Fracture in Net Section (Shear Lag)

This Section was moved to Appendix A for use in the United States. The title of this Section was changed from "Shear Lag Effect in Bolted Connections."

In Subsection (1), the design provisions were revised to use the reduction equation of F_t only for a single bolt or a single row of bolts perpendicular to the force. For multiple bolts in the line parallel to the force, $F_t = F_u$. The definition of "r" was deleted and the definition of "s" was revised.

In Subsection (2), the design provisions were simplified.

E3.3 Bearing

This Section was revised by including two subsections: E3.3.1 – Strength without Consideration of Bolt Hole Deformation and E3.3.2 – Strength with Consideration of Bolt Hole Deformation. In Section E3.3.1, the design format and tables for determining the bearing strength were revised on the basis of the bearing factor, modification factor, and the ratio of bolt diameter to member thickness, d/t. The factor of safety and resistance factor were also revised accordingly. A variable α was introduced in Eq. E3.3.2-1 to accommodate different units used.

E3.4 Shear and Tension in Bolts

This Section was moved to Appendix A for use in the United States.

E4 Screw Connections

Editorial revisions were made in this Section. Definitions of new terms were added for d_w, P_{ss}, P_{tx} *and* t_c.

E4.2 Minimum Edge and End Distances

The minimum distance from the center of a fastener to the edge of any part was revised from 3*d* to 1.5*d*. The nominal shear strength per screw is specified for the end distance parallel to the force.

E4.3.1 Connection Shear Limited by Tilting and Bearing

The title of this Section was revised from "Connection Shear."

E4.3.2 Connection Shear Limited by End Distance

This Section was completely revised. It was moved to Appendix A for use in the United States.

E4.4 Tension

The sentence "Ω and ϕ shall be determined according to Section F1" was deleted.

E4.4.1 Pull-Out

The definition of t_c was deleted.

E4.4.2 Pull-Over

Editorial revision was made for the definition of d_w.

E4.4.3 Tension in Screws

This Section was revised by adding a new equation for calculating the nominal tensile strength for screws.

E5 Rupture

The entire section including Subsections E5.1, E5.2, and E5.3 were moved to Appendix A for use in the United States.

F1.1 Load and Resistance Factor Design and Limit States Design

Editorial revisions were made in the first paragraph with the update of several section numbers in the text.

The footnote in the 1996 AISI Specification was added to the text as a Note.

F3.1 Full Section

Item (d) of this Section was revised to require one full section test be made from each master coil for acceptance and control purposes.

F3.3 Virgin Steel

Minor editorial revisions were made in this Section.

F. Design of Cold-Formed Steel Structural Members and Connections for Cyclic Loading (Fatigue)

This is a new chapter for fatigue design. It was developed on the basis of the available research data on cold-formed steel members and the AISC provisions.

Appendix A: Provisions Applicable to the United States

This is a new Appendix. It contains Sections A1.1a, A2.2, A3.1, A4.1.2, A5.1.2, C2, C3.1.4, E2a, E3a, E3.1, E3.2, E3.4, E4.3.2, and E5, which are applicable only to the United States.