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S157-17/S157.1-17

Strength design in aluminum/ Commentary on CSA S157-17, *Strength design in aluminum*

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Contents

Technical Committee on Strength Design in Aluminum *12*

Preface *14*

S157-17, *Strength design in aluminum*

1 Scope *17*
1.1 Applicability *17*
1.2 Other standards *17*
1.3 Rational design *17*
1.4 Terminology *17*
1.5 Units of measure *17*

2 Reference publications *18*

3 Definitions and symbols *22*
3.1 Definitions *22*
3.2 Symbols *25*

4 Structural documents *33*
4.1 General *33*
4.2 Structural design documents *33*
4.2.1 Required information *33*
4.2.2 Additional information *34*
4.2.3 Revisions *34*
4.2.4 Additional documents *34*
4.3 Fabrication and erection documents *34*
4.3.1 Connection design details *34*
4.3.2 Shop details *34*
4.3.3 Erection diagrams *35*
4.3.4 Erection procedures *35*
4.3.5 Fieldwork details *35*

5 Materials — Standards and identification *35*
5.1 Standards *35*
5.1.1 General *35*
5.1.2 Wrought products *36*
5.1.3 Fasteners *43*
5.1.4 Filler metal for welding *43*
5.2 Properties *43*
5.2.1 Physical properties *43*
5.2.2 Nominal strengths *43*
5.3 Identification *45*
5.3.1 Methods *45*
5.3.2 Affidavit *45*

6 Design requirements/Limit states design *45*

6.1 Limit states *45*
6.1.1 Serviceability limit states *45*
6.1.2 Ultimate limit states *45*
6.1.3 Fatigue *46*
6.2 Loads, load factors, and load combinations for buildings *46*
6.2.1 Loads *46*
6.2.2 Load factors *46*
6.2.3 Load combinations *46*
6.3 Loads, load factors, and load combinations for applications other than buildings *46*
6.4 Resistance factors *46*

7 Strength of elements/Gross and net areas, effective section, and effective strength *46*
7.1 General *46*
7.2 Gross area *47*
7.3 Effective section *47*
7.3.1 General *47*
7.3.2 Effective thickness at welds *47*
7.3.3 Effective thickness after local buckling of flat elements *48*
7.3.4 Deflection under service loads *48*
7.4 Effective strength and overall buckling *48*
7.4.1 General *48*
7.4.2 Influence of welding *48*
7.4.3 Influence of local buckling *49*
7.5 Local buckling of flat elements *49*
7.5.1 Buckling stress *49*
7.5.2 Elements supported on both longitudinal edges *50*
7.5.3 Elements supported at one longitudinal edge only *51*
7.5.4 Elements supported at one edge with a lip at the other edge *52*
7.6 Panels/Flat panels with multiple stiffeners *54*
7.6.1 Axial compression *54*
7.6.2 In-plane shear *54*
7.7 Curved panels and tubes *55*
7.7.1 Axial compression *55*
7.7.2 Radial compression *56*
7.7.3 Shear *56*
7.8 Curved axially stiffened panels in axial compression *57*

8 Analysis of structures/Methods of analysis and design *57*

9 Design of members for tension *58*
9.1 Cross-sectional areas *58*
9.1.1 Gross area *58*
9.1.2 Effective net area *58*
9.2 Members in tension *59*
9.2.1 Shear lag effect *59*
9.2.2 Tensile strength *60*
9.2.3 Oblique welds *60*

10 Design of members for compression *61*

10.1 General provisions *61*
10.1.1 Factored compressive strength and limiting stress *61*
10.1.2 Normalized slenderness *62*
10.1.3 Buckling stress *62*
10.1.4 Influence of longitudinal welds *63*
10.2 Member buckling *63*
10.2.1 Flexural buckling *63*
10.2.2 Torsional buckling *64*
10.2.3 Torsional-flexural buckling *66*
10.3 Built-up compression members *66*

11 Design of members for flexure *66*
11.1 Classification of members in bending *66*
11.2 Moment resistance of members not subject to lateral-torsional buckling (LTB) *66*
11.3 Flexural strength of members subject to lateral-torsional buckling *67*
11.3.1 Members without lateral restraint *67*
11.3.2 Members with lateral restraint of the tension flange only *69*

12 Design of members for shear *70*
12.1 Flat webs of flexural members with two flanges *70*
12.1.1 General *70*
12.1.2 Flat webs without stiffeners *70*
12.1.3 Flat webs with stiffeners *70*
12.1.4 Limiting shear strength at the boundaries *71*
12.1.5 Combined shear and bending in webs *72*
12.2 Web stiffeners *72*
12.2.1 Stiffener locations *72*
12.2.2 Transverse stiffeners *72*
12.2.3 Longitudinal stiffeners *72*
12.3 Web crippling *73*
12.4 Flat webs of flexural members supported on one flange *74*
12.5 Shear strength for round and oval tubes and pipes *74*
12.6 Shear strength for rods *75*
12.7 Other shapes *75*

13 Members in torsion *76*
13.1 General *76*
13.2 Hollow sections *76*
13.2.1 Torsional resistance *76*
13.2.2 Combined axial compression, flexure, and torsion *76*
13.3 Solid sections *76*
13.3.1 Torsional resistance for circular rods *76*
13.3.2 Torsional resistance for solid compact bars *77*
13.4 Open sections *77*
13.4.1 Torsional resistance for sections without warping resistance *77*
13.4.2 Torsional resistance for sections with warping resistance *77*
13.4.3 Combined bending and torsion *77*

14 Design of members subject to flexure and axial force *77*

15 Design and detailing of welded connections *78*
15.1 General *78*
15.1.1 Reference standard *78*
15.1.2 Sharing of loads *78*
15.1.3 Materials *78*
15.2 Groove welds *78*
15.2.1 Tension *78*
15.2.2 Compression *78*
15.2.3 Shear *79*
15.3 Flare groove welds *79*
15.4 Fillet welds *79*
15.4.1 Concentrically loaded fillet welds *79*
15.4.2 Eccentrically loaded fillet welds *80*
15.5 Slot and plug welds *82*
15.6 Stud welds *82*
15.7 Influence of welds, heat-affected zone *83*
15.7.1 General *83*
15.7.2 Severity of softening *83*
15.7.3 Extent of HAZ *83*

16 Design and detailing of mechanically fastened connections *84*
16.1 General *84*
16.1.1 Connection types *84*
16.1.2 Sharing of loads *84*
16.1.3 Materials *84*
16.1.4 Nominal dimensions *84*
16.1.5 Bearing action *84*
16.1.6 Slip-critical joints *84*
16.1.7 Joint symmetry *85*
16.2 Detailing *85*
16.2.1 Minimum fastener spacing *85*
16.2.2 Maximum fastener spacing *85*
16.2.3 Bolted connections *86*
16.3 Bolts and rivets in shear and/or tension *87*
16.3.1 Shear strength *87*
16.3.2 Tensile strength *88*
16.3.3 Combined shear and tension *88*
16.4 Bolts and rivets in bearing *88*
16.4.1 Bearing strength *88*
16.4.2 Lap joints *89*
16.4.3 Oblique end edges *89*
16.5 Block shear rupture *89*
16.5.1 General *89*
16.5.2 Tension: rectangular patterns *89*
16.5.3 Tension: trapezoidal patterns *90*
16.5.4 Block shear in webs *90*
16.5.5 Tear-out of groups subjected to torque *91*
16.6 Eccentrically loaded fastener groups *91*
16.6.1 Highest fastener force (elastic) *91*

16.6.2 Factored strength (fully plastic) *92*
16.7 Tapping screws *92*
16.7.1 General *92*
16.7.2 Holes for screws *92*
16.7.3 Minimum spacing of screws *94*
16.7.4 Minimum edge distance of screws *94*
16.7.5 Screwed connection tension *94*
16.7.6 Screwed connection shear *98*

17 Design for serviceability *99*
17.1 Deflections and vibrations *99*
17.1.1 Deflection *99*
17.1.2 Vibration *99*
17.1.3 Wind-induced motion *99*
17.1.4 Expansion and contraction *100*
17.1.5 Connection slip *100*
17.2 Limiting slenderness for members *100*

18 Fabrication *100*
18.1 General *100*
18.2 Tolerances *100*
18.2.1 Fabrication tolerances *100*
18.2.2 Bolt hole end distance tolerance *100*
18.3 Marking *100*
18.4 Forming *100*
18.4.1 Temperature *100*
18.4.2 Bends *101*
18.4.3 Flattening *101*
18.5 Cutting *101*
18.5.1 Thickness limit *101*
18.5.2 Fatigue *101*
18.5.3 Gas cutting *101*
18.5.4 Re-entrant cuts *101*
18.6 Storage of materials *101*
18.7 Mechanical connections *101*
18.7.1 Rivets *101*
18.7.2 Bolts *102*
18.8 Welding *102*
18.8.1 General *102*
18.8.2 Fabricator and erector qualification *102*
18.8.3 Stud welding *102*

19 Protection from corrosion *102*
19.1 General *102*
19.2 Contact with dissimilar materials *103*
19.3 Cleaning and treatment of metal surfaces *103*
19.4 Stress corrosion *103*

20 Erection *104*

20.1 Temporary conditions *104*
20.1.1 General *104*
20.1.2 Temporary loads *104*
20.1.3 Temporary bracing *104*
20.1.4 Adequacy of temporary connections *104*
20.2 Alignment and layout *104*
20.2.1 Alignment *104*
20.2.2 Layout *104*
20.3 Erection tolerances *104*
20.3.1 General *104*
20.3.2 Elevation of base plates *105*
20.3.3 Plumbness of columns *105*
20.3.4 Horizontal alignment of members *105*
20.3.5 Elevations of members *105*
20.3.6 Alignment of braced members *105*
20.3.7 Members with adjustable connections *105*
20.3.8 Column splices *106*
20.3.9 Welded joint fit-up *106*
20.3.10 Bolted joint fit-up *106*
20.3.11 Turn-of-nut tightening *106*

21 Inspection *107*
21.1 General *107*
21.2 Co-operation *107*
21.3 Rejection *107*
21.4 Installation and inspection of high-strength bolted joints *107*
21.5 Welding inspection *107*
21.5.1 Extent of examination *107*
21.5.2 Competence of inspectors *107*
21.5.3 Quality of welds *107*
21.6 Identification of aluminum by marking *108*

22 Testing *108*
22.1 General *108*
22.1.1 Acceptable methods for testing *108*
22.1.2 Adequacy by testing *108*
22.1.3 Roofing and siding *108*
22.1.4 Test types *109*
22.1.5 Compliance *109*
22.2 Test methods *109*
22.2.1 Representation *109*
22.2.2 Procedures *109*
22.2.3 Documentation *109*
22.3 Test procedures *109*
22.3.1 Confirmatory tests *109*
22.3.2 Performance tests *110*

23 Fatigue *112*
23.1 General *112*

23.2 Live-load-induced fatigue *112*
23.2.1 Design criteria *112*
23.2.2 Cumulative fatigue damage *112*
23.2.3 Fatigue constants and detail categories *113*
23.3 Distortion-induced fatigue *113*
23.3.1 General *113*
23.3.2 Width-to-thickness ratios of transversely stiffened webs *113*
23.4 Unknown load spectra *113*
23.5 Low cycle stress limit *113*
23.6 Local stress approaches *113*
23.6.1 Notch stress approach *113*
23.6.2 Hot-spot stress approach *113*
23.7 Fatigue performance improving post-weld treatments *114*

24 Composite beams *121*
24.1 Application *121*
24.2 General *121*
24.2.1 Deflections *121*
24.2.2 Vertical shear *123*
24.2.3 End connections *123*
24.2.4 Metal deck *123*
24.2.5 Corrosion protection *123*
24.3 Design effective width of concrete *123*
24.3.1 Slabs extending on both sides of aluminum section *123*
24.3.2 Slabs extending on one side of aluminum section *123*
24.4 Slab reinforcement *123*
24.4.1 General *123*
24.4.2 Parallel reinforcement *123*
24.4.3 Transverse reinforcement — Concrete slab on metal deck *124*
24.4.4 Transverse reinforcement — Ribbed slabs *124*
24.5 Interconnection *124*
24.6 Shear connectors *124*
24.7 Ties *124*
24.8 Design of composite beams with shear connectors *124*
24.8.1 Composite beam components *124*
24.8.2 Maximum effective area *125*
24.8.3 Stress distribution *125*
24.8.4 Limits for composite action *126*
24.8.5 Full shear connection *126*
24.8.6 Partial shear connection *126*
24.8.7 Continuous composite beams *126*
24.8.8 Distribution of shear connectors *127*
24.8.9 Longitudinal shear *127*
24.9 Service stress in aluminum section *128*
24.10 Beams during construction *129*

25 Aluminum composite material (ACM) *129*

26 Structural design for fire protection *129*

Annexes

Annex A (informative) — Aluminum applications other than in buildings *130*
Annex B (informative) — Structural design for fire conditions *134*
Annex C (informative) — Combined forces *135*
Annex D (normative) — Built-up compression members *141*
Annex E (informative) — Arbitration procedure for pretensioning bolted connections *145*
Annex F (informative) — Deflections of composite beams due to shrinkage of concrete *147*
Annex G (informative) — Aluminum composite material (ACM) *151*
Annex H (informative) — Limiting slenderness for members *154*

Preface *156*

S157.1-17, *Commentary on CSA S157-17, Strength design in aluminum*

Introduction *157*

C1 Scope *157*

C4 Structural documents *157*
C4.2 Structural design documents *157*
C4.2.1 Required information *157*
C4.2.2 Additional information *158*
C4.2.4 Additional documents *158*
C4.3 Fabrication and erection documents *158*
C4.3.2 Shop details *158*
C4.3.3 Erection diagrams *158*

C5 Materials — Standards and identification *158*
C5.1 Standards *158*
C5.1.3 Fasteners *158*
C5.1.4 Filler metal for welding *158*
C5.2 Properties *159*
C5.2.1 Physical properties *159*
C5.2.2 Nominal strengths *159*

C6 Design requirements/Limit states design *160*
C6.1 Limit states *160*
C6.2 Loads, load factors, and load combinations for buildings *160*
C6.4 Resistance factors *160*

C7 Strength of elements/Gross and net areas, effective section, and effective strength *160*
C7.3 Effective section *160*
C7.3.2 Effective thickness at welds *160*
C7.3.3 Effective thickness after local buckling of flat elements *161*
C7.3.4 Deflection under service loads *163*
C7.4 Effective strength and overall buckling *163*
C7.4.1 General *163*
C7.4.2 Influence of welding *163*

C7.4.3 Influence of local buckling *163*
C7.5 Local buckling of flat elements *164*
C7.5.1 Buckling stress *164*
C7.5.2 Elements supported on both longitudinal edges *165*
C7.5.3 Elements supported at one longitudinal edge only *167*
C7.5.4 Elements supported at one edge with a lip at the other edge *168*
C7.6 Panels/Flat panels with multiple stiffeners *169*
C7.6.1 Axial compression *169*
C7.6.2 In-plane shear *169*
C7.7 Curved panels and tubes *169*
C7.7.1 Axial compression *169*
C7.7.2 Radial compression *170*
C7.7.3 Shear *170*
C7.8 Curved axially stiffened panels in axial compression *170*

C8 Analysis of structures/Methods of analysis and design *170*

C9 Design of members for tension *171*
C9.1 Cross-sectional areas *171*
C9.1.2 Effective net area *171*
C9.2 Members in tension *172*
C9.2.1 Shear lag effect *172*
C9.2.2 Tensile strength *174*
C9.2.3 Oblique welds *175*

C10 Design of members for compression *175*
C10.1 General provisions *175*
C10.1.3 Buckling stress *181*
C10.2 Member buckling *181*
C10.2.1 Flexural buckling *181*
C10.2.2 Torsional buckling *181*
C10.2.3 Torsional-flexural buckling *182*

C11 Design of members for flexure *182*
C11.1 Classification of members in bending *182*
C11.2 Moment resistance of members not subject to lateral-torsional buckling (LTB) *183*
C11.3 Flexural strength of members subject to lateral-torsional buckling *183*
C11.3.1 Members without lateral restraint *183*
C11.3.2 Members with lateral restraint of the tension flange only *186*

C12 Design of members for shear *187*
C12.1 Flat webs of flexural members with two flanges *187*
C12.1.5 Combined shear and bending in webs *190*
C12.2 Web stiffeners *190*
C12.3 Web crippling *191*
C12.4 Flat webs of flexural members supported on one flange *192*
C12.5 Shear strength for round and oval tubes and pipes *192*

C13 Members in torsion *192*
C13.2 Hollow sections *192*

C13.2.1 Torsional resistance *192*
C13.3 Solid sections *193*
C13.3.1 Torsional resistance for circular rods *193*
C13.3.2 Torsional resistance for solid compact bars *193*
C13.4 Open sections *193*
C13.4.1 Torsional resistance for sections without warping resistance *193*
C13.4.2 Torsional resistance for sections with warping resistance *194*
C13.4.3 Combined bending and torsion *194*

C14 Design of members subject to flexure and axial force *195*

C15 Design and detailing of welded connections *195*
C15.1 General *195*
C15.2 Groove welds *195*
C15.2.1 Tension *195*
C15.2.2 Compression *195*
C15.2.3 Shear *196*
C15.3 Flare groove welds *196*
C15.4 Fillet welds *196*
C15.4.1 Concentrically loaded fillet welds *196*
C15.4.2 Eccentrically loaded fillet welds *198*
C15.5 Slot and plug welds *200*
C15.6 Stud welds *200*
C15.7 Influence of welds, heat-affected zone *200*

C16 Design and detailing of mechanically fastened connections *201*
C16.1 General *201*
C16.1.1 Connection types *201*
C16.1.6 Slip-critical joints *201*
C16.2 Detailing *201*
C16.2.1 Minimum fastener spacing *201*
C16.2.2 Maximum fastener spacing *201*
C16.2.3.4 Maximum number of bolts *201*
16.3 Bolts and rivets in shear and/or tension *202*
C16.3.1 Shear strength *202*
C16.3.2 Tensile strength *202*
C16.3.3 Combined shear and tension *205*
C16.4 Bolts and rivets in bearing *205*
C16.4.1 Bearing strength *205*
C16.4.2 Lap joints *205*
C16.4.3 Oblique end edges *205*
C16.5 Block shear rupture *206*
C16.5.5 Tear-out of groups subjected to torque *206*
C16.6 Eccentrically loaded fastener groups *207*
C16.6.1 Highest fastener force (elastic) *207*
C16.6.2 Factored strength (fully plastic) *208*
C16.7 Tapping screws *208*

C17 Design for serviceability *208*

C17.2 Limiting slenderness for members *208*

C22 Testing *209*
C22.1 General *209*
C22.1.3 Roofing and siding *209*
C22.2 Test methods *209*
C22.3 Test procedures *209*
C22.3.1 Confirmatory tests *209*
C22.3.2 Performance tests *210*

C23 Fatigue *211*
C23.1 General *211*
C23.2 Live-load-induced fatigue *211*
C23.3 Distortion-induced fatigue *211*
C23.4 Unknown load spectra *212*
C23.6 Local stress approaches *212*
C23.7 Fatigue performance improving post-weld treatments *212*

C24 Composite beams *213*
C24.1 Application *213*
C24.2 General *213*
C24.2.1 Deflections *213*
C24.2.3 End connections *213*
C24.3 Design effective width of concrete *214*
C24.4 Slab reinforcement *214*
C24.4.2 Parallel reinforcement *214*
C24.4.3 Transverse reinforcement — Concrete slab on metal deck *214*
C24.4.4 Transverse reinforcement — Ribbed slabs *214*
C24.6 Shear connectors *214*
C24.8 Design of composite beams with shear connectors *215*
C24.8.3 Stress distribution *215*
C24.8.4 Limits for composite action *216*
C24.8.5 Full shear connection *217*
C24.8.8 Distribution of shear connectors *217*
C24.8.9 Longitudinal shear *217*
C24.9 Service stress in aluminum section *219*

C25 Aluminum composite material (ACM) *219*

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Preface

This is the fifth edition of CSA S157, *Strength design in aluminum*. It supersedes the previous editions published in 2005, 1983, 1969, and 1962.

This Standard is for building applications but it is written in a form that may be used for all types of aluminum load-bearing components or assemblies. Expressions for the strength of structural components are based on the concept of limit states design.

Requirements to satisfy the ultimate limit state form the core of the Standard. As a document referenced by the *National Building Code of Canada*, the load factors and resistance factors specified by that Code are given. However, because the design expressions predict the nominal resistance of components and connections, this Standard is useful in any field of engineering in which known applied loads are to be supported.

Serviceability limit states depend on the desired behaviour under service loads for each particular application and are not specified in this Standard. For components used in buildings, reference is made to Commentary A of the *National Building Code of Canada*.

CSA S157.1, *Commentary on CSA S157-17,* Strength design in aluminum (hereinafter referred to as the Commentary), is provided which, while not a mandatory part of the Standard, is essential to the implementation of this Standard's requirements. In this Standard, cross-references to the Commentary are identified by the prefix "C" before the clause, table, or figure number.

This edition of CSA S157 contains significant changes from the previous edition and follows, wherever possible, the same order of presentation as CSA S16, in order to facilitate the use of these two Standards:

a) A more comprehensive list of symbols is provided in Clause 3.
b) Clause 4 contains a new set of requirements on structural documents.
c) A significantly longer list of wrought aluminum products conforming to the ASTM specifications is presented in Table 1. Time-temperature limits are provided for T5 and T6 tempers and nominal strengths of aluminum filler metals are given in a new table.
d) In Clause 8, elastic analyses of structures now include second order effects and the effects of geometric imperfections. This has significant implications on the design of members subject to flexure and axial forces (Clause 14).
e) The design of built-up compression members is moved to a mandatory Annex.
f) Clause 11 presents generalized design equations for members subject to lateral-torsional buckling.
g) The extent of the heat-affected-zone (HAZ) in welded connections is redefined in Clause 15. It is now similar to the provisions of Eurocode 9 and Section 17 of CSA S6.
h) A new set of recommendations for the design of screws is included in Clause 16.7.
i) Clauses 18, 20, 21, and 22 on fabrication, erection, inspection and testing, respectively, are new clauses. They are adapted from CSA S16.
j) The specifications on the fatigue of aluminum presented in Clause 23 have been revised by incorporating the detail category and S-N curve definitions from Section 17 of CSA S6. The detail category definitions are similar to the steel definitions in Section 10 of CSA S6. The S-N curve definitions are consistent with the *Aluminum Design Manual*.
k) Clause 24 presents a new set of provisions for the design of composite beams (concrete slab on aluminum girders). This is an adaptation of the provisions of CSA S16 to aluminum.

CSA Group acknowledges that the development of this Standard was made possible, in part, by the financial support of the Aluminum Association of Canada, Alubec, and the Centre québécois de recherche et de développement de l'aluminium.

This Standard was prepared by the Technical Committee on Strength Design in Aluminum, under the jurisdiction of the Strategic Steering Committee on Construction and Civil Infrastructure, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at standardsactivities.csa.ca.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

S157-17
Strength design in aluminum

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S157-17
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1 Scope

1.1 Applicability

This Standard applies to limit state design, fabrication, erection, and inspection of aluminum alloy members and assemblies

a) intended to comply with building codes such as the *National Building Code of Canada (NBCC);* or
b) not addressed by another CSA Group standard.

When this Standard is referenced by other CSA Group standards (e.g., product standards), the requirements of this Standard apply as so specified in the referencing CSA Group standard.

Note: *Annex A lists some applications to which other standards apply.*

1.2 Other standards

The use of other standards for the design, fabrication, erection, and/or inspection of members or parts of aluminum structures is neither warranted nor acceptable except where specifically directed in this Standard. The substitution of other standards or criteria for design, fabrication, erection, and/or inspection is expressly prohibited unless specifically directed in this Standard.

1.3 Rational design

Where this Standard does not provide requirements for a specific situation, a rational design is to be used, based on appropriate theories, tests, analyses, or engineering experience. The design formulas provided in this Standard may be supplemented by such a rational design, provided that nominal margins (or factors) of safety are at least equal to those intended in the provisions of this Standard.

1.4 Terminology

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the Standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.5 Units of measure

The expressions contained herein are dimensionally uniform, and any consistent system of units may be employed. Where dimensions are identified, SI units are used, typically newtons (N) for force, millimetres (mm) for length, and megapascals (MPa = N/mm^2) for stress.

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below.

CSA Group

B51-14
Boiler, Pressure Vessel, and Pressure Piping Code

CAN/CSA-B311-02 (R2012)
Safety Code for Manlifts

CAN/CSA-B354.2-01 (R2013)
Self-propelled elevating work platforms

B602-16
Mechanical couplings for drain, waste, and vent pipe and sewer pipe

CAN/CSA-C225-10 (R2015)
Vehicle-mounted aerial devices

S6-14
Canadian Highway Bridge Design Code

S16-14
Design of steel structures

S37-13
Antennas, towers and antenna-supporting structures

S269.1-16
Falsework and formwork

S269.2-16
Access scaffolding for construction purposes

S408-11
Guidelines for the development of limit states design

W47.2-11 (R2015)
Certification of companies for fusion welding of aluminum

W59.2-M1991 (R2013)
Welded aluminum construction

W178.1-14
Certification of welding inspection organizations

W178.2-14
Certification of welding inspectors