

Australian/New Zealand Standard®

Aluminium structures

Part 2: Allowable stress design

AS/NZS 1664.2:1997

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee BD/50, Aluminium Structures. It was approved on behalf of the Council of Standards Australia on 27 June 1997 and on behalf of the Council of Standards New Zealand on 11 July 1997. It was published on 5 September 1997.

The following interests are represented on Committee BD/50:

Aluminium Development Council
Association of Consulting Engineers, Australia
Australian Building Codes Board
Institution of Professional Engineers New Zealand
University of Sydney

Review of Standards. To keep abreast of progress in industry, Joint Australian/New Zealand Standards are subject to periodic review and are kept up to date by the issue of amendments or new editions as necessary. It is important therefore that Standards users ensure that they are in possession of the latest edition, and any amendments thereto.

Full details of all Joint Standards and related publications will be found in the Standards Australia and Standards New Zealand Catalogue of Publications; this information is supplemented each month by the magazines 'The Australian Standard' and 'Standards New Zealand', which subscribing members receive, and which give details of new publications, new editions and amendments, and of withdrawn Standards.

Suggestions for improvements to Joint Standards, addressed to the head office of either Standards Australia or Standards New Zealand, are welcomed. Notification of any inaccuracy or ambiguity found in a Joint Australian/New Zealand Standard should be made without delay in order that the matter may be investigated and appropriate action taken.

Australian/New Zealand Standard[®]

Aluminium structures

Part 2: Allowable stress design

Originated in Australia as part of AS 1664—1975.
Previous Australian edition AS 1664—1979.
Jointly revised and designated AS/NZS 1664.2:1997.

Incorporating:
Amdt 1—1999

PUBLISHED JOINTLY BY:

STANDARDS AUSTRALIA
1 The Crescent,
Homebush NSW 2140 Australia

STANDARDS NEW ZEALAND
Level 10, Radio New Zealand House,
155 The Terrace,
Wellington 6001 New Zealand

PREFACE

This Joint Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD/50, Aluminium Structures, to supersede, in part, AS 1664—1979, *Rules for the use of aluminium in structures (known as SAA Aluminium Structures Code)*.

This Standard is technically equivalent to *The Aluminium Design Manual: Specifications and guidelines for aluminium structures. Part 1A: Specifications for Aluminium structures allowable stress design* issued by the U.S. Aluminium Association Inc.

The objective of this Standard is to provide designers of aluminium alloy load carrying members and elements with allowable stress design criteria for use in design applications.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

© Copyright — STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Users of Standards are reminded that copyright subsists in all Standards Australia and Standards New Zealand publications and software. Except where the Copyright Act allows and except where provided for below no publications or software produced by Standards Australia or Standards New Zealand may be reproduced, stored in a retrieval system in any form or transmitted by any means without prior permission in writing from Standards Australia or Standards New Zealand. Permission may be conditional on an appropriate royalty payment. Australian requests for permission and information on commercial software royalties should be directed to the head office of Standards Australia. New Zealand requests should be directed to Standards New Zealand.

Up to 10 percent of the technical content pages of a Standard may be copied for use exclusively in-house by purchasers of the Standard without payment of a royalty or advice to Standards Australia or Standards New Zealand.

Inclusion of copyright material in computer software programs is also permitted without royalty payment provided such programs are used exclusively in-house by the creators of the programs.

Care should be taken to ensure that material used is from the current edition of the Standard and that it is updated whenever the Standard is amended or revised. The number and date of the Standard should therefore be clearly identified.

The use of material in print form or in computer software programs to be used commercially, with or without payment, or in commercial contracts is subject to the payment of a royalty. This policy may be varied by Standards Australia or Standards New Zealand at any time.

CONTENTS

	<i>Page</i>
SECTION 1 GENERAL	
1.1 SCOPE	5
1.2 MATERIALS	5
1.3 SAFETY FACTORS	5
1.4 REFERENCED DOCUMENTS	5
SECTION 2 DESIGN PROCEDURE	
2.1 PROPERTIES OF SECTIONS	7
2.2 PROCEDURE	7
2.3 LOADING	7
SECTION 3 GENERAL DESIGN RULES	
3.1 INTRODUCTION	8
3.2 NOMENCLATURE	8
3.3 TABLES RELATING TO MECHANICAL PROPERTIES AND BUCKLING CONSTANTS	14
3.4 ALLOWABLE STRESSES	20
SECTION 4 SPECIAL DESIGN RULES	
4.1 COMBINED AXIAL LOAD AND BENDING	45
4.2 TORSION AND SHEAR IN TUBES	46
4.3 TORSION AND BENDING IN OPEN SHAPES	46
4.4 COMBINED SHEAR, COMPRESSION AND BENDING	46
4.5 HORIZONTAL STIFFENERS FOR WEBS	47
4.6 VERTICAL STIFFENERS FOR SHEAR WEBS	47
4.7 EFFECTS OF LOCAL BUCKLING ON MEMBER PERFORMANCE	48
4.8 FATIGUE	52
4.9 COMPRESSION IN SINGLE WEB BEAMS AND BEAMS HAVING SECTIONS CONTAINING TUBULAR PORTIONS	57
4.10 COMPRESSION IN ELASTICALLY SUPPORTED FLANGES	62
SECTION 5 MECHANICAL CONNECTIONS	
5.1 BOLTED AND RIVETED CONNECTIONS	63
5.2 METAL STITCHING STAPLES	69
5.3 SELF TAPPING SCREW CONNECTIONS	69
SECTION 6 FABRICATION	
6.1 LAYING OUT	72
6.2 CUTTING	72
6.3 HEATING	72
6.4 PUNCHING, DRILLING AND REAMING	72
6.5 RIVETING	73
6.6 PAINTING	73
6.7 CLEANING AND TREATMENT OF METAL SURFACES	74

SECTION 7 WELDED CONSTRUCTION

7.1	ALLOWABLE STRESSES FOR WELDED MEMBERS	75
7.2	FILLER WIRE	75
7.3	MEMBERS WITH LONGITUDINAL WELDS	75
7.4	MEMBERS WITH TRANSVERSE WELDS	76
7.5	WELDING FABRICATION	76

SECTION 8 TESTING

8.1	SCOPE AND GENERAL	78
8.2	TEST REQUIREMENTS	78
8.3	TESTS FOR DETERMINING MATERIAL PROPERTIES	78
8.4	PROCEDURE	78
8.5	REPORTING OF TEST RESULTS	79

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Aluminium structures****Part 2: Allowable stress design**

SECTION 1 GENERAL

1.1 SCOPE This Standard specifies requirements for the design of aluminium alloy load carrying members and elements. The allowable stress design (ASD) criteria are intended as an alternative to the limit state design (LSD) criteria (see AS 1664.1). One design specification (ASD or LSD) applies throughout the design of a single structure.

1.2 MATERIALS The principal materials to which these specifications apply are aluminium alloys that comply with AS 1734, AS 1865, AS 1866, AS 1867 and AS 2848.1. Those structural members frequently used are listed in Table 3.3(A).

1.3 SAFETY FACTORS

1.3.1 Building type structures Basic allowable tensile stresses for buildings, structural supports for highway signs, luminaires, traffic signals and similar structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.65, or the minimum ultimate tensile strength divided by a factor of safety of 1.95. Other allowable stresses for buildings and similar structures shall be based upon the factors of safety shown in Table 3.4(A).

1.3.2 Bridge type structures Basic allowable tensile stresses for bridge type structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.85, or the minimum ultimate tensile strength divided by a factor of safety of 2.2. Other allowable stresses for bridge and similar structures shall be based upon the factors of safety shown in Table 3.4(A).

1.3.3 Other type structures Where it is customary or standard practice to use factors of safety other than those given in Clauses 1.3.1 or 1.3.2, the general formulas in Table 3.4(C) shall be permitted to be used with the desired factors of safety substituted for n_u , n_y or n_a .

1.4 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

1170	Minimum design loads on structures (known as the SAA Loading Code)
1170.1	Part 1: Dead and live loads and load combinations
1170.2	Part 2: Wind loads
1170.3	Part 3: Snow loads
1170.4	Part 4: Earthquake loads
1391	Methods for tensile testing of metals

AS/NZS

1664	Aluminium structures
1664.1	Part 1: Limit state design
1664.2	Supplement 1, Part 2: Allowable stress design—Commentary

AS	
1665	Welding of aluminium structures
1734	Aluminium and aluminium alloys—Flat sheet, coiled sheet and plate (adopted in New Zealand as NZS/AS 1734)
1865	Aluminium and aluminium alloys—Drawn wire, rod, bar and strip (adopted in New Zealand as NZS/AS 1865)
1866	Aluminium and aluminium alloys—Extruded rod, bar, solid and hollow shapes (adopted in New Zealand as NZS/AS 1866)
1867	Aluminium and aluminium alloys—Drawn tubes (adopted in New Zealand as NZS/AS 1867)
2848	Aluminium and aluminium alloys—Compositions and designations
2848.1	Part 1: Wrought products
NZS	
4203	Code of practice for general structural design and design loadings for buildings (1984 edition)
ASTM	
B 557	Test methods of tension testing wrought and cast aluminium- and magnesium- alloy products
D 962	Specification for aluminium powder and paste pigments for paints
E 330	Test method for structural performance of exterior windows, curtain walls, and doors by uniform static air pressure difference

SECTION 2 DESIGN PROCEDURE

2.1 PROPERTIES OF SECTIONS Properties of sections, such as cross-sectional area, moment of inertia, section modulus, radius of gyration and torsion constants, shall be determined in accordance with accepted methods of structural analysis.

2.2 PROCEDURE Computations of forces, moments, stresses and deflections shall be in accordance with accepted methods of elastic structural analysis and engineering design. The formulas and methods for determining allowable stresses in this Standard have been simplified in many cases for ease of computation but are not intended to preclude the use of more rigorous analysis.

2.3 LOADING The loads on the structure shall be in accordance with the applicable parts of AS 1170 (Australia) or the applicable parts of NZS 4203:1984 (New Zealand).

When computing allowable stresses in Australia, the most adverse load combination from the following shall be used:

- (a) $G + Q$
- (b) $0.75 (G + Q + W_p)$
- (c) $0.75 (G + Q + F_{eq})$
- (d) $0.75 (G' + W'_p)$

where

G = dead load

Q = live load

W_p = wind load based on basic wind speed V_p

F_{eq} = earthquake load

W'_p = wind load causing stresses of opposite sign to the dead load

G' = that part of the dead load that cannot be removed from the structure

In the case of wind and ice loads, the form of the structure and any of its exposed components (e.g. increased area exposed to wind due to icing) shall be considered.

SECTION 3 GENERAL DESIGN RULES

3.1 INTRODUCTION The nomenclature of terms used in developing the allowable stresses is given in Clause 3.2. Minimum mechanical properties for each alloy (non-welded material) included in this Standard are listed in Table 3.3(A).

Minimum mechanical properties for welded material are shown in Table 3.3(B).

3.2 NOMENCLATURE A consistent set of units shall be used throughout these specifications, as follows:

a	=	detail dimension parallel to the direction of stress
a_e	=	equivalent width of rectangular panel
a_1	=	shorter dimension of rectangular panel
a_2	=	longer dimension of rectangular panel
A	=	area
A, B, C, D, E, F	=	detail categories for fatigue
A_c	=	area of compression element (compression flange plus 1/3 of area of web between compression flange and neutral axis)
A_h	=	gross area of cross-section of horizontal stiffener
A_s	=	area of the stiffener
A_w	=	the portion of area of cross-section A lying within 25 mm of a weld
b	=	width of section or element
b_o	=	width of element with an intermediate stiffener as shown in Figure 3.4.10.3
b_e	=	effective width of flat plate element to be used in deflection calculations
b/t	=	width to thickness ratio of a rectangular element of a cross-section
B, D, C	=	buckling formula constants, with the following subscripts: c —compression in columns p —compression in flat plates t —compression in round tubes tb —bending in round tubes br —bending in rectangular bars s —shear in flat plates
c	=	distance from neutral axis to extreme fibre
C	=	coefficient which depends on screw location
C_b	=	coefficient which depends on moment gradient
C_m	=	0.6 – 0.4(M_1/M_2) for members whose ends are prevented from swaying; or 0.85 for members whose ends are not prevented from swaying
C_p	=	correction factor
C_w	=	torsional warping constant of the cross-section

C_{wa}	=	$t^2 \sin \theta (0.46 F_{cy} + 0.02 \sqrt{EF_{cy}})$
C_{wb}	=	$C_3 + R_i (1 - \cos \theta)$
C_1	=	140 m; or coefficient defined in Clause 4.9.5
C_2	=	33 mm; or coefficient defined in Clause 4.9.2
C_3	=	10 mm
d	=	depth of section or beam
d_1	=	clear distance from the neutral axis to the compression flange
d_s	=	length of lip stiffener shown in Figure 3.4.10.2(A)
D	=	diameter
D_h	=	nominal hole diameter
D_n	=	nominal dead load
D_s	=	defined in Figure 3.4.10.2(A)
D_w	=	nominal washer diameter
D_{ws}	=	larger of the nominal washer diameter and the screw head
e	=	base for natural logarithms ≈ 2.72
E	=	compressive modulus of elasticity (See Table 3.3(A))
f	=	calculated stress
f_a	=	average stress on cross-section produced by axial load
f_b	=	maximum bending stress produced by transverse loads or bending moments, or both
f_s	=	shear stress caused by torsion or transverse shear loads
F	=	allowable stress
F_a	=	allowable compressive stress for a member considered as an axially loaded column according to Clauses 3.4.8 to 3.4.11
F_{ao}	=	allowable compressive stress of axially loaded member considered as a short column according to Clause 4.7.2
F_b	=	allowable bending stress for members subjected to bending only
F_{bu}	=	bearing ultimate strength
F_{buw}	=	bearing ultimate strength within 25 mm of a weld
F_{bu1}	=	bearing ultimate strength of member in contact with the screw head
F_{bu2}	=	bearing ultimate strength of member not in contact with the screw head
F_{by}	=	bearing yield strength
F_{byw}	=	bearing yield strength within 25 mm of a weld
F_{by1}	=	bearing yield strength of member in contact with the screw head
F_{by2}	=	bearing yield strength of member not in contact with the screw head
F_c	=	allowable compressive stress
F_{cr}	=	local buckling stress for element from Clause 4.7.1
F_{cy}	=	compressive yield strength

F_{cyw}	=	compressive yield strength across a butt weld (0.2 percent offset in 250 mm gauge length)
F_e	=	elastic buckling stress divided by n_u
	=	$\frac{\pi^2 E}{n_u (kL/r)^2}$
F_{ec}	=	allowable elastic lateral buckling stress of beam calculated assuming that the elements are not buckled
F_{ex}	=	$\frac{\pi^2 E}{\left(\frac{k_x L_b}{r_x} \right)^2}$
F_m	=	mean value of the fabrication factor
F_n	=	allowable stress for cross-section 25 mm or more from weld
F_{pw}	=	allowable stress for cross-section, part of whose area lies within 25 mm of a weld
F_{rb}	=	allowable stress for beam with buckled elements
F_{rc}	=	allowable stress for column with buckled elements
F_s	=	allowable shear stress for members subjected only to torsion or shear
F_{ST}	=	allowable stress according to Clause 3.4.10.2 or Clause 3.4.19
F_{su}	=	shear ultimate strength
F_{suw}	=	shear ultimate strength within 25 mm of a weld
F_{sy}	=	shear yield strength
F_{syw}	=	shear yield strength within 25 mm of a weld
F_t	=	allowable tensile stress for the member considered loaded only axially according to Clause 3.4.2
F_{tb}	=	$\frac{1}{Ar_o^2} \left(GJ + \frac{\pi^2 EC_w}{(k_o L_t)^2} \right)$
F_{tu}	=	tensile ultimate strength
F_{tuw}	=	tensile ultimate strength across a butt weld
F_{ty}	=	tensile yield strength
F_{tyw}	=	tensile yield strength across a butt weld (0.2 percent offset in 250 mm gauge length)
F_{tu1}	=	tensile ultimate strength of member in contact with the screw head
F_{tu2}	=	tensile ultimate strength of member not in contact with the screw head
F_{UT}	=	allowable stress according to Clause 3.4.10.2 or Clause 3.4.19
F_y	=	either F_{ty} or F_{cy} , whichever is smaller
F_w	=	allowable stress on cross-section if entire area were to lie within 25 mm of weld
g	=	distance from shear centre to the point of application of load

g_r	=	spacing of rivet or bolt holes perpendicular to direction of load
G	=	shear modulus
G_r	=	grip of rivet or bolt
h	=	clear height of shear web
I	=	moment of inertia
I_b	=	required moment of inertia of bearing stiffener
I_{cy}	=	moment of inertia of compression flange about web
I_h	=	moment of inertia of horizontal stiffener
I_o	=	moment of inertia of the stiffener about the centroidal axis of the stiffener parallel to the flat plate element that is stiffened
I_s	=	moment of inertia of transverse stiffener to resist shear buckling
I_x	=	moment of inertia of a beam about axis perpendicular to web
I_y	=	moment of inertia of a beam about axis parallel to web
I_{yc}	=	moment of inertia of compression element about axis parallel to vertical web
j	=	parameter defined by Equation 4.9.4(3) or (4)
J	=	torsion constant
k	=	the effective length factor. k is taken as larger than or equal to unity unless rational analysis justifies a smaller value
k_c	=	coefficient for compression members
k_o	=	effective length coefficient for torsional buckling. k_o is taken as larger than or equal to unity unless rational analysis justifies a smaller value
k_t	=	coefficient for tension members
k_x	=	effective length coefficient for buckling about the x-axis
k_y	=	effective length coefficient for buckling about the y-axis
k_1	=	coefficient for determining slenderness limit S_2 for sections for which the allowable compressive stress is based on ultimate strength
k_2	=	coefficient for determining allowable compressive stress in sections with slenderness ratio above S_2 for which the allowable compressive stress is based on ultimate strength
K	=	constant to be determined from Table 4.8.2
L	=	unsupported length in the plane of bending
L_b	=	unbraced length for bending
L_n	=	nominal live load
L_o	=	length of tube between circumferential stiffeners
L_t	=	unbraced length for twisting
m	=	constant determined from Table 4.8.2
M	=	bending moment applied to the member

M_a	= allowable bending moment for the member if bending moment alone is applied to the member
M_A	= absolute value of moment at quarter-point of the unbraced beam segment
M_B	= absolute value of moment at mid-point of the unbraced beam segment
M_C	= absolute value of moment at three-quarter-point of the unbraced beam segment
M_e	= elastic critical moment
M_i	= bending strength of member with intermediate thickness
M_m	= mean value of the material factor
M_{MAX}	= absolute value of maximum moment in the unbraced beam segment
M_1	= bending strength of member of thinnest material
M_2	= bending strength of member of thickest material
M_1/M_2	= ratio of end moments where M_2 is the larger of the two end moments and M_1/M_2 is positive when the member is bent in reverse curvature, negative when bent in single curvature
n	= number of tests
n_a	= factor of safety on appearance of buckling
n_s	= factor of safety for screw connections
n_u	= factor of safety on ultimate strength
n_y	= factor of safety on yield strength
N	= number of cycles to failure
N_b	= length of bearing at reaction or concentrated load
N_s	= number stress ranges in the spectrum
P	= concentrated load on bearing stiffener
P_{as}	= allowable shear force per screw
P_{at}	= allowable tensile force per screw
P_c	= allowable reaction or concentrated load per web
P_{not}	= pull-out force per screw
P_{nov}	= pull-over force per screw
P_{ns}	= nominal shear strength per screw
P_{nt}	= nominal tensile strength per screw
P_w	= applied interior reaction or concentrated load per web for flat webs
q	= uniform design load
r	= radius of gyration
r_o	= $\sqrt{r_{x^2} + r_{y^2} + x_{o^2} + y_{o^2}}$
r_s	= radius of gyration of the stiffener
r_x, r_y	= radii of gyration of the cross-section about the centroidal principal axes

r_y	=	radius of gyration of a beam (about axis parallel to web). (For beams that are unsymmetrical about the horizontal axis, r_y shall be calculated as though both flanges were the same as the compression flange)
r_{ye}	=	effective radius of gyration
R	=	ratio defined in Clauses 3.4.10.2 and 3.4.19
R_b	=	mid-thickness radius of curvature of curved plate and tubular beam elements
R_i	=	bend radius at juncture of flange and web measured to inside surface of bend
R_m	=	mid-thickness radius of round tubular column or maximum mid-thickness radius of oval tubular column
R_o	=	outside radius of round tube or maximum outside radius of oval tube
R_p	=	average value of failure loads in all tests
R_t	=	transition radius, the radius of an attachment of the weld detail
s	=	spacing of transverse stiffeners (clear distance between stiffeners for stiffeners consisting of a pair of members, one on each side of the web, centre-to-centre distance between stiffeners consisting of a member on one side of the web only); spacing of rivet or bolt holes parallel to direction of load
S	=	$1.28 \sqrt{\frac{E}{F_{cy}}}$
SR	=	stress ratio, the ratio of minimum stress to maximum stress
S_{ra}	=	the applied stress range
S_{rd}	=	allowable stress range
S_{re}	=	equivalent stress range
S_{ri}	=	the i th stress range in the spectrum
S_x	=	standard deviation of the test results
S_1, S_2	=	slenderness limits
t	=	thickness of flange, plate, web or tube (for tapered flanges, t is the average thickness)
t_i	=	thickness of the intermediate thickness material tested
t_1	=	thickness of member in contact with the screw head
t_2	=	thickness of member not in contact with the screw head
U	=	parameter defined by Equation 4.9.4(5)
V	=	shear force on web at stiffener location
V_F	=	coefficient of variation of the fabrication factor
V_M	=	coefficient of variation of the material factor
V_P	=	coefficient of variation of the ratio of the observed failure loads divided by the average value of all the observed failure loads
V_Q	=	coefficient of variation of the loads
X_o	=	x-coordinate of the shear centre

X_a	=	strength at which 99 percent of the material is expected to conform at a confidence level of 95 percent
X_m	=	mean of the test results
y_o	=	y-coordinate of the shear centre
Z_c	=	section modulus of a beam, compression side
Z_t	=	section modulus of a beam, tension side
α	=	a factor equal to unity for a stiffener consisting of equal members on both sides of the web and equal to 3.5 for a stiffener consisting of a member on one side only
α_i	=	number of cycles in the spectrum of the i th stress range divided by the total number of cycles
β	=	$1 - (x_o/r_o)^2$
β_o	=	the target reliability index
β_s	=	spring constant (transverse force applied to the compression flange of the member of unit length divided by the deflection due to the force)
λ_s	=	equivalent slenderness ratio for an intermediate stiffener
θ	=	angle between plane of web and plane of bearing surface ($\theta \leq 90$ degrees)

3.3 TABLES RELATING TO MECHANICAL PROPERTIES AND BUCKLING CONSTANTS Formulas for determining allowable stresses and constants and coefficients needed for these formulas are given in Tables 3.3(A), 3.3(B), 3.3(C) and 3.3(D).

TABLE 3.3(A)
MINIMUM MECHANICAL PROPERTIES FOR ALUMINIUM ALLOYS

Alloy and temper	Product	Thickness range mm	Tension		Compression F_{cy} MPa	Shear		Bearing		Compressive modulus of elasticity† E MPa
			F_{tu}^* MPa	F_{ty}^* MPa		F_{su} MPa	F_{sy} MPa	F_{bu} MPa	F_{by} MPa	
1100-H12	Sheet, plate	All	96	76	69	63	45	193	124	70 000
-H14	Rolled rod & bar	All	110	96	90	69	55	220	145	70 000
1200-H12	Sheet, plate, drawn tube	≤50	96	75	69	62	45	193	124	69 637
-H14	Sheet, plate, drawn tube	≤25	110	96	90	69	55	221	145	69 637
2014-T6	Sheet	1.0–6.5	455	400	407	276	227	860	640	75 000
-T651	Plate	6.4–50	462	407	400	276	234	875	648	75 000
-T6, T6510, T6511	Extrusions	All	414	365	359	241	213	786	586	75 000
-T6, T651	Cold finished rod & bar, drawn tube	All	448	379	365	262	220	855	606	75 000
Alclad										
2014-T6	Sheet	0.6–1.0	434	379	386	262	220	827	606	74 000
-T6	Sheet	1.0–6.3	441	393	400	269	227	841	627	74 000
-T651	Plate	6.3–12.7	441	393	386	269	227	841	627	74 000
3003-H12	Sheet & plate	0.4–50	117	83	69	76	48	234	131	70 000
-H14	Sheet & plate	0.2–25	138	117	96	83	69	276	172	70 000
-H16	Sheet	0.15–4	165	145	124	96	83	317	214	70 000
-H18	Sheet	0.15–3.2	186	165	138	103	96	338	234	70 000
3003-H12	Drawn tube	All	117	83	76	76	48	234	131	70 000
-H14	Drawn tube	All	138	117	110	83	69	276	172	70 000
-H16	Drawn tube	All	165	145	131	96	83	317	214	70 000
-H18	Drawn tube	All	186	165	145	103	96	338	234	70 000
Alclad										
3003-H12	Sheet & plate	0.4–50	110	76	62	69	45	220	124	70 000
-H14	Sheet & plate	0.2–25	131	110	90	82	62	262	165	70 000
-H16	Sheet	0.15–4	158	138	117	96	83	303	207	70 000
-H18	Sheet	0.15–3.2	179	158	131	103	90	324	220	70 000
Alclad										
3003-H14	Drawn tube	0.6–6.6	131	110	103	82	62	262	165	70 000
-H18	Drawn tube	0.2–12.7	179	158	138	103	90	324	220	70 000
3004-H32	Sheet & plate	0.4–50	193	145	124	117	83	386	248	70 000
-H34	Sheet & plate	0.2–25	220	172	152	131	96	441	276	70 000
-H36	Sheet	0.15–1.6	241	193	172	138	110	482	310	70 000
-H38	Sheet	0.15–3.2	262	214	200	145	124	496	310	70 000
3004-H34	Drawn tube	0.5–11.4	220	172	165	131	96	441	276	70 000
-H36	Drawn tube	0.5–11.4	241	193	186	138	110	482	310	70 000
Alclad										
3004-H32	Sheet	0.4–6.3	186	138	117	110	83	372	234	70 000
-H34	Sheet	0.2–6.3	214	165	145	124	96	427	262	70 000
-H36	Sheet	0.15–1.6	234	186	165	131	110	469	296	70 000
-H38	Sheet	0.15–3.2	255	207	193	145	117	483	303	70 000
-H14	Sheet & plate	0.2–12	220	179	165	131	103	441	269	70 000
-H16	Sheet	0.15–4.1	241	207	193	138	117	455	310	70 000
-H131, H241, H341	Sheet	0.6–1.3	214	179	152	124	103	427	269	70 000
-H151, H261, H361	Sheet	0.6–1.3	234	207	193	131	117	455	310	70 000
3005-H25	Sheet	0.3–1.3	179	151	138	103	89	338	241	70 000
-H28	Sheet	0.15–2.0	214	186	172	117	110	386	262	70 000
3006-H391	Sheet	0.25–1.3	214	186	186	138	110	414	303	70 000
3105-H25	Sheet	0.3–2.0	158	131	117	96	76	303	193	70 000
3203-H14	Sheet, plate	≤12	139	117	97	83	69	276	172	69 637
-H16	Sheet	≤4	162	138	117	97	83	303	206	69 637

(continued)

TABLE 3.3(A) (continued)

Alloy and temper	Product	Thickness range mm	Tension		Compression F_{cy} MPa	Shear		Bearing		Compressive modulus of elasticity† E MPa
			F_{tu}^* MPa	F_{ty}^* MPa		F_{su} MPa	F_{sy} MPa	F_{bu} MPa	F_{by} MPa	
5005-H12	Sheet & plate	0.4–50	124	96	90	76	55	234	152	70 000
-H14	Sheet & plate	0.2–25	145	117	103	83	69	276	172	70 000
-H16	Sheet	0.15–1.6	165	138	124	96	83	331	207	70 000
-H32	Sheet & plate	0.4–50	117	83	76	76	48	234	138	70 000
-H34	Sheet & plate	0.2–25	138	103	96	83	58	276	165	70 000
-H36	Sheet	0.15–1.6	158	124	110	90	76	331	200	70 000
5050-H32	Sheet	0.4–6.3	152	110	96	96	62	303	186	70 000
-H34	Sheet	0.2–6.3	172	138	124	103	83	345	220	70 000
-H32	Cold fin. rod & bar* Drawn tube	All	152	110	103	90	62	303	186	70 000
-H34	Cold fin. rod & bar* Drawn tube	All	172	138	131	103	83	345	220	70 000
5052-H32	Sheet & plate	All	214	158	145	131	90	414	269	70 000
-H34	Cold fin. rod & bar Drawn tube	All	234	179	165	138	103	448	303	70 000
-H36	Sheet	0.15–4.1	255	200	179	152	117	483	317	70 000
-H38	Sheet	≤3.25	268	220	207	152	124	510	338	70 327
-H391	Sheet	≤2	290	241	227	159	138	524	358	70 327
5083-H111	Extrusions	Up to 12	276	165	145	165	96	538	282	72 000
-H111	Extrusions	Over 12	276	165	145	158	96	538	262	72 000
-H321, H116	Sheet & plate	4.8–38	303	214	179	179	124	579	365	72 000
-H321, H116	Plate	38–76	283	200	165	165	117	538	338	72 000
-H323	Sheet	0.4–6.3	310	234	220	179	138	607	400	72 000
-H343	Sheet	0.4–6.3	345	269	255	200	158	655	455	72 000
5086-H111	Extrusions	Up to 12	248	145	124	145	83	483	248	72 000
-H111	Extrusions	Over 12	248	145	124	145	83	483	234	72 000
-H112	Plate	6–12	248	124	117	152	69	496	214	72 000
-H112	Plate	12–25	241	110	110	145	62	483	193	72 000
-H112	Plate	25–50	241	96	103	145	55	483	193	72 000
-H112	Plate	50–70	234	96	103	145	55	469	193	72 000
-H116, H32	Sheet & plate	All	276	193	179	165	110	538	331	72 000
-H34	Drawn tube	All	303	234	220	179	138	579	400	72 000
5154-H38	Sheet	0.15–3.2	310	241	227	165	138	558	386	72 000
5251-H34	Sheet, plate	≤25	231	179	159	131	103	434	303	70 327
5454-H111	Extrusions	Up to 12	228	131	110	138	76	441	220	72 000
-H111	Extrusions	Over 12	228	131	110	131	76	441	207	72 000
-H112	Extrusions	Up to 127	214	83	90	131	48	427	165	72 000
-H32	Sheet & plate	0.5–50	248	179	165	145	103	483	303	72 000
-H34	Sheet & plate	0.5–25	269	200	186	158	117	510	338	72 000
5456-H111	Extrusions	Up to 12	290	179	152	172	103	565	303	72 000
-H111	Extrusions	Over 12	290	179	152	165	103	565	290	72 000
-H112	Extrusions	Up to 127	283	131	138	165	76	565	262	72 000
-H116, H321	Sheet & plate	4.8–32	317	227	186	186	131	600	386	72 000
-H116, H321	Plate	32–38	303	214	172	172	124	579	365	72 000
-H116, H321	Plate	38–76	283	200	172	172	117	565	338	72 000
6005-T5	Extrusions	Up to 25	262	241	241	165	138	552	386	70 000
6105-T5	Extrusions	Up to 25	262	241	241	165	138	552	386	70 000
6061-T6, T651	Sheet & plate	0.25–102	290	241	241	186	138	607	400	70 000
-T6, T6510, T6511	Extrusions	Up to 25	262	241	241	165	138	551	386	70 000
-T6, T651	Cold fin. rod & bar	Up to 200	290	241	241	172	138	607	386	70 000
-T6	Drawn tube	0.6–12	290	241	241	186	138	607	386	70 000
-T6	Pipe	Up to 25	290	241	241	186	138	607	386	70 000
-T6	Pipe	Over 25	262	241	241	165	138	551	386	70 000

(continued)

TABLE 3.3(A) (continued)

Alloy and temper	Product	Thickness range mm	Tension		Compression F_{cy} MPa	Shear		Bearing		Compressive modulus of elasticity† E MPa
			F_{tu}^* MPa	F_{ty}^* MPa		F_{su} MPa	F_{sy} MPa	F_{bu} MPa	F_{by} MPa	
6063-T5	Extrusions	Up to 12	152	110	110	90	62	317	179	70 000
-T5	Extrusions	Over 12	145	103	103	83	59	303	165	70 000
-T6	Extrusions & pipe	All	207	172	172	131	96	434	276	70 000
-T83	Drawn tube	All	275	248	248	165	138	579	393	69 637
6351-T5	Extrusions	Up to 25	262	241	241	165	138	551	386	70 000
-T6	Extrusions	≤150	293	255	255	172	145	607	421	69 637

* F_{tu} and F_{ty} are minimum specified values (except F_{ty} for 1100-H12, -H14 cold finished rod and bar and drawn tube, Alclad 3003-H18 sheet and 5050-H32, -H34 cold finished rod and bar which are minimum expected values); other strength properties are corresponding minimum expected values.

† Typical values. For deflection calculations an average modulus of elasticity is used; numerically this is 700 MPa lower than values in this column.

TABLE 3.3(B)
MINIMUM MECHANICAL PROPERTIES FOR WELDED ALUMINIUM ALLOYS

Alloy and temper	Product and thickness range mm	Tension		Compression $F_{cyw}^{\dagger}$ MPa	Shear		Bearing	
		F_{tuw}^* MPa	$F_{tyw}^{\dagger}$ MPa		F_{suw} MPa	F_{syw} MPa	F_{buw} MPa	F_{byw} MPa
1100-H12, H14	All	76	31	31	55	17	158	55
3003-H12, H14, H16, H18	All	96	48	48	69	27	207	83
Alclad								
3003-H12, H14, H16, H18	All	90	41	41	69	24	207	76
3004-H32, H34, H36, H38	All	152	76	76	96	45	317	138
Alclad								
3004-H32, H34, H36, H38	All	145	76	76	90	45	303	131
3005-H25	Sheet	117	62	62	83	34	248	103
5005-H12, H14, H32, H34	All	96	48	48	62	27	193	69
5050-H32, H34	All	124	55	55	83	31	248	83
5052-H32, H34	All	172	90	90	110	52	345	131
5083-H111	Extrusions	269	145	138	158	83	538	221
-H116, H321	Sheet & plate 5–38	276	165	165	165	96	551	248
-H116, H321	Plate 38–76	269	158	158	165	90	538	234
-H323, H343	Sheet	276	165	165	165	96	551	248
5086-H111	Extrusions	241	124	117	145	69	483	193
-H112	Plate 6–12	241	117	117	145	65	483	193
-H112	Plate 12–25	241	110	110	145	62	483	193
-H112	Plate 25–51	241	96	96	145	55	483	193
-H32, H34, H116	Sheet & plate	241	131	131	145	76	483	193
5154-H38	Sheet	207	103	103	131	59	414	158
5454-H111	Extrusions	214	110	103	131	65	427	165
-H112	Extrusions	214	83	83	131	48	427	165
-H32, H34	Sheet & plate	214	110	110	131	65	427	165
5456-H111	Extrusions	283	165	152	165	96	565	262
-H112	Extrusions	283	131	131	165	76	565	262
-H116, H321	Sheet & plate 5–38	290	179	165	172	103	579	262
-H116, H321	Plate 38–76	283	165	158	172	96	565	262
6005-T5	Extrusions up to 6	165	117	117	103	69	345	207
6061-T6, T651, T6510, T6511‡	All	165	138	138	103	83	345	207
-T6, T651, T6510, T6511§	Over 9	165	103	103	103	62	345	207
6063-T5, T6	All	117	76	76	76	45	234	152
6351-T5‡	Extrusions	165	138	138	103	83	345	207
-T5§	Over 9	165	103	103	103	62	345	207

* Filler wires are recommended in Table 7.2(A), Values of F_{tuw} are ASME weld qualification values.

† 0.2 percent of offset in 250 mm gauge length across a butt weld.

‡ Values when welded with 5183, 5356 or 5556 alloy filler wire, regardless of thickness. Values also apply to thickness less than 10 mm, when welded with 4043, 5154, 5254, or 5554 alloy filler wire.

§ Values when welded with 4043, 5154, 5254, or 5554 alloy fire wire.

NOTE: When formulas from Table 3.4(C) in the specification section are applied to welded structures, the tensile ultimate strength F_{tu} shall be 90% of the F_{tuw} values given in the above table which are ASME weld qualification test values of ultimate strength.

TABLE 3.3(C)
FORMULAS FOR BUCKLING CONSTANTS FOR PRODUCTS WHOSE TEMPER
DESIGNATION BEGINS WITH -O, -H, -T1, -T2, -T3, or -T4

Type of member and stress	Intercept, MPa	Slope, MPa	Intersection
Compression in columns and beam flanges	$B_c = F_{cy} \left[1 + \left(\frac{F_{cy}}{6900} \right)^{1/2} \right]$	$D_c = \frac{B_c}{20} \left(\frac{6B_c}{E} \right)^{1/2}$	$C_c = \frac{2B_c}{3D_c}$
Compression in flat plates	$B_p = F_{cy} \left[1 + \frac{(F_{cy})^{1/2}}{14.5} \right]$	$D_p = \frac{B_p}{20} \left(\frac{6B_p}{E} \right)^{1/2}$	$C_p = \frac{2B_p}{3D_p}$
Compression in round tubes under axial end load	$B_t = F_{cy} \left[1 + \frac{(F_{cy})^{1/2}}{8.5} \right]$	$D_t = \frac{B_t}{3.7} \left(\frac{B_t}{E} \right)^{1/2}$	$C_t *$
Compressive bending stress in solid rectangular bars	$B_{br} = 1.3F_{cy} \left[1 + \frac{(F_{cy})^{1/2}}{13.3} \right]$	$D_{br} = \frac{B_{br}}{20} \left(\frac{6B_{br}}{E} \right)^{1/2}$	$C_{br} = \frac{2B_{br}}{3D_{br}}$
Compressive bending stress in round tubes	$B_{tb} = 1.5F_y \left[1 + \frac{(F_y)^{1/2}}{8.5} \right]$	$D_{tb} = \frac{B_{tb}}{2.7} \left(\frac{B_{tb}}{E} \right)^{1/2}$	$C_{tb} = \left(\frac{B_{tb} - B_t}{D_{tb} - D_t} \right)^2$
Shear stress in flat plates	$B_s = F_{sy} \left[1 + \frac{(F_{sy})^{1/2}}{11.8} \right]$	$D_s = \frac{B_s}{20} \left(\frac{6B_s}{E} \right)^{1/2}$	$C_s = \frac{2B_s}{3D_s}$
Ultimate strength of flat plates in compression or bending	$k_1 = 0.50, \quad k_2 = 2.04$		

* C_t can be found from a plot of curves of allowable stress based on elastic and inelastic buckling or by trial and error solution.

TABLE 3.3(D)
FORMULAS FOR BUCKLING CONSTANTS FOR PRODUCTS WHOSE TEMPER
DESIGNATION BEGINS WITH -T5, -T6, -T7, -T8 or -T9

Type of member and stress	Intercept, MPa	Slope, MPa	Intersection
Compression in columns and beam flanges	$B_c = F_{cy} \left[1 + \left(\frac{F_{cy}}{15510} \right)^{1/2} \right]$	$D_c = \frac{B_c}{10} \left(\frac{B_c}{E} \right)^{1/2}$	$C_c = 0.41 \frac{B_c}{D_c}$
Compression in flat plates	$B_p = F_{cy} \left[1 + \frac{(F_{cy})^{1/2}}{21.7} \right]$	$D_p = \frac{B_p}{10} \left(\frac{B_p}{E} \right)^{1/2}$	$C_p = 0.41 \frac{B_p}{D_p}$
Compression in round tubes under axial end load	$B_t = F_{cy} \left[1 + \frac{(F_{cy})^{1/5}}{12.8} \right]$	$D_t = \frac{B_t}{4.5} \left(\frac{B_t}{E} \right)^{1/5}$	$C_t *$
Compressive bending stress in solid rectangular bars	$B_{br} = 1.3 F_{cy} \left[1 + \frac{(F_{cy})^{1/2}}{13.3} \right]$	$D_{br} = \frac{B_{br}}{20} \left(\frac{6 B_{br}}{E} \right)^{1/2}$	$C_{br} = \frac{2 B_{br}}{3 D_{br}}$
Compressive bending stress in round tubes	$B_{tb} = 1.5 F_y \left[1 + \frac{(F_y)^{1/5}}{12.8} \right]$	$D_{tb} = \frac{B_{tb}}{2.7} \left(\frac{B_{tb}}{E} \right)^{1/5}$	$C_{tb} = \left(\frac{B_{tb} - B_t}{D_{tb} - D_t} \right)^2$
Shear stress in flat plates	$B_s = F_{sy} \left[1 + \frac{(F_{sy})^{1/2}}{17.7} \right]$	$D_s = \frac{B_s}{10} \left(\frac{B_s}{E} \right)^{1/2}$	$C_s = 0.41 \frac{B_s}{D_s}$
Ultimate strength of flat plates in compression	$k_1 = 0.35, \quad k_2 = 2.27$		
Ultimate strength of flat plates in bending	$k_1 = 0.50, \quad k_2 = 2.04$		

* C_t can be found from a plot of curves of allowable stress based on elastic and inelastic buckling or by trial and error solution.

3.4 ALLOWABLE STRESSES

3.4.1 General Allowable stresses for aluminium alloy members shall be determined in accordance with provisions of Clauses 3.4.2 to 3.4.25.

In the formulas of Clauses 3.4.2 to 3.4.25, note the following:

- When more than one formula is given, the smallest of the resulting stresses should be used.
- The factors n_u , n_y and n_a shall be taken from Table 3.4(A).
- Values of coefficients k_t and k_c shall be taken from Table 3.4(B).
- Values of k_1 and k_2 are given in Tables 3.3(C) and 3.3(D).

The formulas are also listed in Table 3.4(C).

The allowable stresses for casting alloys for bridge type structures are given in Table 3.4(D).

TABLE 3.4(A)
FACTORS OF SAFETY

Factor of safety type	Building and similar type structures	Bridge and similar type structures
n_u	1.95	2.20
n_y	1.65	1.85
n_a	1.20	1.35

NOTE: Other factors of safety are given throughout this Standard.

TABLE 3.4(B)
VALUES OF COEFFICIENTS k_t AND k_c *

Alloy and temper	Non-welded or regions farther than 25 mm from a weld		Regions within 25 mm of a weld	
	k_t	k_c	k_t	$k_c^\dagger$
2014-T6, -T651‡ Alclad 2014-T6, -T651	1.25	1.12	—	—
6005-T5, 6061-T6, T651‡, 6063-T5, -T6, -T83 6105-T5, 6351-T5	1.0	1.12	1.0	1.0
All others listed in Table 3.3(A)	1.0	1.10	1.0	1.0

* These coefficients are used in the formulas in Table 3.4(C).

† If the weld compressive yield strength exceeds 0.9 times the parent material compressive yield strength, the allowable compressive stress within 25 mm of a weld shall be taken as equal to the allowable compressive stress for non-welded material.

‡ Values also apply to -T6510, -T6511 extrusion tempers.

TABLE 3.4(C)

GENERAL FORMULAS FOR DETERMINING ALLOWABLE STRESSES FROM CLAUSE 3.4

Type of stress	Type of member or component	Clause	Allowable stress				
Tension (axial, net section)	Any tension member	3.4.2	F_{ty}/n_y or $F_{tw}/(k_t/n_u)$				
Tension in beams (extreme fibre, net section)	Rectangular tubes, structural shapes bend around strong axis	3.4.3	F_{ty}/n_y or $F_{tw}/(k_t/n_u)$				
	Round or oval tubes	3.4.4	$1.17F_{ty}/n_y$ or $1.24F_{tw}/(k_t/n_u)$				
	Shapes bend about weak axis, bars, plates	3.4.5	$1.30F_{ty}/n_y$ or $1.42F_{tw}/(k_t/n_u)$				
Bearing	On rivets and bolts	3.4.6	F_{by}/n_y or $F_{bu}/(1.2n_u)$				
	On flat surfaces and pins and on bolts in slotted holes	3.4.7	$F_{by}/(1.5n_y)$ or $F_{bu}/(1.8n_u)$				
Type of stress	Type of member or component	Clause	Allowable stress slenderness $\leq S_1$	Slenderness limit S_1 (see Note)	Allowable stress slenderness between S_1 and S_2	Slenderness limit S_2	Allowable stress slenderness $\geq S_2$
Compression in columns (axial, gross section)	All columns	3.4.8	$\frac{F_{cy}}{k_c n_y}$	$\frac{kL}{r} = \frac{B_c - \frac{n_u F_{cy}}{k_c n_y}}{D_c}$	$\frac{1}{n_u} \left(B_c - D_c \frac{kL}{r} \right)$	$\frac{kL}{r} = C_c$	$\frac{\pi^2 E}{n_u \left(\frac{kL}{r} \right)^2}$
Compression in components of columns (gross section)	Flat plates supported along one edge—columns buckling about a symmetry axis	3.4.9.1	$\frac{F_{cy}}{k_c n_y}$	$\frac{b}{t} = \frac{B_p - \frac{n_u F_{cy}}{k_c n_y}}{5.1 D_p}$	$\frac{1}{n_u} \left(B_p - 5.1 D_p \frac{b}{t} \right)$	$\frac{b}{t} = \frac{k_1 B_p}{5.1 D_p}$	$\frac{k_2 \sqrt{B_p E}}{n_u (5.1 b/t)}$
	Flat plates supported along one edge—columns not buckling about a symmetry axis	3.4.9.2	$\frac{F_{cy}}{k_c n_y}$	$\frac{b}{t} = \frac{B_p - \frac{n_u F_{cy}}{k_c n_y}}{5.1 D_p}$	$\frac{1}{n_u} \left(B_p - 5.1 D_p \frac{b}{t} \right)$	$\frac{b}{t} = \frac{C_p}{5.1}$	$\frac{\pi^2 E}{n_u (5.1 b/t)^2}$
	Flat plates with both edges supported	3.4.10.1	$\frac{F_{cy}}{k_c n_y}$	$\frac{b}{t} = \frac{B_p - \frac{n_u F_{cy}}{k_c n_y}}{1.6 D_p}$	$\frac{1}{n_u} \left(B_p - 1.6 D_p \frac{b}{t} \right)$	$\frac{b}{t} = \frac{k_1 B_p}{1.6 D_p}$	$\frac{k_2 \sqrt{B_p E}}{n_u (1.6 b/t)}$
	Flat plates with one edge supported and other edge with stiffener	3.4.10.2	See Clause 3.4.10.2				

(continued)

TABLE 3.4(C) (continued)

Type of stress	Type of member or component	Clause	Allowable stress slenderness $\leq S_1$	Slenderness Limit S_1 (see Note)	Allowable stress slenderness between S_1 and S_2	Slenderness limit S_2	Allowable stress slenderness $\geq S_2$
Compression in components of columns (gross section)	Flat plates with both edges supported and with an intermediate stiffener	3.4.10.3	See Clause 3.4.10.3				
	Curved plates supported on both edges, walls of round or oval tubes	3.4.11	$\frac{F_{cy}}{k_c n_y}$	$\frac{R}{t} = \left(\frac{B_t - \frac{n_u F_{cy}}{k_c n_y}}{D_t} \right)^2$	$\frac{1}{n_u} \left(B_t - D_t \sqrt{\frac{R}{t}} \right)$	$\frac{R}{t} = C_t$	$\frac{\pi^2 E}{16 n_u \left(\frac{R}{t} \right) \left(1 + \frac{\sqrt{R/t}}{35} \right)^2}$
Compression in beams (extreme fibre gross section)	Single web beams bent about strong axis	3.4.12	$\frac{F_{cy}}{n_y}$	$\frac{L_b}{r_y} = \frac{1.2(B_c - F_{cy})}{D_c}$	$\frac{1}{n_y} \left(B_c - \frac{D_c L_b}{1.2 r_y} \right)$	$\frac{L_b}{r_y} = 1.2 C_c$	$\frac{\pi^2 E}{n_y \left(\frac{L_b}{1.2 r_y} \right)^2}$
	Round or oval tubes	3.4.13*	$\frac{1.17 F_{cy}}{n_y}$	$\frac{R_b}{t} = \left(\frac{B_{tb} - 1.17 F_{cy}}{D_{tb}} \right)^2$	$\frac{1}{n_y} \left(B_{tb} - D_{tb} \sqrt{\frac{R_b}{t}} \right)$	$\frac{R_b}{t} = \left[\frac{\left(\frac{n_u B_{tb} - B_t}{n_y} \right)^2}{\left(\frac{n_u D_{tb} - D_t}{n_y} \right)} \right]^2$	Same as Clause 3.4.11
	Solid rectangular and round section beams	3.4.14	$\frac{1.3 F_{cy}}{n_y}$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = \frac{B_{br} - 1.3 F_{cy}}{2.3 D_{br}}$	$\frac{1}{n_y} \left(B_{br} - 2.3 D_{br} \frac{d}{t} \sqrt{\frac{L_b}{d}} \right)$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = \frac{C_{br}}{2.3}$	$\frac{\pi^2 E}{5.29 n_y \left(\frac{d}{t} \right)^2 \frac{L_b}{d}}$
	Rectangular tubes and box sections	3.4.15	$\frac{F_{cy}}{n_y}$	$\frac{L_b S_c}{0.5 \sqrt{I_y J}} = \left(\frac{B_c - F_{cy}}{1.6 D_c} \right)^2$	$\frac{1}{n_y} \left(B_c - 1.6 D_c \sqrt{\frac{L_b S_c}{0.5 \sqrt{I_y J}}} \right)$	$\frac{L_b S_c}{0.5 \sqrt{I_y J}} = \left(\frac{C_c}{1.6} \right)^2$	$\frac{\pi^2 E}{2.56 n_y \left(\frac{L_b S_c}{0.5 \sqrt{I_y J}} \right)}$
Compression in components of beams (component under uniform compression, gross section)	Flat plates supported on one edge	3.4.16	$\frac{F_{cy}}{n_y}$	$\frac{b}{t} = \frac{B_p - F_{cy}}{5.1 D_p}$	$\frac{1}{n_y} \left[B_p - 5.1 D_p \left(\frac{b}{t} \right) \right]$	$\frac{b}{t} = \frac{k_1 B_p}{5.1 D_p}$	$\frac{k_2 \sqrt{B_p E}}{n_y (5.1 b/t)}$
	Flat plates with both edges supported	3.4.17	$\frac{F_{cy}}{n_y}$	$\frac{b}{t} = \frac{B_p - F_{cy}}{1.6 D_p}$	$\frac{1}{n_y} \left(B_p - 1.6 D_p \left(\frac{b}{t} \right) \right)$	$\frac{b}{t} = \frac{k_1 B_p}{1.6 D_p}$	$\frac{k_2 \sqrt{B_p E}}{n_y (1.6 b/t)}$

(continued)

* For tubes with circumferential welds, equations of Clauses 3.4.11, 3.4.13 and 3.4.18 apply for $R/t \leq 20$.