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Summary

The paper describes the recent development of an Australian standard for the design of cold-formed stainless steel structures. The standard is based on the ANSI/ASCE-8 (1991) Specification for the Design of Cold-formed Stainless Steel Structural Members but augmented to provide rules for cold-formed hollow section members and welded connections. Explicit design rules for the flexural buckling of compression members are also implemented. Further, mechanical properties are included for weldable chromium steels and austenitic-ferritic (duplex) alloys, which are in addition to the alloys included in the ANSI/ASCE-8 Specification. The purpose of this paper is to summarise the new rules and mechanical properties implemented in the draft Australian standard.

1 Introduction

In 1998, Standards Australia constituted a committee to prepare an Australian standard for the design of stainless steel structures. The draft (DR00011, 2000) was completed in December 1999 and issued for public comment on 15 January 2000. The Standard is expected to be published in the second half of 2000.

It was decided at an early stage of development to base the Australian Standard on an existing standard and the ANSI/ASCE-8 (1991) Specification for the Design of Cold-formed Stainless Steel Structural Members as well as Part 1.4 of Eurocode3 (1996) were considered for this purpose. The European standard was favored by several committee members because its design provisions are explicit and resemble those of Parts 1.1 and 1.3 of Eurocode3 for hot-rolled and cold-formed carbon steel structures respectively. It is also based on a target reliability index which is consistent with that used for its carbon steel counterparts. However, the ANSI/ASCE-8 Specification was chosen as basis for the Australian Standard because of its similarity with the AISI Specification for cold-formed carbon steel structures (AISI, 1997). The 1996-edition of the Australian Standard for cold-formed carbon steel structures (AS/NZS4600, 1996) was based on the AISI Specification and hence, the same similarity as exist between the American specifications for cold-formed carbon and cold-formed stainless steel structures could be achieved for the corresponding Australian standards by adapting the ANSI/ASCE-8 Specification. This decision was made in spite of opposition to the iterative nature of those clauses of the ANSI/ASCE-8 Specification which govern stability design and the fact that the calibration of the ANSI/ASCE-8 Specification was based on a target reliability index (β) for members of 3.0 rather than 2.5 as was used for the calibration of the AISI Specification.

In adapting the ANSI/ASCE-8 Specification, it was decided to implement new design rules for tubular members and welded tubular connections based on research undertaken at the University of Sydney. New rules were also included for an explicit design procedure for columns failing by flexural buckling. In addition, data was collected to provide mechanical properties for a wider range of alloys than is presently included in the ANSI/ASCE-8 Specification.

2 Mechanical properties

2.1 Range of alloys

Appendix A of the ANSI/ASCE-8 Specification contains graphs and tables for the yield stress and ultimate tensile strength, as well as the tangent (E_t), secant (E_s) and initial (E_0) moduli for the austenitic alloys AISI 201, 301, 304 and 316, and the ferritic alloys 409, 430 and 439. For the austenitic alloys, properties are provided for annealed, 1/16, 1/4 and 1/2 hard grades.

Industry representative of the Standards committee deemed that the structural use in Australia of the 201, 301 and 439 alloys is insignificant, as is the use of 1/16, 1/4 and 1/2 hard austenitic grades. Mechanical properties were therefore not included in the draft Standard for these alloys and grades. In stead, it was decided to include properties for the low-carbon austenitic alloys 304L and 316L as well as the chromium weldable steel 1.4003 (EN1088, 1995), which has similar properties to 3Cr12 and ASTM S41050, and the austenitic-ferritic (or duplex) alloy ASTM S31803 commonly known as 2205.

2.2 Mechanical properties for normal stress

2.2.1 General. For each alloy included in the draft, values were provided for the initial Young's modulus (E_0), the 0.2 % proof stress (f_y), also referred to as the yield stress, the tensile strength (f_u), the proportionality stress (f_p), also referred to as the initial yield stress, and the n-parameter of the Ramberg-Osgood expression (Ramberg and Osgood, 1943). The latter controls the sharpness of the knee of the stress-strain curve.

Mechanical properties for tension and compression were provided for the longitudinal (rolling) and transverse directions. The complete set of properties is shown in Tables 1a-1d.

		304 316	**304L 316L**	**409**	**1.4003 (3Cr12)**	**430**	**S31803 (2205)**
Initial Young's modulus (E_0)	(GPa)	195	195	185	195	185	200
0.2% proof stress (f_y)	(MPa)	205	205	205	250	275	430
Ultimate tensile strength (f_u)	(MPa)	520	485	380	435	450	590
Proportionality stress (f_p)	(MPa)	140	140	155	180	195	245
n-parameter		7.5	7.5	11	9	8.5	5.5

a) Longitudinal tension

		304 316	304L 316L	409	1.4003 (3Cr12)	430	S31803 (2205)
Initial Young's modulus (E_0)	(GPa)	195	195	185	210	185	195
0.2% proof stress (f_y)	(MPa)	195	195	205	260	275	435
Proportionality stress (f_p)	(MPa)	90	90	150	170	170	245
n-parameter		4	4	9.5	7.5	6.5	5

b) Longitudinal compression

		304 316	304L 316L	409	1.4003 (3Cr12)	430	S31803 (2205)
Initial Young's modulus (E_0)	(GPa)	195	195	200	220	200	205
0.2% proof stress (f_y)	(MPa)	205	205	240	280	310	450
Ultimate tensile strength (f_u)	(MPa)	520	485	380	460	450	620
Proportionality stress (f_p)	(MPa)	118	118	200	215	250	245
n-parameter		5.5	5.5	16	11.5	14	5

c) Transverse tension

		304 316	304L 316L	409	1.4003 (3Cr12)	430	S31803 (2205)
Initial Young's modulus (E_0)	(GPa)	195	195	200	230	200	205
0.2% proof stress (f_y)	(MPa)	205	205	240	285	310	445
Proportionality stress (f_p)	(MPa)	135	135	200	220	255	265
n-parameter		7	7	16	11.5	15	5.5

d) Transverse compression

		304 316	304L 316L	409	1.4003 (3Cr12)	430	S31803 (2205)
Initial elastic modulus (G_0)	(GPa)	75	75	75	75	75	75
0.2% proof stress (f_{yv})	(MPa)	115	115	130	155	165	255
n-parameter		6	6	13	10	11	5.5

e) Shear

Table 1: Mechanical properties

The n-values for 304, 316, 409 and 430 alloys shown in Tables 1a-1d were obtained using eqn. (1) in conjunction with the ratio (f_p / f_y) of proportionality stress to yield stress given in Table A17 of the ANSI/ASCE-8 Specification. The n-values differ slightly from those given in Table B of the ANSI/ASCE-8 Specification.

$$n = \frac{\ln(20)}{\ln(f_y / f_p)} \tag{1}$$

In using eqn. (1), it is implicit that the proportionality and yield stresses are determined as the 0.01% and 0.2% proof stresses respectively.

The mechanical properties for 1.4003 alloy were obtained as those given for 3Cr12 in the South African Specification for the design of Cold-formed Stainless Steel Structural Members (SABS 1997). The alloy 1.4003 is the equivalent of 3Cr12 predominantly used in Australia. The alloy composition of 1.4003 is slightly different from that of 3Cr12 and the yield stress is generally slightly higher.

2.2.2 Compilation of mechanical properties for 304L, 316L and S31803. In selecting mechanical properties for 304L, 316L and S31803, compliance with the reliability calibration underpinning the ANSI/ASCE-8 Specification (Lin et al. 1988) was sought by choosing the nominal values of yield stress and tensile strength such that the following requirements were met:

$$\text{Yield stress:} \quad M_m \geq 1.149 \qquad V_M \leq 0.0902 \tag{2}$$

$$\text{Tensile strength:} \quad M_m \geq 1.178 \qquad V_M \leq 0.0560 \tag{3}$$

where M_m and V_M are the mean and coefficient of variation respectively of the ratio of measured value (yield stress or tensile strength) to nominal value. For instance, on an average basis, the measured yield stress should exceed 1.149 times the nominal yield stress. The limits for M_m and V_M shown in eqns (2-3) are those used in Lin et al. (1988) to derive the resistance factors implemented in the ANSI/ASCE-8 Specification.

Statistical data for 304L and 316L was obtained from tensile test records compiled by the Australian stainless steel sheet and coil producer Broken Hill Propriety – Stainless (BHP, 1994). In excess of 500 production-run coupon tests were conducted in the period from 1990 to 1994 on 304L and 316L in the thickness range from 0.55 mm to 6 mm. The mean values and coefficient of variation of measured yield stress and tensile strength are shown in Table 2.

Alloy	Yield stress			Ultimate tensile strength		
	f_{ym}	$M_m=f_{ym} / f_{yn}$	V_M=COV(f_y)	f_{um}	$M_m=f_{um} / f_{un}$	V_M=COV(f_u)
	(MPa)			(MPa)		
304L	266	1.297	0.080	601	1.293	0.045
316L	296	1.443	0.112	602	1.241	0.040

Table 2: Statistical data for yield stress and tensile strength (BHP, 1994), transverse tension. (See Table 1c for nominal values of yield stress (f_{yn}) and tensile strength (f_{un})).

Supplementary data was obtained from the report SCI-RT-251 prepared by the Steel Construction Institute (SCI, 1991) describing coupon tests on material collected from three major European stainless steel producers. For the alloys 304L, 316L and S31803, coupons were tested over a wide range of thicknesses using three distinct stress rates (0.3 N/mm^2/s, 3 N/mm^2/s and 30 N/mm^2/s). Different stress rates were used to assess the rate sensitivity in the testing of stainless steel coupons. The fastest rate (30 N/mm^2/s) was chosen to represent that used commercial production run testing, while the slowest (0.3 N/mm^2/s) was representative of a quasi-static test. By analysing the test data of the SCI-RT-251 report statistically, the values for tension in the transverse direction shown in Table 3 were obtained. The mean measured values of yield stress shown in Table 3 can also be found in Table C.3.2 of the EURO-INOX Design Manual (EURO-INOX, 1994).

Alloy	Yield stress			Ultimate tensile strength		
	f_{ym}	$M_m=f_{ym} / f_{yn}$	$V_M=COV(f_y)$	f_{um}	$M_m=f_{um} / f_{un}$	$V_M=COV(f_u)$
	(MPa)			(MPa)		
304L	259	1.263	0.050	591	1.218	0.028
316L	286	1.395	0.079	587	1.210	0.025
S31803	544	1.208	0.107	799	1.229	0.045

Table 3: Statistical data for yield stress and tensile strength (SCI, 1991), transverse tension. (See Table 1c for nominal values of yield stress (f_{yn}) and tensile strength (f_{un})).

The coefficients of variation (V_M) of the test data shown in Tables 2 and 3 were within the limits stated in eqns (2-3) above, except for the coefficient of variation of the yield stress of 316L (COV(f_y)=0.112), as shown in Table 2, and the yield stress of S31803 (COV(f_y)=0.107), as shown in Table 3, which were slightly higher than the limit of 0.0902. However, the higher values were tolerated because firstly, the mean measured yield stress for 316L shown in Table 2 (f_{ym}=296 MPa) was significantly higher than the nominal value (f_{yn}=205 MPa), and secondly, the wide range of stress rates used in the SCI tests would produce artificially high values of coefficients of variation including that for S31803.

The target value of nominal yield stress of f_{yn} =205 MPa was chosen for 304L and 316, since this was also the yield stress specified for 304 and 316 in ASTM A240 (1984) and AS1449 (1994). This approach was consistent with Eurocode3, Part 1.4, which specifies the same yield stress for 304 and 304L, and for 316 and 316L. The fact that the yield stress of 205 MPa was higher than the nominal value of 170 MPa specified for 304L and 316L in ASTM A240 and AS1449 was considered to be justified by the high ratios of mean to nominal yield stress (f_{ym}/f_{yn}) shown in Tables 2 and 3, which in all cases exceeded the lower limit of 1.149, see eqn. (2), by significant margin.

In a similar fashion to the yield stress, it was sought to apply the same nominal tensile strength (f_{un}=520 MPa) to 304L and 316L as is specified for 304 and 316 in ASTM A240 and AS1449. However, in this case, the ratio of mean to nominal did not meet the minimum requirement of 1.178 given by eqn. (3). The nominal tensile strength of f_{un}=485 MPa specified in ASTM A240 and AS1449 for 304L and 316L was therefore selected. This value produced ratios of mean to nominal tensile strength (f_{ym}/f_{yn}) which exceeded the requirement of 1.178 in all cases, as shown in Tables 2 and 3. Consistent with the ANSI/ASCE-8 Specification, the nominal tensile strength for longitudinal tension was assumed to be the same as that for transverse tension.

On the basis of these considerations, it was decided to use the same mechanical properties for 304, 304L, 316 and 316L, except for the tensile strength, for which a distinction was made between (304,316) and (304L,316L).

The nominal values of yield stress and tensile strength of 450 MPa and 620 MPa were selected for S31803 (transverse tension), as obtained from ASTM A240 and AS1449. The values produced ratios of mean to nominal of 1.208 and 1.229 for the yield stress and tensile strength respectively, which satisfied the minimum requirements of 1.149 and 1.178 respectively, see Table 3 and eqns (2-3). The yield stress and tensile strength for transverse compression, longitudinal tension and longitudinal tension were obtained by scaling the mean values for these directions, as obtained from report SCI-RT-251, by the same factor as the one that scaled the mean measured value to the nominal value for transverse tension. The scaling factors were 450/544=0.827 and 620/799=0.776 for the yield stress and ultimate tensile strength respectively. The mean values of E_0 and f_p/f_y, as obtained from SCI-RT-251, were adopted. It is noted that the mechanical properties for S31803 (2205) given in SCI-RT-251 were obtained from tests on plates which generally exceeded 4 mm in thickness and thus probably were hot-rolled. The properties can therefore be assumed to be conservative compared to the properties which would result from coupon tests of thinner plates which usually are cold-rolled and more likely to be used in structural applications involving cold-formed members.

In line with AS1449, the mechanical properties thus obtained for 304L, 316L and S31803 were rounded to their nearest multiple of 5 MPa for stresses and 5 GPa for initial elastic moduli. The n-parameter was rounded to its nearest 0.5.

2.3 *Mechanical properties shear*

The yield stress values for shear (f_{yv}) given in Table A1 of the ANSI/ASCE-8 Specification have been selected for 304, 316, 409 and 430 alloys, as summarised in Table 1e. It has been assumed that the yield stress values for shear for 304L and 316L alloys are the same as those for 304 and 316. This assumption was made on the basis of the conclusion drawn by Wang and Winter (1969) who showed that the shear yield stress can be determined approximately by dividing the mean of the four yield stress values for longitudinal tension (LT), longitudinal compression (LC), transverse tension (TT), and transverse compression (TC) by $\sqrt{3}$. Since the nominal yield stress values for LT, LC, TT and TC have been chosen to be the same for 304, 316, 304L and 316L, Wang and Winter's conclusion leads to the same yield stress values for shear for these alloys. The yield stress (f_{yv}) is shown in Table 1e.

Wang and Winter's conclusion was also used to compute the yield stress for shear for 1.4003 (3Cr12) and S31803 (2205). Thus, the yield stress values shown in Table 1e were obtained by dividing the mean of the yield stress values for LT, LC, TT and TC by $\sqrt{3}$.

Wang and Winter (1969) also showed that the initial shear modulus can be obtained approximately as,

$$G_0 = \frac{E_0}{2(1+\upsilon)} \tag{4}$$

where E_0 is the mean of the initial Young's moduli for LT, LC, TT and TC, and Poisson's ratio (ν) can be taken as 0.31. The initial shear moduli shown in Table 1e have been computed using eqn. (4).

2.4 Expressions for moduli

2.4.1 Normal stress. Appendix A of the ANSI/ASCE-8 Specification provides tables and graphs of the tangent (E_t) and secant (E_s) moduli for a range of alloys. In the South African Standard (SABS 1997), these tables and graphs are replaced by expressions for the moduli derived from the Ramberg-Osgood expression as follows:

$$E_t = \frac{df}{d\varepsilon} = \frac{E_0}{1 + 0.002 E_0 / f_y n (f / f_y)^{n-1}} \tag{5}$$

$$E_s = \frac{f}{\varepsilon} = \frac{E_0}{1 + 0.002 E_0 / f_y (f / f_y)^{n-1}} \tag{6}$$

where f and ε are the normal stress and strain respectively. The tangent and secant moduli can be determined from eqns (5-6) for given values of the Ramberg-Osgood parameters (E_0, f_y, n). The South African approach was chosen for the draft Australian Standard.

2.4.2 Shear stress. Following Wang and Winter's recommendation (1969), expressions for the secant (G_s) and tangent (G_t) shear moduli have been obtained using the concept of affinity factors. Accordingly, the shear stress (f_v) and strain (γ) are expressed as,

$$f_v = \alpha f \tag{7}$$

$$\gamma = \beta \varepsilon \tag{8}$$

where the normal stress (f) and strain (ε) are those pertaining to the "average" stress strain curve obtained for a given normal strain by averaging the four stresses for LT, LC, TT and TC. Wang and Winter (1969) found that sufficient engineering accuracy could be achieved using $\alpha = 1/\sqrt{3}$ and $\beta = 1.5$.

By using the affinity factor concept and expressing the stress-strain curve for shear as a Ramberg-Osood curve, the secant and tangent moduli for shear can be approximated by:

$$G_s = \frac{f_v}{\gamma} = \frac{G_0}{1 + 0.003 G_0 / f_{yv} (f_v / f_{yv})^{n-1}} \tag{9}$$

$$G_t = \frac{df_v}{d\gamma} = \frac{G_0}{1 + 0.003 G_0 / f_{yv} n (f_v / f_{yv})^{n-1}} \tag{10}$$

In the expressions for G_s and G_t, the n-parameter is obtained as the average of the values for LT, LC, TT and TC. The values are given in Table 1e.

3 Design rules for tubular members and welded connections

3.1 General

New design recommendations for cold-formed stainless steel tubular members and welded connections were included in the draft Standard. The recommendations were based on research undertaken at the University of Sydney and in Europe (Burgan et al. 2000). The focus of the Sydney University research was to develop design guidelines which would allow the substantial increase in proof stress arising from the cold-forming process to be utilised in design. Coupon and stub column tests on square, rectangular and circular sections indicated that the nominal proof stress of the virgin strip was typically doubled by the cold-forming process. Thus, there was a strong incentive to make allowance for the strength enhancement in the design provisions.

3.2 Flexural members

3.2.1 Rectangular hollow sections. Based on the recommendations made in Rasmussen and Hancock (1993b), provision were included which allowed the nominal section bending strength (M_n) of rectangular tubes to be based on the *plastic* section modulus (S_p),

$$M_n = S_p f_y \tag{11}$$

provided the flat width to thickness ratio (*w/t*) of the compression flange satisfied,

$$w/t \leq \frac{1.1}{f_y / E_0} \tag{12}$$

In using eqns (11,12), the nominal yield stress (f_y) may be the enhanced value determined from the finished product. The section bending strength determined from eqn. (11) is more liberal than the current provisions of the ANSI/ASCE-8 Specification which limit the bending section strength to the yield moment by use of the *elastic* section modulus.

3.2.2 Circular hollow sections. Using the results contained in Rasmussen and Hancock (1993b) and Burgan et al. (2000), new rules were included for the bending section strength of circular hollow sections, as follows:

$$M_n = \begin{cases} S_p f_y & D/t \leq 0.12 E_0 / f_y \\ \left(S_p - (S_p - S_f) \dfrac{D/t \times F_y / E_0 - 0.12}{0.11} \right) f_y & 0.12 E_0 / f_y < D/t \leq 0.23 E_0 / f_y \\ K_c S_f f_y & 0.23 E_0 / f_y < D/t \leq 0.881 E_0 / f_y \end{cases} \tag{13}$$

In equation (13), D is the outside diameter, S_f is the elastic section modulus, and K_c is a slenderness reduction factor as defined in Section 3.6.1 of the ANSI/ASCE-8 Specification. Equation (13) leads to higher bending section strengths than the ANSI/ASCE-8 Specification because firstly, it allows the plastic moment, rather than yield moment, to be utilised and secondly, the yield *D/t*-ratio is changed from 0.112 E_0/f_y to 0.23 E_0/f_y according to the data presented in Burgan et al. (2000).

3.3 Compression members

It was shown in Rasmussen and Hancock (1993a) that the column strength can be based on the tangent modulus curve obtained from the finished tube, and that the column strength thus obtained was significantly higher than that based on the tangent modulus curve for the virgin strip. The ANSI/ASCE-8 Specification does not include provisions for determining the tangent modulus from the finished product and it is implicit that the virgin properties apply. In the testing provisions of the draft Standard, reference is made to ASTM E111 (1982) for determining tangent and secant moduli from testing.

3.4 Combined bending and shear

Following the recommendation made in Rasmussen and Hancock (1993b), the bending section strength of compact rectangular hollow sections satisfying eqn. (12) shall not be reduced by the concurrent presence of bending and shear according to the draft Standard. This provision was included in recognition of the fact that the bending section strength is likely to be significantly higher than the plastic moment given by eqn. (11) and that a concurrent shear therefore can be tolerated without reduction in plastic capacity.

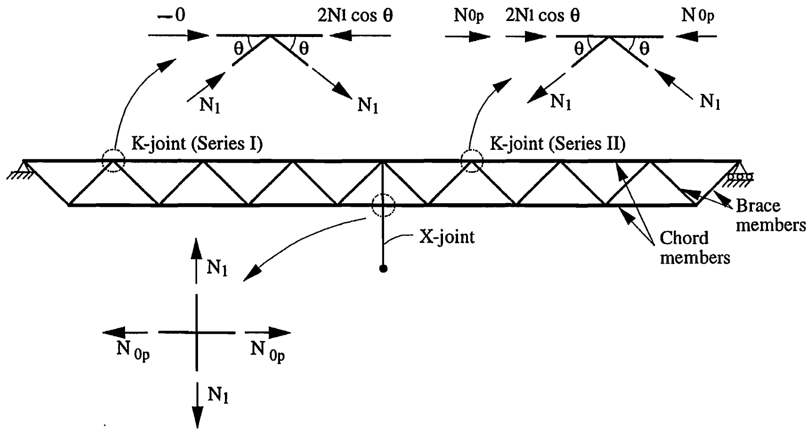

Figure 1: X- and K-joints in welded Warren truss with continuous chords

3.5 Welded connections

The tests reported in Rasmussen and Young (1994) and Rasmussen and Hasham (1994) on welded X- and K-joints in square and circular hollow sections (see Fig. 1) showed that the CIDECT (1991, 1992) design provisions for welded *carbon* steel tubular joints can also be applied to stainless steel hollow sections. In applying the CIDECT strength equations to cold-formed stainless steel tubes, the enhanced 0.2 % proof stress of the finished product may be substituted for the yield stress. Appendix G of the draft Standard contains the CIDECT strength equations in a similar form to that used in Annex K of Eurocode3 (1992). Unlike the CIDECT strength equations, which incorporate resistance factors in a non-explicit form, the strength equations given in Appendix G of the draft Standard explicitly list the resistance factors. The range of applications covered by the CIDECT strength equations is significantly broader than that covered by the tests on stainless steel joints. However, the tests strengths were consistently conservative and it was deemed safe to extend the applicability range to that of the CIDECT strength equations on this basis.

The investigations described in Rasmussen and Young (1994) and Rasmussen & Hasham (1994) paid particular attention to the serviceability deformations of the joints. It was demonstrated that as a result of the gradual softening of stainless steel alloys, the deformations grew at a faster rate than for carbon steel tubes leading to increased joint deformations at service loads. However, the serviceability deformation limit of 1 % of the chord width (or diameter) was not exceeded and thus it would not be necessary to check joint deformations under service loads when using the CIDECT strength equations. The deformation limit of 1 % of the chord width has emerged from the CIDECT research work as a *de facto* serviceability limit for welded tubular joints.

4 Explicit design rules for columns failing by flexural buckling

The explicit design procedure developed by Rasmussen and Rondal (1997b) was included in the draft Standard as an alternative to the iterative procedure of the ANSI/ASCE-8 Specification which is based on the tangent modulus approach.

According to the explicit procedure, the compressive flexural design strength ($\Phi_c P_n$) is determined as,

$$\Phi_c = 0.9 \tag{14}$$

$$P_n = A_e f_n \tag{15}$$

where Φ_c is the resistance factor, A_e is the effective area and f_n is the buckling stress determined as,

$$f_n = \frac{f_y}{\phi + \sqrt{\phi^2 - \lambda^2}} \le f_y \tag{16}$$

$$\phi = \tfrac{1}{2}\left(1 + \eta + \lambda^2\right) \tag{17}$$

$$\eta = \alpha\left((\lambda - \lambda_1)^\beta - \lambda_0\right) \tag{18}$$

$$\lambda = \sqrt{\frac{f_y}{f_{E_0}}} = \sqrt{\frac{f_y}{\pi^2 E_0}}\frac{KL}{r} \tag{19}$$

In eqn. (19), *KL* is the effective length and *r* is the radius of gyration. Table 4 shows the values of α, β, λ_0 and λ_1 included in the draft Standard. The values were obtained by substituting the values E_0, f_y and n given in Table 1b into the analytic expressions for α, β, λ_0 and λ_1 given in Rasmussen and Rondal (1997a).

	304 316	304L 316L	409	1.4003 (3Cr12)	430	S31803 (2205)
α	1.59	1.59	0.77	0.94	1.04	1.16
β	0.28	0.28	0.19	0.15	0.14	0.13
λ_0	0.55	0.55	0.51	0.56	0.59	0.65
λ_1	0.20	0.20	0.19	0.27	0.33	0.42

Table 4: Values of α, β, λ_0 and λ_1

5 Conclusions

The development of a draft Australian standard for the design of cold-formed stainless steel structures has been summarised. In particular, new design rules for stainless steel hollow section members and welded joints have been implemented in the draft, as have new rules for an explicit design procedure for compression members failing by flexural buckling. Mechanical properties for a wider range of alloys than is currently included in the ANSI/ASCE-8 Specification have also been included in the draft. The draft Standard was issued for public comment in January 2000 and is expected to be finalised in the second half of 2000.

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