**Appendix A: Ambient Temperature Axial Compression Capacity of 90x35x8x0.75 mm Stud –**

**(Model G)**

**A1 Based on Direct Strength Method (DSM) – AS/NZS 4600 (SA, 2005)**

A1.1 Stud centerline dimensions and section properties

c

b

a

Nominal External Dimensions

A = 8 mm, B = 35 mm and C = 90 mm

Thickness (BMT) – 0.75 mm

*Note: Dimensions A to C are stud external dimensions and a to c are centerline dimensions.*

x

y

Effective length about the major axis of bending Lx = 3,000 mm

Effective length about the minor axis of bending Ly = 300 mm (screw spacing at 300 mm c/c)

Section properties of the Stud (from CUFSM):

Gross area of the section Ag = 129.75 mm2

Second moment of area about the major axis Ixx = 165,847 mm4

Second moment of area about the minor axis Iyy = 21,044 mm4

Radius of gyration about major axis mm

Radius of gyration about minor axismm

Mechanical properties of the Stud (Nominal values):

Yield Strength at ambient temperature fy,20 = 550 MPa

Elastic modulus at ambient temperature E20 = 200,000 MPa

A1.2 Elastic flexural buckling stress (foc) – Cl 3.4 AS/NZS 4600 (SA, 2005)

Plasterboard provides torsional and flexural-torsional buckling restraints to the studs in gypsum plasterboard lined walls, thus the stud sections are not subjected to torsional or flexural-torsional buckling.

Elastic flexural buckling stress about the major axis fox

MPa

Elastic flexural buckling stress about the minor axis foy

MPa

Elastic flexural buckling stress foc = Lesser of fox and foy = 280.31 MPa

A1.3 Flexural buckling capacity of the stud (Nce)

Elastic flexural buckling load

kN

Nominal yield load

kN

Flexural Buckling Capacity

kN

A1.4 Local buckling capacity of the stud

Local buckling load factor = 0.13 (see the CUFSM signature curve for Model G – 90x35x8x0.75 mm Stud – Figure 4 in Report 4)

Critical local buckling load (Local buckling load factor)

= 129.75 x (0.13 x 550) = 9.28 kN

Local buckling capacity of the stud 

= 17.50 kN

If flexural, torsional and flexural-torsional buckling modes are restrained local buckling capacity of the stud is:

Local buckling capacity of the stud 

= 29.46 kN

**Ultimate Capacity of 90x35x8x0.75 mm Stud at Ambient Temperature = 17.50 kN**

**(Local + flexural buckling modes)**

**A2 Based on Effective Width Method (EWM) – AS/NZS 4600 (SA, 2005)**

A2.1 Critical stress (fn) – Cl 3.4 AS/NZS 4600 (SA, 2005)

Elastic flexural buckling stress foc = Lesser of fox and foy = 280.31 MPa (see Section A1.2)

Non-dimensional slenderness

Critical stress for

= MPa

A2.1 Effective widths of uniformly compressed elements

A2.1.1 Web

Effective width of uniformly compressed stiffened elements - Cl 2.2.1 AS/NZS 4600 (SA, 2005)

Plate elastic buckling stress

= 51.06 MPa

The slenderness ratio

Effective width factor

mm

A2.1.2 Flange

Effective widths of uniformly compressed elements with an edge stiffener - Cl 2.4 AS/NZS 4600 (SA, 2005)

Slenderness factor

mm4

mm4

mm4

mm4 < Ia

mm4

Plate buckling coefficient k based on Table 2.4.2 of AS/NZS 4600 (SA, 2005)

= 3.527

Plate elastic buckling stress

= 305.71 MPa

The slenderness ratio

Effective width factor

mm

mm

mm

A2.1.3 Lip

Effective width of uniformly compressed unstiffened elements - Cl 2.3.1 AS/NZS 4600 (SA, 2005)

Plate elastic buckling stress

= 752.00 MPa

The slenderness ratio

Effective width factor

mm

mm

A2.1.4 Nominal member capacity (Nc)

Effective area of 90x35x8x0.75 mm Stud in pure compression at ambient temperature Aeff mm2

**Nominal Member Capacity Nc** = 77.89 x 241.87

**= 18.84 kN**

A2.2 Nominal section capacity (Ns)

A2.2.1 Web

The slenderness ratio

Effective width factor

mm

A2.2.2 Flange

Slenderness factor

mm4

mm4

mm4

mm4 < Ia

mm4

Plate buckling coefficient k based on Table 2.4.2 of AS/NZS 4600 (SA, 2005)

= 3.644

Plate elastic buckling stress

= 315.85 MPa

The slenderness ratio

Effective width factor

mm

mm

mm

A2.2.3 Lip

The slenderness ratio

Effective width factor

mm

Effective area of 90x35x8x0.75 mm Stud in pure compression at ambient temperature Aeff mm2

**Nominal Section Capacity Ns** = 55.07 x 550

**= 30.29 kN**

**Ultimate Capacity of 90x35x8x0.75 mm Stud at Ambient Temperature = 18.84 kN**

**(Local + flexural buckling modes)**

**Table A1: Comparison of FE Analysis Results with Predictions from DSM based Design Rules in AS/NZS 4600 for Type W1 LSF Wall Studs**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Stud FE Model No | LSF Wall Panels | | Ultimate Axial Compression Capacity (kN) | | | | |
| Stud Size  (External Dimensions) | Stud Thickness (mm) | DSM – Section capacity allowing for local buckling (Ncl,2) | DSM – allowing for Flexural buckling (Nce) | DSM – Member capacity allowing for local and flexural buckling (Ncl,1) | FE Analysis | Stud Failure Mode in FE |
| Model A | 75x35x8 Lipped Channel Stud | 0.55 | 17.98 | 15.57 | 8.82 | 15.97 | Local |
| Model B | 0.75 | 30.95 | 21.00 | 14.93 | 29.65 | Local |
| Model C | 1.00 | 50.09 | 27.58 | 23.70 | 46.83 | Local |
| Model D | 1.20 | 64.24 | 32.76 | 31.84 | 57.65 | Local + Global |
| Model E | 1.60 | 96.14 | 42.70 | 42.70 | 78.27 | Global |
| Model F | 90x35x8 Lipped Channel Stud | 0.55 | 17.21 | 23.23 | 10.32 | 16.13 | Local |
| Model G | 0.75 | 29.46 | 31.38 | 17.50 | 29.51 | Local |
| Model H | 1.00 | 48.17 | 41.41 | 28.30 | 44.45 | Local |
| Model I | 1.20 | 62.06 | 48.28 | 37.90 | 61.85 | Local + Global |
| Model J | 1.60 | 93.86 | 61.38 | 59.10 | 70.69 | Local + Global |
| Model K | 100 C-Purlin  (102x51x12.5 mm) | 1.00 | 57.62 | 67.39 | 39.11 | 54.41 | Local |
| Model L | 1.20 | 73.56 | 77.26 | 51.44 | 75.12 | Local |
| Model M | 100 C-Purlin  (102x51x13.5 mm) | 1.50 | 101.30 | 91.86 | 72.80 | 107.96 | Local |
| Model N | 100 C-Purlin  (102x51x14.5 mm) | 1.90 | 152.72 | 115.92 | 108.52 | 147.82 | Local + Global |
| Model O | 150 C-Purlin  (152x64x14.5 mm) | 1.20 | 75.35 | 141.21 | 64.10 | 79.36 | Local |
| Model P | 150 C-Purlin  (152x64x15.5 mm) | 1.50 | 103.15 | 163.20 | 88.95 | 117.17 | Local |
| Model Q | 150 C-Purlin  (152x64x16.5 mm) | 1.90 | 156.23 | 206.73 | 134.32 | 169.77 | Local |
| Model R | 150 C-Purlin  (152x64x18.5 mm) | 2.40 | 234.78 | 262.35 | 201.09 | 246.34 | Local |

**Table A2: Comparison of FE Analysis Results with Predictions from EWM based Design Rules in AS/NZS 4600 for Type W1 LSF Wall Studs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stud FE Model No | LSF Wall Panels | | Ultimate Axial Compressive Capacity (kN) | | |
| Stud Size  (External Dimensions) | Stud Thickness (mm) | EWM – Nominal Section capacity – (Ns) | EWM– Nominal Member capacity (Nc) | FE Analysis |
| Model A | 75x35x8 Lipped Channel Stud | 0.55 | 18.74 | 9.92 | 15.97 |
| Model B | 0.75 | 30.40 | 15.38 | 29.65 |
| Model C | 1.00 | 46.97 | 23.44 | 46.83 |
| Model D | 1.20 | 57.64 | 29.82 | 57.65 |
| Model E | 1.60 | 87.85 | 42.09 | 78.27 |
| Model F | 90x35x8 Lipped Channel Stud | 0.55 | 18.79 | 12.05 | 16.13 |
| Model G | 0.75 | 30.29 | 18.84 | 29.51 |
| Model H | 1.00 | 47.17 | 28.76 | 44.45 |
| Model I | 1.20 | 58.69 | 37.51 | 61.85 |
| Model J | 1.60 | 89.15 | 54.66 | 70.69 |
| Model K | 100 C-Purlin  (102x51x12.5 mm) | 1.00 | 57.42 | 41.27 | 54.41 |
| Model L | 1.20 | 72.15 | 51.80 | 75.12 |
| Model M | 100 C-Purlin  (102x51x13.5 mm) | 1.50 | 96.12 | 70.99 | 107.96 |
| Model N | 100 C-Purlin  (102x51x14.5 mm) | 1.90 | 138.19 | 104.09 | 146.33 |
| Model O | 150 C-Purlin  (152x64x14.5 mm) | 1.20 | 77.93 | 67.91 | 79.36 |
| Model P | 150 C-Purlin  (152x64x15.5 mm) | 1.50 | 105.85 | 92.44 | 117.17 |
| Model Q | 150 C-Purlin  (152x64x16.5 mm) | 1.90 | 153.24 | 132.25 | 169.77 |
| Model R | 150 C-Purlin  (152x64x18.5 mm) | 2.40 | 224.69 | 199.71 | 245.82 |