BAILEY SHEET METAL SCREWS

Design Capacities for Sheet Metal Screws in Lightweight Steel Framing Applications

This Technical Product Data Sheet provides the factored resistance of connections made with sheet metal screws calculated in accordance with CAN/CSA-S136-01 *North American Specification for the Design of Cold Formed Steel Structural Members*, with the 2004 Supplement. This data is intended as a guide to help simplify the design of these connections.[1]

Material Properties

Calculations are based on the mechanical properties of the lightweight steel framing components listed in Table 1, and the properties of the screws listed in Table 2.

Factored Resistance of Screwed Connections

The factored resistance of screwed connections is a function of the failure type, screw size and sheet properties. Listed in Table 3 are the factored resistance values for the various limits. The minimum value of the controlling limit state will govern.

TABLE 1: Design Thickness and Mechanical Properties of LSF Components

Thickness Designation (mils)	Design Thickness, t (mm)	Strength	
		Yield, F_y (MPa)	Ultimate, F_u (MPa)
33	0.879	230	310
43	1.146	230	310
54	1.438	345	450
68	1.811	345	450
97	2.583	345	450

TABLE 2: Nominal Diameter and Stength of Screws[2]

Number Designer for Screw	Norminal Diameter, d (mm)	Nominal Shear Strength, F_{ss} (kN)	Nominal Tension Strength, F_{ts} (kN)
#6 – 20	3.56	3.34	5.72
#8 – 18	4.06	4.45	6.87
#10 – 16	4.83	6.23	8.61
#12 – 14	5.33	8.90	12.36
1/4 – 14	6.35	11.57	18.06

1. While the material is believed to be technically correct and in accordance with recognized practice at the time of publication, it does not obviate the need to determine its suitability for a given situation. Neither the Canadian Sheet Steel Building Institute nor its Members warrant or assume any liability for the suitability of the material for any general or particular purpose.
2. These values were taken from the ITW Buildex 2006/2007 product catalogue for TEKS self-drilling, self-tapping screws and may not be appropriate for other screw types or products from other screw manufacturers.

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Design Equations for Shear (S136 Clause E4.3)

Connection Shear Limited by Tilting and Bearing (S136 Clause E4.3.1):

For $t_2 / t_1 \leq 1.0$,
P_{ns} equals the smallest of;

$P_{ns} = 4.2(t_2^3 d)^{1/2} F_{u2}$
$P_{ns} = 2.7 t_1 d F_{u1}$
$P_{ns} = 2.7 t_2 d F_{u2}$

For $t_2 / t_1 \geq 2.5$,
P_{ns} equals the smallest of;

$P_{ns} = 2.7 t_1 d F_{u1}$
$P_{ns} = 2.7 t_2 d F_{u2}$

For t_2 / t_1 values between 1.0 & 2.5, P_{ns} is determined through linear interpolation

End Distance (S136 Clause E4.3.2): Another mode of failure is the possibility of a single screw tearing out from the end of the connected sheet; however, this mode will not govern if $e \geq 1.7d$.

Shear in Screws (S136 Clause E4.3.3): The nominal shear resistance of the screw is taken as P_{ss}.

Design Equations for Tension (S136 Clause E4.4)

Pull-Out (S136 Clause E4.4.1):

$P_{not} = 0.85 t_c d F_{u2}$

Pull-Over (S136 Clause E4.4.2):

$P_{nov} = 1.5 t_1 d_w F_{u1}$

Tension in Screws (S136 Clause E4.4.3): The nominal tensile resistance of the screw is taken as P_{ts}.

Combined Shear and Pull-Over (S136 Clause E4.5)

For connections subjected to a combination of both shear and tension forces, the following interaction equation applies.

$$\frac{\bar{Q}}{P_{ns}} + 0.71\frac{\bar{T}}{P_{nov}} \leq 1.10\phi \quad \text{where, } \phi = 0.55$$

The shear/pull-over interaction equation is valid for connections that meet the following limits:
1. $0.724\text{ mm} \leq t_1 \leq 1.13\text{ mm}$ **2.** #12 and #14 self-drilling screws with or without washers **3.** $d_w \leq 19.1\text{ mm}$ **4.** $F_{U1} \leq 483\text{ MPa}$ **5.** $t_2 / t_1 \geq 2.5$

For eccentrically loaded connections that produce a non-uniform pull-over force on the fastener, the nominal pull-over resistance shall be taken as 50% of P_{nov}.

Rupture (S136 Clause E5)

The other failure mode that must be considered is the block tear-out of a group of fasteners.

SYMBOLS

d = Nominal screw diameter

d_w = Larger of the screw head diameter or washer diameter

e = Distance from the centre of the fastener to the end of the connected sheet

F_{u1} = Tensile strength of member in contact with screw head

F_{u2} = Tensile strength of member not in contact with screw head

P_{nov} = Nominal pull-over resistance per screw

P_{ss} = Nominal shear resistance of screw as reported by manufacturer or determined by independent laboratory testing

P_{ts} = Nominal tension resistance of screw as reported by manufacturer or determined by independent laboratory testing

$\bar{Q}$ = **V_f** = Factored shear force in connection

t_1 = Thickness of member in contact with screw head

t_2 = Thickness of member not in contact with screw head

t_c = Lesser of depth of penetration and thickness **t_2**

$\bar{T}$ = **T_f** = Factored tensile force in connection

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TABLE 3: Factored Resistances of Screwed Connections (kN)

Using the Tables: For shear loading, the lesser of øP_{ss} or øP_{ns} governs. For tension loading the lesser of øP_{ts}, øP_{not} or øP_{nov} governs. Check P_{ss} and P_{ts} for different screw types or manufacture.

#6-20 SCREW øP_{ss} = 1.34 kN øP_{ts} = 2.29 kN ø = 0.40

	Tilting and Bearing (øP_{ns})					Tension									
						Pull-Out (øP_{not})					Pull-Over (øP_{nov})*				
	33	43	54	68	97	33	43	54	68	97	33	43	54	68	97
33	0.180	1.05	1.05	1.05	1.05	0.330	0.430	0.783	0.986	1.41	1.30	1.30	1.30	1.30	1.30
43	0.180	1.21	1.37	1.37	1.37	0.330	0.430	0.783	0.986	1.41	1.69	1.69	1.69	1.69	1.69
54	0.180	1.21	2.46	2.49	2.49	0.330	0.430	0.783	0.986	1.41	3.08	3.08	3.08	3.08	3.08
68	0.180	1.21	2.46	3.13	3.13	0.330	0.430	0.783	0.986	1.41	3.88	3.88	3.88	3.88	3.88
97	0.180	1.21	2.46	3.13	4.47	0.330	0.430	0.783	0.986	1.41	5.54	5.54	5.54	5.54	5.54

#8-18 SCREW øP_{ss} = 1.78 kN øP_{ts} = 2.75 kN ø = 0.40

	Tilting and Bearing (øP_{ns})					Tension									
						Pull-Out (øP_{not})					Pull-Over (øP_{nov})*				
	33	43	54	68	97	33	43	54	68	97	33	43	54	68	97
33	0.865	1.19	1.19	1.19	1.19	0.376	0.490	0.893	1.12	1.60	1.30	1.30	1.30	1.30	1.30
43	0.865	1.29	1.56	1.56	1.56	0.376	0.490	0.893	1.12	1.60	1.69	1.69	1.69	1.69	1.69
54	0.865	1.29	2.63	2.84	2.84	0.376	0.490	0.893	1.12	1.60	3.08	3.08	3.08	3.08	3.08
68	0.865	1.29	2.63	3.57	3.57	0.376	0.490	0.893	1.12	1.60	3.88	3.88	3.88	3.88	3.88
97	0.865	1.29	2.63	3.57	5.10	0.376	0.490	0.893	1.12	1.60	5.54	5.54	5.54	5.54	5.54

#10-16 SCREW **øP_{ss} = 2.49 kN** **øP_{ts} = 3.44 kN** **ø = 0.40**

	Tilting and Bearing (øP_{ns})					Tension									
						Pull-Out (øP_{not})					Pull-Over (øP_{nov})*				
	33	43	54	68	97	33	43	54	68	97	33	43	54	68	97
33	0.943	1.41	1.42	1.42	1.42	0.447	0.583	1.06	1.34	1.91	1.30	1.30	1.30	1.30	1.30
43	0.943	1.40	1.85	1.85	1.85	0.447	0.583	1.06	1.34	1.91	1.69	1.69	1.69	1.69	1.69
54	0.943	1.40	2.87	3.38	3.38	0.447	0.583	1.06	1.34	1.91	3.08	3.08	3.08	3.08	3.08
68	0.943	1.40	2.87	4.05	4.25	0.447	0.583	1.06	1.34	1.91	3.88	3.88	3.88	3.88	3.88
97	0.943	1.40	2.87	4.05	6.06	0.447	0.583	1.06	1.34	1.91	5.54	5.54	5.54	5.54	5.54

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#12-14 SCREW — ϕP_{ss} = 3.56 kN — ϕP_{ts} = 4.94 kN — ϕ = 0.40

	Tilting and Bearing (ϕP_{ns})					Tension									
						Pull-Out (ϕP_{not})					Pull-Over (ϕP_{nov})*				
	33	**43**	**54**	**68**	**97**	**33**	**43**	**54**	**68**	**97**	**33**	**43**	**54**	**68**	**97**
33	0.991	1.49	1.57	1.57	1.57	0.494	0.644	1.17	1.48	2.11	1.30	1.30	1.30	1.30	1.30
43	0.991	1.48	2.05	2.05	2.05	0.494	0.644	1.17	1.48	2.11	1.69	1.69	1.69	1.69	1.69
54	0.991	1.48	3.01	3.72	3.72	0.494	0.644	1.17	1.48	2.11	3.08	3.08	3.08	3.08	3.08
68	0.991	1.48	3.01	4.25	4.69	0.494	0.644	1.17	1.48	2.11	3.88	3.88	3.88	3.88	3.88
97	0.991	1.48	3.01	4.25	6.69	0.494	0.644	1.17	1.48	2.11	5.54	5.54	5.54	5.54	5.54

#1/4-14 SCREW — ϕP_{ss} = 4.63 kN — ϕP_{ts} = 7.22 kN — ϕ = 0.40

	Tilting and Bearing (ϕP_{ns})					Tension									
						Pull-Out (ϕP_{not})					Pull-Over (ϕP_{nov})*				
	33	**43**	**54**	**68**	**97**	**33**	**43**	**54**	**68**	**97**	**33**	**43**	**54**	**68**	**97**
33	1.08	1.66	1.87	1.87	1.87	0.588	0.767	1.40	1.76	2.51	1.30	1.30	1.30	1.30	1.30
43	1.08	1.61	2.44	2.44	2.44	0.588	0.767	1.40	1.76	2.51	1.69	1.69	1.69	1.69	1.69
54	1.08	1.61	3.29	4.44	4.44	0.588	0.767	1.40	1.76	2.51	3.08	3.08	3.08	3.08	3.08
68	1.08	1.61	3.29	4.64	5.59	0.588	0.767	1.40	1.76	2.51	3.88	3.88	3.88	3.88	3.88
97	1.08	1.61	3.29	4.64	7.91	0.588	0.767	1.40	1.76	2.51	5.54	5.54	5.54	5.54	5.54

* Tabulated values assume d_w=7.94 mm. For d_w larger than 7.94 mm, multiply tabulated P_{nov} values by (actual d_w)/7.94. The limit of $d_w \leq$ 19.1 mm also applies.

Note: The product information and the data in this report was provided by the Canadian Sheet Steel Building Institute (CSSBI).

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