

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 Screws²

Number Designer for Screw	Nominal 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.

BAILEY SHEET METAL SCREWS

Design Equations for Shear (S136 Clause E4.3)

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

For $t_2/t_1 \leq 1.0$,	For $t_2/t_1 \geq 2.5$,
P_{ns} equals the smallest of;	P_{ns} equals the smallest of;
$P_{ns} = 4.2(t_2^3d)^{1/2}F_{u2}$	$P_{ns} = 2.7t_1dF_{u1}$
$P_{ns} = 2.7t_1dF_{u1}$	$P_{ns} = 2.7t_2dF_{u2}$
$P_{ns} = 2.7t_2dF_{u2}$	

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)

<i>Pull-Out (S136 Clause E4.4.1):</i>	<i>Pull-Over (S136 Clause E4.4.2):</i>
$P_{not} = 0.85t_c d F_{u2}$	$P_{nov} = 1.5t_1 d_w F_{u1}$

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
- Q̄ = V_f** = Factored shear force in connection
- t₁** = Thickness of member in contact with screw head
- t₂** = Thickness of member not in contact with screw head
- t_c** = Lesser of depth of penetration and thickness **t₂**
- T̄ = T_f** = Factored tensile force in connection

BAILEY SHEET METAL SCREWS

TABLE 3: Factored Resistances of Screwed Connections (kN)

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

#6-20 SCREW		$\phi P_{ss} = 1.34 \text{ kN}$					$\phi P_{ts} = 2.29 \text{ kN}$					$\phi = 0.40$				
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	0.180	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		$\phi P_{ss} = 1.78 \text{ kN}$					$\phi P_{ts} = 2.75 \text{ kN}$					$\phi = 0.40$				
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	0.865	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		$\phi P_{ss} = 2.49 \text{ kN}$					$\phi P_{ts} = 3.44 \text{ kN}$					$\phi = 0.40$				
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	0.943	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	

BAILEY SHEET METAL SCREWS

#12-14 SCREW						$\phi P_{ss} = 3.56 \text{ kN}$					$\phi P_{ts} = 4.94 \text{ kN}$					$\phi = 0.40$				
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						$\phi P_{ss} = 4.63 \text{ kN}$					$\phi P_{ts} = 7.22 \text{ kN}$					$\phi = 0.40$				
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 $d_w = 7.94 \text{ mm}$. For d_w larger than 7.94 mm, multiply tabulated P_{nov} values by $(\text{actual } d_w) / 7.94$. The limit of $d_w \leq 19.1 \text{ mm}$ also applies.



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



BUILD GREEN WITH BAILEY PRODUCTS

BUILD BETTER WITH BAILEY

MONTREAL
 LES PRODUITS METALLIQUES BAILEY LTEE
 525 Avenue Edward VII
 Dorval QC H9P 1E7
 Tel: (514) 735 3455
 (800) 263 3455
 Fax: (514) 735 5052

TORONTO
 One Caldari Road
 Concord ON L4K 3Z9
 Tel: (905) 738 9267
 (800) 668 2154
 Fax: (905) 738 5712

CALGARY
 3924 27th Street NE
 Calgary AB T1Y 5K7
 Tel: (403) 248 3536
 (800) 665 2013
 Fax: (403) 248 0288

EDMONTON
 5710 Roper Road N.W., Suite 101
 Edmonton AB T6B 3G7
 Tel: (780) 462 5757
 (800) 563 1751
 Fax: (780) 465 3791

VANCOUVER
 7715 Anvil Way
 Surrey BC V3W 6A2
 Tel: (604) 590 5100
 (800) 818 2666
 Fax: (604) 599 5371