PIPE

General

Tables of properties and dimensions for steel pipe provided on the following pages are based on ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless". Although not a normal structural quality steel, pipe produced in accordance with the ASTM A53 Standard is available in two grades with the following mechanical properties:

Grade A: $F_y = 205$ MPa, $F_u = 330$ MPa

Grade B: $F_y = 240$ MPa, $F_u = 415$ MPa

and in three types:

F: Furnace-butt-welded, continuous welded Grade A

E: Electric-resistance-welded, Grades A and B

S: Seamless, Grades A and B

Ordering Information

When ordering pipe according to ASTM A53, the size may be specified using either the NPS (nominal pipe size) designator or DN (diameter nominal) designator. The wall thickness of pipe is expressed in terms of "standard wall" (STD), "extra strong" (XS), "double extra strong" (XXS), and in terms of "schedule numbers" (Sch). STD is the same as Sch 40 for all sizes up to and including 273.0 mm outside diameter; XS is the same as Sch 80 for all sizes up to and including 219.1 mm outside diameter; and XXS is the next heavier pipe to the Sch 160 pipe for all sizes up to and including 168.3 mm outside diameter. See ASTM A53 for further information.

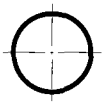
Tolerances and Section Properties

Permissible tolerances for pipe are ± 1% on the outside diameter and ± 10% on the mass. The under-tolerance on the wall thickness is 12.5%.

Tabulated section properties (Area, I, S, r, Z and J) are based on a design wall thickness taken equal to 90% of the nominal thickness.

PIPE

PROPERTIES AND DIMENSIONS



ASTM A53

DN Designator	NPS Designator	Weight Class*	Mass	Dead Load	Outside Diameter	Nominal Wall Thickness	Design Wall Thickness
			kg/m	kN/m	mm	mm	mm
300	12	XXS	187	1.83	323.8	25.40	22.86
		XS	97.4	0.956	323.8	12.70	11.43
		STD	73.8	0.724	323.8	9.52	8.57
250	10	XXS	155	1.52	273.0	25.40	22.86
		XS	81.5	0.800	273.0	12.70	11.43
		STD	60.3	0.591	273.0	9.27	8.34
200	8	XXS	108	1.06	219.1	22.22	20.00
		XS	64.6	0.634	219.1	12.70	11.43
		STD	42.6	0.417	219.1	8.18	7.36
150	6	XXS	79.2	0.777	168.3	21.95	19.76
		XS	42.6	0.418	168.3	10.97	9.87
		STD	28.3	0.277	168.3	7.11	6.40
125	5	XXS	57.4	0.563	141.3	19.05	17.15
		XS	30.9	0.304	141.3	9.52	8.57
		STD	21.8	0.214	141.3	6.55	5.90
100	4	XXS	41.0	0.403	114.3	17.12	15.41
		XS	22.3	0.219	114.3	8.56	7.70
		STD	16.1	0.158	114.3	6.02	5.42
90	3½	XS	18.6	0.183	101.6	8.08	7.27
		STD	13.6	0.133	101.6	5.74	5.17
80	3	XXS	27.7	0.272	88.9	15.24	13.72
		XS	15.3	0.150	88.9	7.62	6.86
		STD	11.3	0.111	88.9	5.49	4.94
65	2½	XXS	20.4	0.200	73.0	14.02	12.62
		XS	11.4	0.112	73.0	7.01	6.31
		STD	8.63	0.084 7	73.0	5.16	4.64
50	2	XXS	13.4	0.132	60.3	11.07	9.96
		XS	7.48	0.073 4	60.3	5.54	4.99
		STD	5.44	0.053 4	60.3	3.91	3.52
40	1½	XXS	9.56	0.093 8	48.3	10.16	9.14
		XS	5.41	0.053 1	48.3	5.08	4.57
		STD	4.05	0.039 7	48.3	3.68	3.31
32	1¼	XXS	7.77	0.076 2	42.2	9.70	8.73
		XS	4.47	0.043 9	42.2	4.85	4.37
		STD	3.39	0.033 3	42.2	3.56	3.20
25	1	XXS	5.45	0.053 5	33.4	9.09	8.18
		XS	3.24	0.031 8	33.4	4.55	4.10
		STD	2.50	0.024 5	33.4	3.38	3.04
20	¾	XXS	3.64	0.035 7	26.7	7.82	7.04
		XS	2.20	0.021 6	26.7	3.91	3.52
		STD	1.69	0.016 6	26.7	2.87	2.58
15	½	XXS	2.55	0.025 0	21.3	7.47	6.72
		XS	1.62	0.015 9	21.3	3.73	3.36
		STD	1.27	0.012 5	21.3	2.77	2.49

* Weight Class: Standard Weight - STD, Extra Strong - XS, Double Extra Strong - XXS

Area	I	S	r	Z	J	Surface Area
mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	$10^3\ mm^3$	$10^3\ mm^4$	m^2/m
21 600	246	1 520	107	2 070	492 000	1.02
11 200	137	846	111	1 120	274 000	1.02
8 490	105	652	111	852	211 000	1.02
18 000	142	1 040	88.8	1 430	283 000	0.858
9 390	80.5	590	92.6	783	161 000	0.858
6 930	60.8	445	93.6	584	122 000	0.858
12 500	62.6	572	70.7	795	125 000	0.688
7 460	40.3	368	73.5	493	80 600	0.688
4 900	27.5	251	74.9	330	54 900	0.688
9 220	25.9	308	53.0	439	51 800	0.529
4 910	15.5	184	56.1	248	30 900	0.529
3 260	10.7	127	57.3	168	21 400	0.529
6 690	13.1	186	44.3	266	26 300	0.444
3 570	7.90	112	47.0	151	15 800	0.444
2 510	5.76	81.6	47.9	108	11 500	0.444
4 790	5.99	105	35.4	152	12 000	0.359
2 580	3.68	64.4	37.8	87.7	7 360	0.359
1 850	2.75	48.2	38.5	64.3	5 510	0.359
2 150	2.41	47.5	33.4	64.8	4 820	0.319
1 570	1.83	35.9	34.1	48.1	3 650	0.319
3 240	2.37	53.2	27.0	78.4	4 730	0.279
1 770	1.50	33.7	29.1	46.3	3 000	0.279
1 300	1.15	25.9	29.7	34.9	2 300	0.279
2 390	1.14	31.2	21.8	46.7	2 280	0.229
1 320	0.742	20.3	23.7	28.1	1 480	0.229
996	0.585	16.0	24.2	21.7	1 170	0.229
1 580	0.518	17.2	18.1	25.6	1 040	0.189
867	0.334	11.1	19.6	15.3	669	0.189
628	0.254	8.42	20.1	11.4	508	0.189
1 120	0.227	9.41	14.2	14.3	455	0.152
628	0.152	6.28	15.5	8.77	303	0.152
468	0.119	4.93	15.9	6.71	238	0.152
918	0.137	6.51	12.2	10.0	275	0.133
519	0.094 1	4.46	13.5	6.28	188	0.133
392	0.075 0	3.56	13.8	4.88	150	0.133
648	0.056 9	3.41	9.37	5.39	114	0.105
377	0.041 3	2.47	10.5	3.54	82.6	0.105
290	0.033 7	2.02	10.8	2.81	67.5	0.105
435	0.023 7	1.78	7.38	2.84	47.4	0.083 9
256	0.017 6	1.32	8.29	1.91	35.2	0.083 9
196	0.014 4	1.08	8.58	1.51	28.8	0.083 9
308	0.009 92	0.931	5.68	1.53	19.8	0.066 9
189	0.007 89	0.740	6.45	1.09	15.8	0.066 9
147	0.006 62	0.622	6.71	0.886	13.2	0.066 9

Note: Section properties are based on a design wall thickness taken equal to 90% of the nominal thickness.

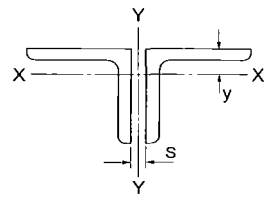
BUILT-UP SECTIONS

Built-up sections may be fabricated from plates and shapes in various configurations to produce efficient and economical structural sections. Generally, the components are joined by welding, although bolting may also be used for some combinations. Frequently used built-up sections include double angles back-to-back, double channels back-to-back or toe-to-toe, and a channel or C shape in combination with a W shape.

Tables of properties and dimensions on the following pages include: equal-leg angles, unequal-leg angles with long legs back-to-back and with short legs back-to-back, double channels, and built-up shapes consisting of W shapes and channels (C shapes). For information on β_x, the monosymmetry constant (or asymmetry parameter) for singly-symmetric beams, see CSA S16-14 Clause 13.6(e).

Many other combinations of built-up members are possible. The information on built-up sections concludes with diagrams and formulas for computing the properties of some possible combinations.

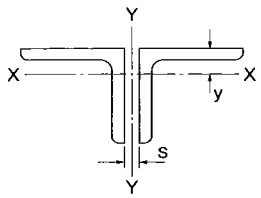
TWO ANGLES EQUAL LEGS
Back-to-Back



PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	mm	0	8	10	12	16	20
L254x254													
x32	238	2.33	30 200	181	1010	77.3	75.2	108	111	111	112	114	115
x29	216	2.11	27 400	166	921	77.7	74.0	107	110	111	112	113	114
x25	192	1.89	24 600	150	827	78.2	72.9	107	110	110	111	112	114
x22	169	1.66	21 600	133	731	78.6	71.7	106	109	110	111	112	113
x19	146	1.44	18 600	117	636	79.1	70.6	106	109	109	110	111	113
L203x203													
x29	169	1.66	21 600	81.4	574	61.4	61.2	86.7	89.6	90.3	91.0	92.5	94.0
x25	152	1.49	19 400	73.8	517	61.8	60.1	86.2	89.0	89.7	90.5	91.9	93.4
x22	134	1.31	17 000	66.0	458	62.2	58.9	85.7	88.5	89.2	89.9	91.4	92.8
x19	116	1.13	14 700	57.7	398	62.7	57.8	85.2	88.0	88.7	89.4	90.8	92.3
x16	97.4	0.955	12 400	49.4	337	63.1	56.6	84.8	87.5	88.2	88.9	90.3	91.8
x14	88.0	0.862	11 200	44.9	306	63.3	56.0	84.6	87.3	88.0	88.7	90.1	91.5
x13	78.6	0.769	10 000	40.4	274	63.6	55.5	84.4	87.0	87.7	88.4	89.8	91.2
L152x152													
x25	111	1.09	14 200	29.3	279	45.5	47.2	65.6	68.5	69.3	70.0	71.5	73.1
x22	98.6	0.963	12 600	26.3	249	45.9	46.1	65.0	67.9	68.7	69.4	70.9	72.5
x19	85.4	0.834	10 900	23.2	217	46.3	45.0	64.5	67.4	68.1	68.8	70.3	71.9
x16	72.0	0.705	9 180	20.0	185	46.7	43.9	64.1	66.9	67.6	68.3	69.8	71.3
x14	65.2	0.638	8 300	18.2	168	46.9	43.3	63.8	66.6	67.3	68.0	69.5	71.0
x13	58.4	0.570	7 420	16.4	150	47.1	42.7	63.6	66.3	67.1	67.8	69.2	70.7
x11	51.2	0.501	6 540	14.6	133	47.4	42.1	63.4	66.1	66.8	67.5	69.0	70.4
x9.5	44.4	0.432	5 620	12.7	115	47.6	41.5	63.2	65.9	66.6	67.3	68.7	70.1
x7.9	37.0	0.362	4 720	10.8	96.8	47.8	41.0	63.0	65.6	66.3	67.0	68.4	69.9
L127x127													
x22	81.0	0.792	10 300	14.8	169	37.9	39.8	55.0	57.9	58.7	59.4	61.0	62.6
x19	70.2	0.687	8 960	13.1	148	38.3	38.7	54.4	57.3	58.1	58.8	60.4	61.9
x16	59.6	0.583	7 560	11.3	127	38.7	37.6	53.9	56.8	57.5	58.3	59.8	61.3
x13	48.2	0.472	6 140	9.37	103	39.1	36.4	53.4	56.2	57.0	57.7	59.2	60.7
x11	42.6	0.415	5 400	8.33	91.4	39.3	35.8	53.2	56.0	56.7	57.4	58.9	60.4
x9.5	36.6	0.359	4 660	7.28	79.4	39.5	35.3	53.0	55.7	56.4	57.2	58.6	60.1
x7.9	30.6	0.301	3 920	6.18	66.9	39.8	34.7	52.8	55.5	56.2	56.9	58.3	59.8
L102x102													
x19	55.0	0.541	7 020	6.45	92.7	30.3	32.4	44.3	47.3	48.1	48.9	50.5	52.1
x16	46.8	0.460	5 940	5.62	79.5	30.7	31.3	43.8	46.7	47.5	48.3	49.8	51.4
x13	38.0	0.374	4 840	4.69	65.3	31.1	30.2	43.3	46.2	46.9	47.7	49.2	50.8
x11	33.6	0.330	4 280	4.19	57.8	31.3	29.6	43.0	45.9	46.6	47.4	48.9	50.4
x9.5	29.2	0.285	3 700	3.68	50.4	31.5	29.0	42.8	45.6	46.4	47.1	48.6	50.1
x7.9	24.4	0.240	3 100	3.13	42.6	31.7	28.4	42.6	45.4	46.1	46.8	48.3	49.8
x6.4	19.6	0.193	2 500	2.56	34.5	31.9	27.9	42.4	45.1	45.8	46.5	48.0	49.5
L89x89													
x13	33.0	0.323	4 200	3.03	48.8	26.9	26.9	38.0	40.9	41.7	42.4	44.0	45.6
x11	29.2	0.285	3 700	2.71	43.3	27.1	26.3	37.7	40.6	41.4	42.1	43.7	45.3
x9.5	25.2	0.247	3 200	2.39	37.8	27.3	25.7	37.5	40.3	41.1	41.8	43.4	45.0
x7.9	21.4	0.208	2 700	2.04	32.0	27.5	25.2	37.3	40.1	40.8	41.6	43.1	44.6
x6.4	17.2	0.168	2 180	1.67	26.0	27.7	24.6	37.0	39.8	40.5	41.3	42.8	44.3

See *Rolled Structural Shapes* for further information on the properties of angles.



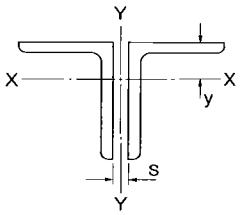
TWO ANGLES EQUAL LEGS
Back-to-Back

PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	mm	0	8	10	12	16	20
L76x76													
x13	28.0	0.273	3 540	1.85	35.1	22.8	23.7	32.9	35.9	36.6	37.4	39.0	40.7
x11	24.8	0.241	3 140	1.66	31.2	23.0	23.1	32.6	35.5	36.3	37.1	38.7	40.3
x9.5	21.4	0.210	2 720	1.47	27.3	23.2	22.5	32.3	35.3	36.0	36.8	38.4	40.0
x7.9	18.2	0.177	2 300	1.26	23.2	23.4	22.0	32.1	35.0	35.7	36.5	38.0	39.6
x6.4	14.6	0.143	1 860	1.04	18.9	23.6	21.4	31.9	34.7	35.4	36.2	37.7	39.3
x4.8	11.0	0.108	1 410	0.800	14.4	23.9	20.8	31.7	34.4	35.2	35.9	37.4	39.0
L64x64													
x13	22.8	0.223	2 900	1.02	23.7	18.8	20.5	27.8	30.8	31.6	32.4	34.1	35.8
x9.5	17.4	0.172	2 240	0.819	18.6	19.1	19.4	27.2	30.2	31.0	31.8	33.4	35.0
x7.9	14.8	0.146	1 880	0.707	15.8	19.3	18.8	27.0	29.9	30.7	31.4	33.0	34.7
x6.4	12.2	0.118	1 540	0.585	12.9	19.5	18.2	26.7	29.6	30.3	31.1	32.7	34.3
x4.8	9.2	0.090	1 160	0.455	9.92	19.8	17.6	26.5	29.3	30.1	30.8	32.4	34.0
L51x51													
x9.5	14.0	0.135	1 750	0.399	11.5	15.1	16.2	22.1	25.2	26.0	26.8	28.5	30.2
x7.9	11.6	0.114	1 480	0.347	9.84	15.3	15.6	21.8	24.8	25.6	26.4	28.1	29.8
x6.4	9.4	0.093	1 210	0.289	8.09	15.5	15.0	21.6	24.5	25.3	26.1	27.7	29.4
x4.8	7.2	0.071	922	0.227	6.24	15.7	14.5	21.3	24.2	25.0	25.8	27.4	29.1
x3.2	4.8	0.048	624	0.158	4.29	15.9	13.9	21.1	23.9	24.7	25.5	27.1	28.7
L44x44													
x6.4	8.2	0.081	1 050	0.190	6.11	13.4	13.4	19.0	22.0	22.8	23.6	25.3	27.0
x4.8	6.2	0.062	802	0.150	4.73	13.7	12.9	18.8	21.7	22.5	23.3	24.9	26.6
x3.2	4.2	0.042	544	0.105	3.26	13.9	12.3	18.5	21.4	22.2	23.0	24.6	26.3
L38x38													
x6.4	6.8	0.068	888	0.115	4.39	11.4	11.8	16.4	19.5	20.3	21.2	22.9	24.6
x4.8	5.4	0.052	680	0.091 5	3.41	11.6	11.3	16.2	19.2	20.0	20.8	22.5	24.2
x4.0	4.4	0.044	572	0.078 6	2.90	11.7	11.0	16.1	19.0	19.8	20.6	22.3	24.0
x3.2	3.6	0.036	464	0.064 8	2.37	11.8	10.7	15.9	18.9	19.6	20.5	22.1	23.8
L32x32													
x6.4	5.6	0.056	726	0.064 2	2.98	9.40	10.2	13.9	17.1	17.9	18.8	20.5	22.3
x4.8	4.4	0.043	560	0.051 4	2.33	9.58	9.69	13.6	16.7	17.5	18.4	20.1	21.9
x3.2	3.0	0.030	384	0.036 8	1.62	9.79	9.12	13.4	16.4	17.2	18.0	19.7	21.5
L25x25													
x6.4	4.4	0.043	566	0.030 7	1.83	7.37	8.62	11.3	14.6	15.5	16.4	18.2	20.0
x4.8	3.6	0.034	438	0.024 9	1.44	7.54	8.07	11.0	14.2	15.1	16.0	17.8	19.6
x3.2	2.4	0.023	302	0.018 1	1.01	7.73	7.52	10.8	13.9	14.7	15.6	17.3	19.1
L19x19													
x3.2	1.8	0.017	222	0.007 3	0.55	5.72	5.93	8.2	11.5	12.3	13.2	15.1	16.9

See *Rolled Structural Shapes* for further information on the properties of angles.

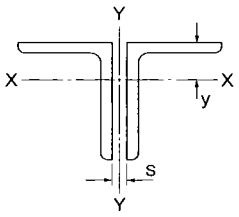
TWO ANGLES UNEQUAL LEGS
Long Legs Back-to-Back



PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	10^6 mm^4	10^3 mm^3	mm	mm	0	8	10	12	16	20
L203x152													
x25	131	1.29	16 800	67.0	494	63.3	67.4	60.6	63.4	64.1	64.9	66.3	67.9
x22	116	1.14	14 800	59.9	438	63.7	66.2	60.1	62.8	63.6	64.3	65.7	67.2
x19	100	0.983	12 800	52.5	381	64.1	65.1	59.6	62.3	63.0	63.7	65.2	66.6
x16	84.4	0.830	10 800	44.9	323	64.6	64.0	59.1	61.8	62.5	63.2	64.6	66.1
x14	76.2	0.750	9 760	40.9	293	64.8	63.4	58.9	61.6	62.3	63.0	64.4	65.8
x13	68.2	0.669	8 700	36.8	262	65.0	62.8	58.7	61.4	62.0	62.7	64.1	65.5
x11	59.8	0.588	7 660	32.5	231	65.3	62.2	58.5	61.1	61.8	62.5	63.9	65.3
L203x102													
x25	111	1.09	14 200	57.9	460	63.8	77.2	37.4	40.4	41.2	41.9	43.5	45.1
x22	98.6	0.967	12 600	51.9	408	64.3	76.0	36.8	39.7	40.4	41.2	42.8	44.3
x19	85.0	0.837	10 900	45.5	355	64.7	74.8	36.3	39.0	39.8	40.5	42.0	43.6
x16	72.0	0.708	9 180	39.1	302	65.2	73.6	35.8	38.5	39.2	39.9	41.4	42.9
x14	64.8	0.640	8 300	35.6	274	65.4	73.0	35.5	38.2	38.9	39.6	41.1	42.6
x13	58.0	0.572	7 420	32.0	245	65.7	72.4	35.3	37.9	38.6	39.3	40.7	42.2
x11	51.2	0.502	6 520	28.3	216	65.9	71.8	35.1	37.6	38.3	39.0	40.4	41.9
L178x102													
x19	77.6	0.764	9 920	31.5	276	56.4	63.7	37.8	40.6	41.4	42.1	43.6	45.2
x16	65.4	0.647	8 360	27.1	235	56.8	62.6	37.3	40.0	40.8	41.5	43.0	44.5
x13	53.0	0.523	6 780	22.3	191	57.3	61.4	36.8	39.5	40.2	40.9	42.4	43.9
x11	46.8	0.460	5 960	19.8	169	57.5	60.8	36.6	39.2	39.9	40.6	42.1	43.6
x9.5	40.4	0.397	5 140	17.2	146	57.8	60.2	36.4	39.0	39.7	40.4	41.8	43.3
L152x102													
x22	80.6	0.792	10 300	22.9	233	47.2	53.7	40.2	43.2	43.9	44.7	46.3	47.9
x19	70.0	0.687	8 960	20.2	203	47.6	52.5	39.7	42.5	43.3	44.0	45.6	47.2
x16	59.2	0.583	7 560	17.5	174	48.0	51.4	39.2	42.0	42.7	43.4	44.9	46.5
x14	53.6	0.528	6 860	16.0	158	48.2	50.8	38.9	41.7	42.4	43.1	44.6	46.2
x13	48.0	0.472	6 120	14.4	141	48.5	50.2	38.7	41.4	42.1	42.8	44.3	45.8
x11	42.4	0.415	5 400	12.8	125	48.7	49.6	38.5	41.1	41.9	42.6	44.0	45.5
x9.5	36.4	0.359	4 660	11.2	108	48.9	49.1	38.3	40.9	41.6	42.3	43.7	45.2
x7.9	30.6	0.301	3 900	9.44	91.2	49.2	48.5	38.1	40.7	41.3	42.0	43.5	44.9
L152x89													
x13	45.4	0.446	5 800	13.7	138	48.6	52.7	32.5	35.3	36.0	36.7	38.2	39.8
x9.5	34.6	0.339	4 420	10.6	106	49.1	51.6	32.1	34.7	35.4	36.2	37.6	39.1
x7.9	29.0	0.285	3 700	9.01	89.1	49.3	51.0	31.9	34.5	35.2	35.9	37.3	38.8
L127x89													
x19	58.6	0.576	7 500	11.6	140	39.3	44.3	35.4	38.4	39.2	39.9	41.5	43.1
x16	49.8	0.490	6 340	10.0	120	39.7	43.2	34.9	37.8	38.5	39.3	40.8	42.4
x13	40.4	0.397	5 160	8.31	97.9	40.1	42.1	34.4	37.2	37.9	38.7	40.2	41.8
x9.5	30.8	0.303	3 940	6.48	75.2	40.6	40.9	33.9	36.6	37.4	38.1	39.6	41.1
x7.9	25.8	0.254	3 300	5.50	63.5	40.8	40.3	33.7	36.4	37.1	37.8	39.3	40.8
x6.4	20.8	0.205	2 660	4.48	51.4	41.0	39.7	33.5	36.2	36.8	37.5	39.0	40.5

See *Rolled Structural Shapes* for further information on the properties of angles.



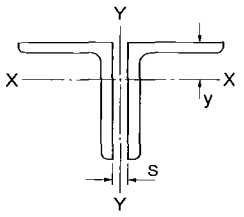
TWO ANGLES UNEQUAL LEGS
Long Legs Back-to-Back

PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	mm	0	8	10	12	16	20
L127x76													
x13	38.0	0.372	4 840	7.87	95.3	40.3	44.5	28.4	31.2	32.0	32.7	34.3	35.9
x11	33.4	0.328	4 280	7.01	84.4	40.6	43.9	28.2	30.9	31.7	32.4	33.9	35.5
x9.5	29.0	0.284	3 700	6.14	73.3	40.8	43.3	27.9	30.6	31.4	32.1	33.6	35.2
x7.9	24.2	0.239	3 100	5.21	61.9	41.0	42.7	27.7	30.4	31.1	31.8	33.3	34.8
x6.4	19.6	0.192	2 500	4.25	50.1	41.2	42.1	27.5	30.1	30.8	31.5	33.0	34.5
L102x89													
x13	35.2	0.348	4 520	4.48	63.9	31.5	31.9	36.6	39.5	40.2	41.0	42.6	44.1
x9.5	27.0	0.266	3 440	3.52	49.4	31.9	30.8	36.1	38.9	39.7	40.4	41.9	43.5
x7.9	22.8	0.224	2 900	3.00	41.7	32.1	30.2	35.9	38.7	39.4	40.1	41.6	43.2
x6.4	18.4	0.180	2 340	2.45	33.9	32.3	29.6	35.7	38.4	39.1	39.9	41.3	42.9
L102x76													
x16	40.4	0.397	5 140	5.09	75.9	31.4	35.0	30.9	33.9	34.6	35.4	37.0	38.7
x13	32.8	0.324	4 200	4.25	62.4	31.8	33.9	30.3	33.2	34.0	34.8	36.3	37.9
x9.5	25.2	0.247	3 200	3.34	48.2	32.2	32.7	29.8	32.6	33.4	34.1	35.7	37.2
x7.9	21.4	0.208	2 700	2.85	40.7	32.4	32.1	29.6	32.4	33.1	33.8	35.4	36.9
x6.4	17.2	0.168	2 180	2.33	33.1	32.7	31.6	29.4	32.1	32.8	33.6	35.0	36.6
L89x76													
x13	30.2	0.298	3 880	2.87	47.7	27.3	28.6	31.5	34.5	35.2	36.0	37.6	39.2
x11	27.0	0.263	3 420	2.58	42.3	27.5	28.0	31.3	34.2	34.9	35.7	37.3	38.9
x9.5	23.4	0.228	2 960	2.27	36.9	27.7	27.4	31.0	33.9	34.6	35.4	36.9	38.5
x7.9	19.6	0.192	2 500	1.94	31.3	27.9	26.9	30.8	33.6	34.3	35.1	36.6	38.2
x6.4	16.0	0.155	2 020	1.59	25.4	28.1	26.3	30.6	33.3	34.1	34.8	36.3	37.9
L89x64													
x13	27.8	0.273	3 540	2.70	46.2	27.6	30.6	25.3	28.3	29.1	29.8	31.5	33.1
x9.5	21.4	0.210	2 720	2.13	35.9	28.0	29.5	24.8	27.6	28.4	29.2	30.8	32.4
x7.9	18.0	0.177	2 300	1.82	30.4	28.2	28.9	24.5	27.4	28.1	28.9	30.4	32.0
x6.4	14.6	0.143	1 860	1.50	24.7	28.4	28.3	24.3	27.1	27.8	28.6	30.1	31.7
L76x64													
x13	25.2	0.248	3 220	1.73	34.1	23.2	25.4	26.4	29.5	30.2	31.0	32.7	34.4
x11	22.6	0.220	2 860	1.56	30.4	23.4	24.8	26.2	29.1	29.9	30.7	32.3	34.0
x9.5	19.6	0.191	2 480	1.38	26.6	23.6	24.3	25.9	28.8	29.6	30.4	32.0	33.6
x7.9	16.6	0.161	2 100	1.18	22.6	23.8	23.7	25.7	28.5	29.3	30.0	31.6	33.3
x6.4	13.4	0.130	1 690	0.977	18.4	24.0	23.1	25.4	28.2	29.0	29.7	31.3	32.9
x4.8	10.2	0.099	1 290	0.755	14.1	24.2	22.6	25.2	28.0	28.7	29.4	31.0	32.6
L76x51													
x13	23.0	0.223	2 900	1.60	32.9	23.5	27.5	20.3	23.4	24.2	25.0	26.7	28.4
x9.5	17.6	0.172	2 240	1.28	25.6	23.9	26.4	19.7	22.7	23.5	24.3	25.9	27.6
x7.9	14.8	0.146	1 880	1.10	21.8	24.1	25.8	19.5	22.4	23.1	23.9	25.6	27.2
x6.4	12.2	0.118	1 540	0.905	17.8	24.3	25.2	19.2	22.1	22.8	23.6	25.2	26.8
x4.8	9.2	0.090	1 160	0.700	13.6	24.5	24.6	19.0	21.8	22.5	23.3	24.8	26.5

See *Rolled Structural Shapes* for further information on the properties of angles.

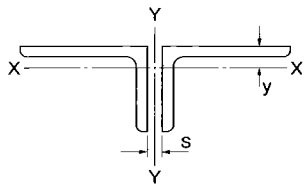
TWO ANGLES UNEQUAL LEGS
Long Legs Back-to-Back



PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	mm	0	8	10	12	16	20
L64x51													
x9.5	15.8	0.154	2 000	0.760	17.9	19.5	21.1	20.8	23.8	24.6	25.4	27.1	28.8
x7.9	13.4	0.130	1 690	0.656	15.3	19.7	20.6	20.5	23.5	24.3	25.1	26.7	28.4
x6.4	10.8	0.106	1 370	0.544	12.5	19.9	20.0	20.3	23.2	23.9	24.7	26.3	28.0
x4.8	8.4	0.080	1 040	0.423	9.60	20.1	19.4	20.1	22.9	23.6	24.4	26.0	27.6
L64x38													
x6.4	9.6	0.093	1 210	0.492	11.9	20.2	22.2	14.2	17.1	17.9	18.8	20.4	22.2
x4.8	7.2	0.071	922	0.383	9.16	20.4	21.6	14.0	16.8	17.6	18.4	20.0	21.8
L51x38													
x6.4	8.4	0.081	1 050	0.263	7.74	15.8	16.9	15.2	18.2	19.0	19.8	21.5	23.3
x4.8	6.2	0.062	802	0.206	5.97	16.0	16.3	14.9	17.9	18.6	19.5	21.1	22.8
x3.2	4.2	0.042	544	0.144	4.11	16.3	15.7	14.7	17.5	18.3	19.1	20.7	22.4

See *Rolled Structural Shapes* for further information on the properties of angles.



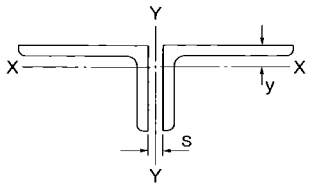
TWO ANGLES UNEQUAL LEGS
Short Legs Back-to-Back

PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	mm	0	8	10	12	16	20
L203x152													
x25	131	1.29	16 800	32.0	291	43.7	41.9	92.4	95.4	96.1	96.9	98.4	99.9
x22	116	1.14	14 800	28.8	259	44.1	40.7	91.9	94.8	95.6	96.3	97.8	99.3
x19	100	0.983	12 800	25.3	225	44.5	39.6	91.4	94.3	95.0	95.7	97.2	98.7
x16	84.4	0.830	10 800	21.8	192	44.9	38.5	90.9	93.7	94.5	95.2	96.7	98.2
x14	76.2	0.750	9 760	19.9	174	45.2	37.9	90.6	93.5	94.2	94.9	96.4	97.9
x13	68.2	0.669	8 700	17.9	156	45.4	37.3	90.4	93.2	93.9	94.6	96.1	97.6
x11	59.8	0.588	7 660	15.9	138	45.6	36.7	90.1	92.9	93.7	94.4	95.8	97.3
L203x102													
x25	111	1.09	14 200	9.81	130	26.3	26.7	100	103	104	105	106	108
x22	98.6	0.967	12 600	8.87	116	26.6	25.5	99.5	103	103	104	106	107
x19	85.0	0.837	10 900	7.87	101	26.9	24.3	98.9	102	103	104	105	107
x16	72.0	0.708	9 180	6.83	86.6	27.3	23.1	98.3	101	102	103	104	106
x14	64.8	0.640	8 300	6.26	78.8	27.4	22.5	98.0	101	102	103	104	106
x13	58.0	0.572	7 420	5.67	70.9	27.6	21.9	97.8	101	102	102	104	105
x11	51.2	0.502	6 520	5.06	62.7	27.9	21.3	97.5	100	101	102	104	105
L178x102													
x19	77.6	0.764	9 920	7.61	99.7	27.7	25.7	85.1	88.1	88.9	89.7	91.2	92.8
x16	65.4	0.647	8 360	6.61	85.4	28.1	24.6	84.5	87.5	88.3	89.1	90.6	92.2
x13	53.0	0.523	6 780	5.50	69.9	28.5	23.4	84.0	86.9	87.7	88.5	90.0	91.5
x11	46.8	0.460	5 960	4.90	61.9	28.7	22.8	83.7	86.6	87.4	88.2	89.7	91.2
x9.5	40.4	0.397	5 140	4.30	53.9	28.9	22.2	83.4	86.4	87.1	87.9	89.4	90.9
L152x102													
x22	80.6	0.792	10 300	8.20	112	28.2	28.7	71.5	74.5	75.3	76.1	77.6	79.2
x19	70.0	0.687	8 960	7.29	97.9	28.6	27.5	70.9	73.9	74.7	75.4	77.0	78.6
x16	59.2	0.583	7 560	6.34	83.8	28.9	26.4	70.3	73.3	74.1	74.8	76.4	77.9
x14	53.6	0.528	6 860	5.82	76.4	29.1	25.8	70.1	73.0	73.8	74.5	76.1	77.6
x13	48.0	0.472	6 120	5.28	68.7	29.3	25.2	69.8	72.7	73.5	74.2	75.8	77.3
x11	42.4	0.415	5 400	4.71	60.9	29.6	24.6	69.5	72.4	73.2	73.9	75.5	77.0
x9.5	36.4	0.359	4 660	4.13	53.0	29.8	24.1	69.3	72.2	72.9	73.7	75.2	76.7
x7.9	30.6	0.301	3 900	3.51	44.7	30.0	23.5	69.0	71.9	72.6	73.4	74.9	76.4
L152x89													
x13	45.4	0.446	5 800	3.54	52.2	24.7	21.2	71.7	74.7	75.5	76.3	77.8	79.4
x9.5	34.6	0.339	4 420	2.78	40.4	25.1	20.0	71.2	74.2	74.9	75.7	77.2	78.7
x7.9	29.0	0.285	3 700	2.37	34.1	25.3	19.4	70.9	73.9	74.6	75.4	76.9	78.4
L127x89													
x19	58.6	0.576	7 500	4.61	72.5	24.8	25.3	59.2	62.3	63.1	63.9	65.5	67.1
x16	49.8	0.490	6 340	4.03	62.2	25.2	24.2	58.7	61.7	62.5	63.2	64.8	66.4
x13	40.4	0.397	5 160	3.37	51.2	25.6	23.0	58.1	61.1	61.9	62.6	64.2	65.7
x9.5	30.8	0.303	3 940	2.65	39.6	26.0	21.9	57.6	60.5	61.3	62.0	63.6	65.1
x7.9	25.8	0.254	3 300	2.26	33.5	26.2	21.3	57.4	60.3	61.0	61.7	63.3	64.8
x6.4	20.8	0.205	2 660	1.86	27.2	26.4	20.7	57.1	60.0	60.7	61.5	63.0	64.5

See *Rolled Structural Shapes* for further information on the properties of angles.

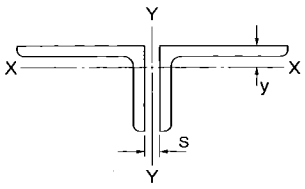
TWO ANGLES UNEQUAL LEGS
Short Legs Back-to-Back



PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	mm	0	8	10	12	16	20
L127x76													
x13	38.0	0.372	4 840	2.15	37.6	21.1	19.1	60.0	63.0	63.8	64.6	66.2	67.8
x11	33.4	0.328	4 280	1.93	33.4	21.3	18.5	59.7	62.7	63.5	64.3	65.8	67.4
x9.5	29.0	0.284	3 700	1.70	29.1	21.5	17.9	59.5	62.4	63.2	64.0	65.5	67.1
x7.9	24.2	0.239	3 100	1.45	24.7	21.7	17.3	59.2	62.1	62.9	63.7	65.2	66.8
x6.4	19.6	0.192	2 500	1.20	20.1	21.9	16.7	58.9	61.9	62.6	63.4	64.9	66.4
L102x89													
x13	35.2	0.348	4 520	3.16	49.7	26.4	25.4	44.8	47.7	48.5	49.3	50.8	52.4
x9.5	27.0	0.266	3 440	2.49	38.5	26.8	24.2	44.3	47.2	47.9	48.7	50.2	51.8
x7.9	22.8	0.224	2 900	2.13	32.6	27.1	23.6	44.1	46.9	47.6	48.4	49.9	51.4
x6.4	18.4	0.180	2 340	1.74	26.5	27.3	23.1	43.8	46.6	47.4	48.1	49.6	51.1
L102x76													
x16	40.4	0.397	5 140	2.40	44.3	21.6	22.1	47.0	50.1	50.9	51.6	53.2	54.9
x13	32.8	0.324	4 200	2.02	36.6	21.9	21.0	46.5	49.4	50.2	51.0	52.6	54.2
x9.5	25.2	0.247	3 200	1.60	28.4	22.3	19.8	45.9	48.9	49.6	50.4	51.9	53.5
x7.9	21.4	0.208	2 700	1.37	24.1	22.5	19.2	45.7	48.6	49.3	50.1	51.6	53.2
x6.4	17.2	0.168	2 180	1.13	19.6	22.7	18.7	45.4	48.3	49.0	49.8	51.3	52.9
L89x76													
x13	30.2	0.298	3 880	1.94	35.9	22.4	22.2	39.5	42.5	43.2	44.0	45.6	47.2
x11	27.0	0.263	3 420	1.74	31.9	22.6	21.7	39.2	42.2	42.9	43.7	45.3	46.9
x9.5	23.4	0.228	2 960	1.54	27.9	22.8	21.1	39.0	41.9	42.6	43.4	45.0	46.6
x7.9	19.6	0.192	2 500	1.32	23.7	23.0	20.5	38.7	41.6	42.3	43.1	44.6	46.2
x6.4	16.0	0.155	2 020	1.09	19.3	23.2	19.9	38.5	41.3	42.1	42.8	44.3	45.9
L89x64													
x13	27.8	0.273	3 540	1.14	24.9	17.9	17.9	41.2	44.2	45.0	45.8	47.4	49.1
x9.5	21.4	0.210	2 720	0.908	19.4	18.3	16.8	40.6	43.6	44.4	45.2	46.8	48.4
x7.9	18.0	0.177	2 300	0.782	16.5	18.5	16.2	40.4	43.3	44.1	44.9	46.4	48.0
x6.4	14.6	0.143	1 860	0.647	13.5	18.7	15.6	40.1	43.0	43.8	44.5	46.1	47.7
L76x64													
x13	25.2	0.248	3 220	1.08	24.4	18.3	19.1	34.4	37.4	38.2	39.0	40.7	42.3
x11	22.6	0.220	2 860	0.978	21.7	18.5	18.5	34.1	37.1	37.9	38.7	40.3	42.0
x9.5	19.6	0.191	2 480	0.868	19.0	18.7	17.9	33.8	36.8	37.6	38.4	40.0	41.6
x7.9	16.6	0.161	2 100	0.748	16.2	18.9	17.4	33.6	36.5	37.3	38.1	39.6	41.3
x6.4	13.4	0.130	1 690	0.619	13.2	19.1	16.8	33.3	36.2	37.0	37.8	39.3	40.9
x4.8	10.2	0.099	1 290	0.480	10.2	19.3	16.2	33.1	36.0	36.7	37.5	39.0	40.6
L76x51													
x13	23.0	0.223	2 900	0.559	15.5	13.9	14.8	36.2	39.3	40.1	40.9	42.6	44.3
x9.5	17.6	0.172	2 240	0.452	12.2	14.2	13.7	35.6	38.6	39.4	40.2	41.9	43.5
x7.9	14.8	0.146	1 880	0.392	10.4	14.4	13.1	35.3	38.3	39.1	39.9	41.5	43.2
x6.4	12.2	0.118	1 540	0.326	8.52	14.6	12.5	35.0	38.0	38.8	39.6	41.2	42.8
x4.8	9.2	0.090	1 160	0.255	6.56	14.8	11.9	34.8	37.7	38.5	39.3	40.8	42.5

See *Rolled Structural Shapes* for further information on the properties of angles.



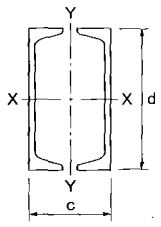
TWO ANGLES UNEQUAL LEGS
Short Legs Back-to-Back

PROPERTIES OF SECTIONS

Designation	Mass of 2 Angles	Dead Load	Area of 2 Angles	Axis X-X				Radii of Gyration about Axis Y-Y					
				I	S	r	y	Back-to-back spacing, s, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	mm	0	8	10	12	16	20
L64x51													
x9.5	15.8	0.154	2 000	0.428	11.9	14.6	14.8	28.7	31.8	32.6	33.4	35.0	36.7
x7.9	13.4	0.130	1 690	0.372	10.2	14.8	14.2	28.5	31.5	32.3	33.1	34.7	36.4
x6.4	10.8	0.106	1 370	0.310	8.34	15.0	13.6	28.2	31.2	32.0	32.7	34.3	36.0
x4.8	8.4	0.080	1 040	0.242	6.42	15.2	13.1	28.0	30.9	31.6	32.4	34.0	35.6
L64x38													
x6.4	9.6	0.093	1 210	0.134	4.69	10.5	9.53	30.0	33.1	33.9	34.7	36.3	38.0
x4.8	7.2	0.071	922	0.106	3.64	10.7	8.94	29.7	32.8	33.5	34.3	36.0	37.6
L51x38													
x6.4	8.4	0.081	1 050	0.126	4.57	11.0	10.5	23.1	26.2	27.0	27.8	29.5	31.2
x4.8	6.2	0.062	802	0.100	3.54	11.2	9.93	22.9	25.9	26.6	27.5	29.1	30.8
x3.2	4.2	0.042	544	0.071	2.46	11.4	9.35	22.6	25.5	26.3	27.1	28.7	30.4

See *Rolled Structural Shapes* for further information on the properties of angles.

TWO CHANNELS
Toe-to-Toe

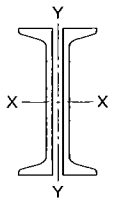


PROPERTIES OF SECTIONS

Channel Size	For Two Channels			Axis X-X			Axis Y-Y					
							Toe-to-Toe			c = d		
	Mass	Dead Load	Area	I_x	S_x	r_x	I_y	S_y	r_y	I_y	S_y	r_y
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	$10^6\ mm^4$	$10^3\ mm^3$	mm	$10^6\ mm^4$	$10^3\ mm^3$	mm
MC460												
x86*	172	1.70	22 000	564	2 460	160	174	1 630	88.9	956	4 180	208
x77.2*	154	1.52	19 700	522	2 280	163	147	1 410	86.3	855	3 740	208
x68.2*	136	1.34	17 400	482	2 100	166	124	1 210	84.4	754	3 300	208
x63.5*	127	1.25	16 300	462	2 020	169	110	1 100	82.4	701	3 070	208
C380												
x74*	148	1.46	19 000	336	1 760	133	112	1 190	76.9	558	2 930	172
x60*	120	1.17	15 200	290	1 520	138	80.2	901	72.8	449	2 360	172
x50*	100	0.990	12 900	262	1 370	143	62.8	730	69.9	381	2 000	172
C310												
x45	90	0.876	11 400	135	884	109	49.4	618	65.9	213	1 400	137
x37	74	0.727	9 480	120	786	113	37.6	488	63.1	177	1 160	137
x31	62	0.603	7 860	107	702	117	28.1	380	59.9	146	956	136
C250												
x45	90	0.873	11 400	85.6	674	86.9	43.6	574	62.0	142	1 120	112
x37	74	0.731	9 480	75.8	598	89.4	34.0	465	59.8	120	948	113
x30	60	0.582	7 580	65.4	514	93.0	24.0	348	56.4	96.4	759	113
x23	46	0.443	5 800	55.6	438	98.2	15.7	242	52.3	72.8	574	113
C230												
x30*	60	0.585	7 580	51.0	444	81.9	22.7	339	54.7	77.5	677	101
x22	44	0.437	5 700	42.6	372	86.6	14.7	233	50.9	57.8	505	101
x20	40	0.389	5 080	39.6	346	88.6	12.0	197	48.8	51.3	448	101
C200												
x28	56	0.548	7 100	36.4	360	71.6	19.1	299	51.9	55.6	548	88.4
x21	42	0.400	5 220	29.8	294	75.8	11.8	199	47.6	41.0	404	88.9
x17	34	0.334	4 360	27.0	266	78.7	8.93	157	45.3	33.9	334	88.4
C180												
x22*	44	0.429	5 580	22.6	254	63.7	12.2	210	46.7	32.9	369	76.8
x18	36	0.356	4 640	20.0	226	65.9	9.04	164	44.2	27.5	310	77.1
x15	30	0.284	3 700	17.7	199	69.3	6.48	122	41.9	21.7	244	76.6
C150												
x19	38	0.377	4 940	14.2	187	53.9	9.12	169	43.2	20.3	268	64.5
x16	32	0.305	3 980	12.4	164	56.1	6.53	128	40.6	16.6	218	64.8
x12	24	0.236	3 100	10.7	141	59.1	4.34	90.4	37.6	12.8	168	64.5
C130												
x13	26	0.261	3 400	7.32	115	46.5	4.65	99.0	37.1	9.49	149	52.9
x10	20	0.194	2 540	6.18	97.2	49.5	2.92	66.3	34.1	6.98	110	52.7
C100												
x11	22	0.211	2 740	3.82	74.8	37.3	3.07	71.4	33.5	4.63	90.7	41.1
x9	18	0.177	2 380	3.36	66.0	38.3	2.49	59.2	32.9	3.95	77.4	41.5
x8	16	0.157	2 060	3.22	63.2	39.7	1.91	47.8	30.6	3.44	67.4	41.0
C75												
x9	18	0.173	2 260	1.69	44.6	27.4	2.07	51.8	30.4	†	†	†
x7	14	0.144	1 900	1.50	39.4	28.3	1.46	39.6	28.0	1.56	41.1	28.9
x6	12	0.118	1 560	1.34	35.2	29.6	1.03	29.5	26.0	1.27	33.3	28.8

* Not available from Canadian mills

† The condition c = d cannot be met for this section.



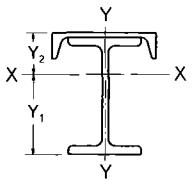
TWO CHANNELS
Back-to-Back

PROPERTIES OF SECTIONS

Channel Size	For Two Channels			Axis X-X			Radii of Gyration about Axis Y-Y					
	Mass	Dead Load	Area	I_x	S_x	r_x	Back-to-Back Channels, millimetres					
	kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	mm	0	8	10	12	16	20
MC460												
x86*	172	1.70	22 000	564	2 460	160	33.9	36.6	37.3	38.0	39.5	41.1
x77.2*	154	1.52	19 700	522	2 280	163	34.2	36.8	37.6	38.3	39.8	41.3
x68.2*	136	1.34	17 400	482	2 100	166	34.5	37.2	37.9	38.6	40.1	41.6
x63.5*	127	1.25	16 300	462	2 020	169	35.0	37.7	38.4	39.1	40.6	42.1
C380												
x74*	148	1.46	19 000	336	1 760	133	30.0	32.8	33.5	34.3	35.9	37.5
x60*	120	1.17	15 200	290	1 520	138	30.0	32.8	33.5	34.2	35.8	37.4
x50*	100	0.990	12 900	262	1 370	143	30.5	33.2	33.9	34.7	36.2	37.8
C310												
x45	90	0.876	11 400	135	884	109	25.7	28.5	29.3	30.0	31.6	33.2
x37	74	0.727	9 480	120	786	113	26.2	28.9	29.7	30.4	32.0	33.6
x31	62	0.603	7 860	107	702	117	26.8	29.5	30.3	31.0	32.6	34.2
C250												
x45	90	0.873	11 400	85.6	674	86.9	23.4	26.3	27.1	27.9	29.5	31.2
x37	74	0.731	9 480	75.8	598	89.4	23.3	26.1	26.9	27.7	29.3	30.9
x30	60	0.582	7 580	65.4	514	93.0	23.3	26.1	26.9	27.7	29.2	30.9
x23	46	0.443	5 800	55.6	438	98.2	23.9	26.8	27.5	28.3	29.9	31.5
C230												
x30*	60	0.585	7 580	51.0	444	81.9	22.0	24.9	25.7	26.4	28.0	29.7
x22	44	0.437	5 700	42.6	372	86.6	22.5	25.4	26.1	26.9	28.5	30.1
x20	40	0.389	5 080	39.6	346	88.6	22.7	25.5	26.3	27.1	28.7	30.3
C200												
x28	56	0.548	7 100	36.4	360	71.6	21.0	23.9	24.7	25.5	27.1	28.8
x21	42	0.400	5 220	29.8	294	75.8	20.9	23.8	24.5	25.3	26.9	28.6
x17	34	0.334	4 360	27.0	266	78.7	21.5	24.3	25.1	25.9	27.5	29.2
C180												
x22*	44	0.429	5 580	22.6	254	63.7	19.7	22.6	23.4	24.2	25.8	27.5
x18	36	0.356	4 640	20.0	226	65.9	19.5	22.4	23.2	24.0	25.6	27.3
x15	30	0.284	3 700	17.7	199	69.3	20.2	23.1	23.9	24.7	26.3	28.0
C150												
x19	38	0.377	4 940	14.2	187	53.9	18.4	21.4	22.2	23.0	24.7	26.4
x16	32	0.305	3 980	12.4	164	56.1	18.3	21.3	22.1	22.9	24.5	26.2
x12	24	0.236	3 100	10.7	141	59.1	18.6	21.6	22.4	23.2	24.9	26.6
C130												
x13	26	0.261	3 400	7.32	115	46.5	17.1	20.1	20.9	21.7	23.4	25.2
x10	20	0.194	2 540	6.18	97.2	49.5	17.5	20.5	21.3	22.1	23.8	25.5
C100												
x11	22	0.211	2 740	3.82	74.8	37.3	16.1	19.2	20.0	20.8	22.5	24.3
x9	18	0.177	2 380	3.36	66.0	38.3	15.8	18.8	19.7	20.5	22.2	23.9
x8	16	0.157	2 060	3.22	63.2	39.7	16.2	19.3	20.1	20.9	22.7	24.4
C75												
x9	18	0.173	2 260	1.69	44.6	27.4	15.5	18.7	19.5	20.4	22.1	23.9
x7	14	0.144	1 900	1.50	39.4	28.3	14.9	18.0	18.9	19.7	21.4	23.2
x6	12	0.118	1 560	1.34	35.2	29.6	14.9	18.1	18.9	19.8	21.5	23.3

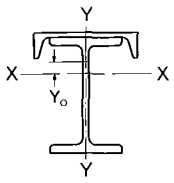
* Not available from Canadian mills

W SHAPES AND CHANNELS



PROPERTIES OF SECTIONS

Beam	Channel	Dead Load	Total Area	Axis X-X					
				I	$S_1 = I / Y_1$	$S_2 = I / Y_2$	r	Y_1	Y_2
		kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	$10^3\ mm^3$	mm	mm	mm
W920x289	MC460x63.5	3.46	44 900	6 410	11 800	16 300	378	545	393
	C380x50	3.33	43 200	6 180	11 600	15 200	378	531	406
x271	MC460x63.5	3.29	42 700	6 050	11 100	15 600	376	547	387
	C380x50	3.16	41 000	5 830	11 000	14 500	377	532	401
x253	MC460x63.5	3.11	40 400	5 680	10 300	14 900	375	549	381
	C380x50	2.98	38 700	5 460	10 200	13 800	376	534	395
x238	MC460x63.5	2.96	38 500	5 340	9 680	14 200	372	551	375
	C380x50	2.83	36 800	5 120	9 560	13 100	373	536	390
x223	MC460x63.5	2.83	36 700	5 020	9 070	13 600	370	554	369
	C380x50	2.69	35 000	4 810	8 950	12 500	371	537	384
W840x226	MC460x63.5	2.85	37 000	4 490	8 700	13 000	348	516	346
	C380x50	2.72	35 300	4 310	8 600	12 000	349	501	360
x210	MC460x63.5	2.69	34 900	4 170	8 040	12 300	346	519	339
	C380x50	2.56	33 200	4 000	7 950	11 300	347	503	353
x193	MC460x63.5	2.53	32 800	3 800	7 290	11 500	340	521	330
	C380x50	2.39	31 100	3 640	7 210	10 500	342	505	345
W760x196	MC460x63.5	2.56	33 200	3 260	6 840	10 700	313	476	305
	C380x50	2.42	31 500	3 120	6 760	9 790	315	462	319
x185	MC460x63.5	2.43	31 600	3 060	6 400	10 200	311	478	299
	C380x50	2.30	29 900	2 930	6 330	9 360	313	463	313
x173	MC460x63.5	2.32	30 200	2 870	5 980	9 790	308	480	293
	C380x50	2.19	28 500	2 750	5 920	8 940	311	465	308
x161	MC460x63.5	2.19	28 500	2 650	5 480	9 270	305	484	286
	C380x50	2.06	26 800	2 530	5 410	8 410	307	467	301
W690x170	C380x50	2.16	28 000	2 260	5 330	8 090	284	424	279
	C310x31	1.96	25 500	2 070	5 200	6 850	285	398	302
x152	C380x50	1.99	25 800	2 050	4 800	7 560	282	427	271
	C310x31	1.79	23 300	1 870	4 670	6 340	283	400	295
x140	C380x50	1.86	24 200	1 880	4 370	7 120	279	430	264
	C310x31	1.67	21 700	1 710	4 260	5 910	281	402	289
W610x125	C380x50	1.72	22 300	1 390	3 550	6 020	250	391	231
	C310x31	1.52	19 800	1 260	3 460	4 950	252	364	255
x113	C380x50	1.60	20 800	1 260	3 190	5 640	246	395	223
	C310x31	1.41	18 300	1 140	3 110	4 590	250	367	248
W530x101	C380x50	1.49	19 300	904	2 550	4 690	216	355	193
	C310x31	1.29	16 800	817	2 490	3 790	221	329	216
x92	C380x50	1.40	18 200	826	2 310	4 440	213	357	186
	C310x31	1.21	15 700	745	2 260	3 550	218	330	210
W460x74	C380x50	1.22	15 900	516	1 630	3 440	180	317	150
	C310x31	1.03	13 400	465	1 590	2 710	186	292	172
W410x54	C380x50	1.02	13 200	308	1 050	2 600	153	295	119
	C310x31	0.824	10 700	277	1 020	1 990	161	271	139
W360x45	C310x31	0.743	9 650	186	765	1 600	139	243	116
	C250x23	0.663	8 610	175	756	1 380	143	232	127
W310x39	C310x31	0.682	8 860	131	598	1 330	122	219	98.2
	C250x23	0.602	7 820	123	590	1 140	125	208	108
W250x33	C250x23	0.543	7 050	73.1	411	846	102	178	86.4
	C200x17	0.488	6 340	69.5	409	743	105	170	93.5
W200x27	C200x17	0.428	5 560	37.6	268	521	82.2	140	72.2



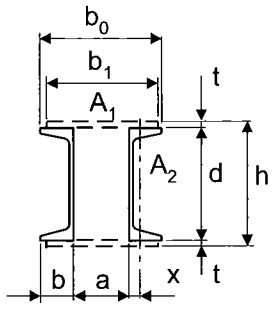
W SHAPES AND CHANNELS

PROPERTIES OF SECTIONS

Mass	Axis Y-Y			Shear Centre	Torsional Constant	Warping Constant	Monosymmetry Constant †
	I	S	r	Y_0	J	C_w	β_x
kg/m	10^6 mm^4	10^3 mm^3	mm	mm	10^3 mm^4	10^9 mm^6	mm
352.5	387	1 690	92.8	212	9 740	53 500	523
339.1	287	1 510	81.5	156	9 650	48 200	395
335.2	376	1 650	93.8	216	8 210	50 100	538
321.9	276	1 450	82.0	161	8 120	45 100	411
317.1	365	1 600	95.1	220	6 780	46 500	554
303.8	265	1 390	82.7	167	6 690	42 000	428
302.2	354	1 550	95.9	225	5 660	43 200	570
288.9	254	1 330	83.1	173	5 570	39 100	445
288.1	343	1 500	96.7	230	4 730	39 800	586
274.8	243	1 280	83.3	180	4 640	36 100	464
290.5	345	1 510	96.6	214	5 650	35 000	545
277.1	245	1 290	83.3	167	5 560	31 700	430
274.0	334	1 460	97.8	219	4 560	31 800	562
260.6	234	1 230	84.0	174	4 470	28 900	450
257.5	321	1 410	99.0	224	3 560	28 200	581
244.1	221	1 160	84.4	182	3 470	25 800	474
260.6	313	1 370	97.0	215	4 550	21 600	548
247.3	213	1 120	82.2	178	4 460	19 800	452
248.1	306	1 340	98.4	217	3 840	19 900	558
234.7	206	1 080	83.0	182	3 750	18 300	465
237.1	300	1 310	99.6	219	3 200	18 300	568
223.7	200	1 050	83.7	186	3 110	16 900	479
223.7	292	1 280	101	222	2 580	16 300	582
210.4	192	1 010	84.6	192	2 490	15 200	498
219.8	197	1 040	83.9	172	3 470	13 500	442
200.2	120	785	68.5	114	3 200	11 400	292
202.5	189	991	85.5	176	2 620	12 000	460
182.9	111	730	69.1	122	2 350	10 200	314
190.0	183	959	86.9	179	2 090	10 800	474
170.3	105	690	69.6	128	1 820	9 250	331
175.1	170	894	87.4	173	1 960	6 820	457
155.4	92.8	609	68.5	133	1 690	5 910	338
163.3	165	868	89.1	175	1 540	6 000	469
143.7	87.8	576	69.3	139	1 270	5 240	357
151.5	158	829	90.5	162	1 440	3 790	434
131.9	80.4	527	69.2	136	1 170	3 350	347
142.9	155	813	92.2	162	1 180	3 360	439
123.2	77.3	507	70.2	139	914	2 990	360
124.8	148	775	96.3	143	938	1 800	384
105.2	70.1	460	72.3	131	669	1 630	342
103.6	141	741	103	125	647	897	313
84.0	63.6	417	77.1	124	378	831	331
75.8	61.7	404	79.9	111	312	533	287
67.6	36.0	283	64.6	100	246	493	268
69.6	60.8	398	82.8	98.2	278	377	231
61.4	35.1	276	67.0	89.9	212	349	237
55.3	32.5	256	67.9	83.8	185	168	192
49.8	18.2	180	53.6	71.7	152	153	188
43.6	16.8	166	55.0	65.2	125	74.0	147

† β_x is positive when the larger flange is in flexural compression, and negative otherwise.

BUILT-UP SECTIONS



$h = d + 2t$

$b_0 = a + 2b$

$A_1 = b_1 t$

$A = 2(A_1 + A_2)$

$$I_{xx} = 2I_{xc} + \frac{b_1}{12}\left(h^3 - d^3\right)$$

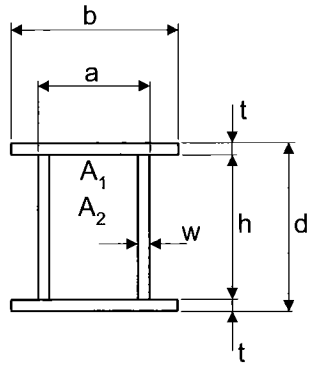
$S_{xx} = 2I_{xx}/h \qquad r_{xx} = \sqrt{I_{xx}/A}$

$$I_{yy} = 2I_{yc} + \frac{A_1}{6}b_1^2 + 2A_2(x + a/2)^2$$

$S_{yy} = 2I_{yy}/b_0$ if $b_1 < b_0$

$S_{yy} = 2I_{yy}/b_1$ if $b_1 \geq b_0$

$r_{yy} = \sqrt{I_{yy}/A}$



$h = d - 2t$

$A_1 = bt$

$A_2 = wh$

$A = 2(A_1 + A_2)$

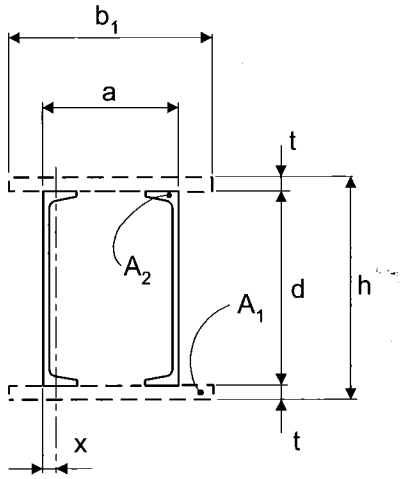
$c = a - 2w$

$$I_{xx} = \frac{1}{12}\left\{b(d^3 - h^3) + 2A_2h^2\right\} \qquad r_{xx} = \sqrt{I_{xx}/A}$$

$$S_{xx} = 2I_{xx}/d \qquad Z_{xx} = \frac{b}{4}\left(d^2 - h^2\right) + \frac{A_2h}{2}$$

$$I_{yy} = \frac{1}{12}\left\{2A_1b^2 + h(a^3 - c^3)\right\} \qquad r_{yy} = \sqrt{I_{yy}/A}$$

$$S_{yy} = 2I_{yy}/b \qquad Z_{yy} = \frac{h}{4}\left(a^2 - c^2\right) + \frac{A_1b}{2}$$



$h = d + 2t \qquad A_1 = b_1 t \qquad A = 2(A_1 + A_2)$

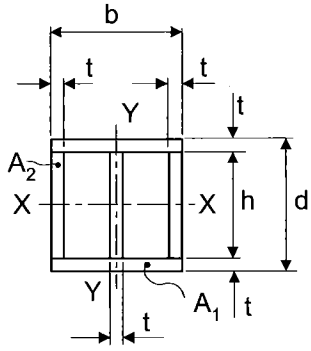
$$I_{xx} = 2I_{xc} + \frac{b_1}{12}(h^3 - d^3) \qquad S_{xx} = 2I_{xx}/h$$

$$I_{yy} = 2I_{yc} + \frac{A_1}{6}b_1^2 + 2A_2(a/2 - x)^2$$

$S_{yy} = 2I_{yy}/b_1$ if $a < b_1$

$S_{yy} = 2I_{yy}/a$ if $a \geq b_1$

$r_{xx} = \sqrt{I_{xx}/A} \qquad r_{yy} = \sqrt{I_{yy}/A}$



$h = d - 2t$

$A_1 = bt$

$A_2 = ht$

$A = 2A_1 + 3A_2$

$$I_{xx} = \frac{1}{12}\left\{3A_2h^2 + b(d^3 - h^3)\right\}$$

$$S_{xx} = 2I_{xx}/d \qquad Z_{xx} = \frac{3A_2h}{4} + A_1(d - t)$$

$$I_{yy} = \frac{1}{12}\left\{2A_1b^2 + A_2t^2 + h\left[b^3 - (b - 2t)^3\right]\right\}$$

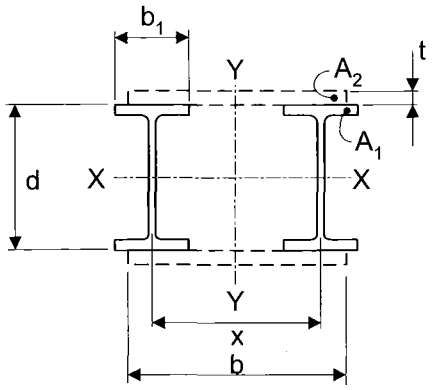
$$S_{yy} = 2I_{yy}/b \qquad Z_{yy} = \frac{A_1b}{2} + \frac{A_2t}{4} + A_2(b - t)$$

$r_{xx} = \sqrt{I_{xx}/A} \qquad r_{yy} = \sqrt{I_{yy}/A}$

Elements of the shape which are shown in dotted outline are optional and, if omitted, the variable defining their size should be set equal to zero.

All elements of the shape are assumed to be continuous along the length of the shape.

BUILT-UP SECTIONS



$A = 2(A_1 + A_2) \quad A_2 = b\,t$

$I_{xx} = 2\,I_{xw} + \frac{1}{12} b\left[(d + 2t)^3 - d^3\right]$

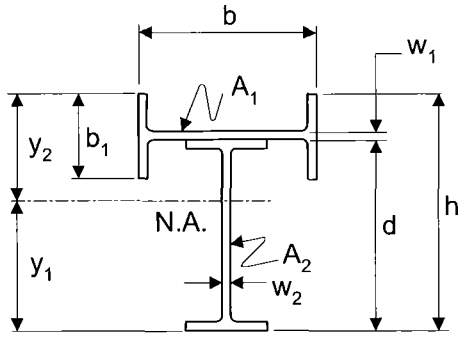
$S_{xx} = 2\,I_{xx} / (d + 2\,t)$

$I_{yy} = 2\,I_{yw} + \frac{1}{6} A_2 b^2 + \frac{1}{2} A_1 x^2$

For $(x + b_1) > b$: $S_{yy} = 2\,I_{yy} / (x + b_1)$

For $(x + b_1) \le b$: $S_{yy} = 2\,I_{yy} / b$

$r_{xx} = \sqrt{I_{xx} / A} \quad r_{yy} = \sqrt{I_{yy} / A}$



$h = d + \frac{1}{2}(b_1 + w_1) \quad A = A_1 + A_2$

$y_1 = \dfrac{A_1(d + w_1/2) + A_2 d/2}{A_1 + A_2} \quad y_2 = h - y_1$

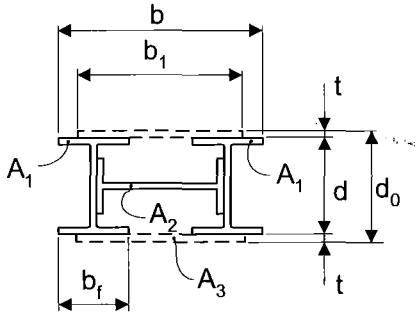
$I_{xx} = I_{y1} + I_{x2} + A_1 (y_2 - b_1/2)^2 + A_2 (y_1 - d/2)^2$

$S_{x1} = I_{xx} / y_1 \quad S_{x2} = I_{xx} / y_2$

$I_{yy} = I_{x1} + I_{y2} \quad S_{yy} = 2\,I_{yy} / b$

$*I_{yT} = I_{x1} + I_{y2}/2 - (y_1 - d/2) w_2^3 / 12$

$r_{xx} = \sqrt{I_{xx} / A} \quad r_{yy} = \sqrt{I_{yy} / A}$



$d_0 = d + 2\,t$

$A = 2(A_1 + A_3) + A_2 \quad A_3 = b_1\,t$

$I_{xx} = 2\,I_{x1} + I_{y2} + \frac{b_1}{12}(d_0^3 - d^3)$

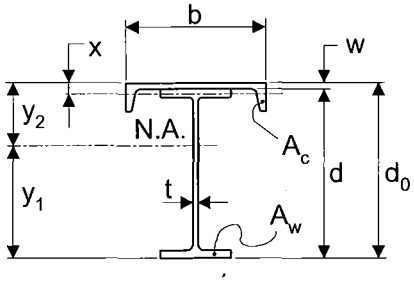
$S_{xx} = 2\,I_{xx} / d_0$

$I_{yy} = I_{x2} + 2\,I_{y1} + \frac{A_3}{6} b_1^2 + A_1 (b - b_f)^2 / 2$

$S_{yy} = 2\,I_{yy} / b_1 \quad$ if $b < b_1$

$S_{yy} = 2\,I_{yy} / b \quad$ if $b \ge b_1$

$r_{xx} = \sqrt{I_{xx} / A} \quad r_{yy} = \sqrt{I_{yy} / A}$



$A = A_c + A_w \quad d_0 = d + w$

$y_1 = \dfrac{A_w d/2 + A_c (d_0 - x)}{A} \quad y_2 = d_0 - y_1$

$I_{xx} = I_{xw} + I_{yc} + A_w (y_1 - d/2)^2 + A_c (y_2 - x)^2$

$I_{yy} = I_{yw} + I_{xc}$

$*I_{yT} = I_{xc} + \frac{I_{yw}}{2} - (y_1 - d/2)\frac{t^3}{12}$

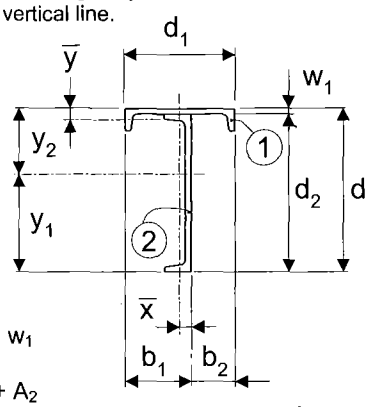
$S_{x1} = I_{xx} / y_1 \quad S_{x2} = I_{xx} / y_2 \quad S_{yy} = 2\,I_{yy} / b$

$r_{xx} = \sqrt{I_{xx} / A} \quad r_{yy} = \sqrt{I_{yy} / A}$

*I_{yT} is the moment of inertia of the T-section above the neutral axis.

BUILT-UP SECTIONS

Note: Centres of gravity of both channels are on the same vertical line.



$d = d_2 + w_1$

$A = A_1 + A_2$

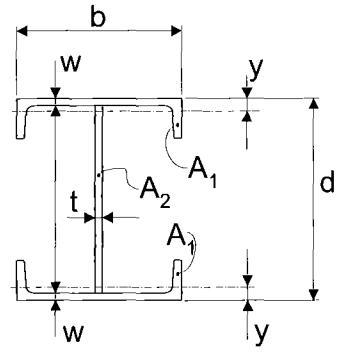
$b_1 = (d_1/2) + \bar{x} \qquad y_1 = \dfrac{A_1(d-\bar{y}) + \frac{A_2}{2} d_2}{A}$

$b_2 = d_1 - b_1 \qquad y_2 = d - y_1$

$I_{xx} = I_{1y} + I_{2x} + A_1(y_2 - \bar{y})^2 + A_2(y_1 - \frac{d_2}{2})^2$

$S_{x1} = I_{xx}/y_1 \qquad S_{x2} = I_{xx}/y_2 \qquad r_{xx} = \sqrt{I_{xx}/A}$

$I_{yy} = I_{x1} + I_{y2} \qquad S_y = 2\,I_{yy}/d_1 \qquad r_{yy} = \sqrt{I_{yy}/A}$



$h = d - 2w$

$A = 2A_1 + A_2 \qquad A_2 = ht$

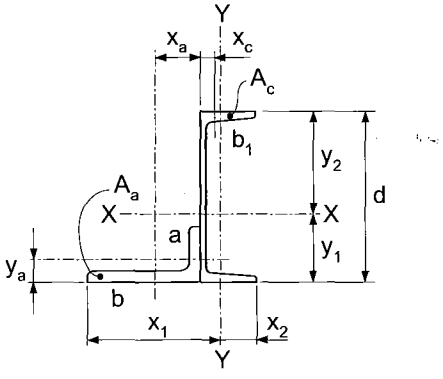
$I_{xx} = 2I_{yc} + \dfrac{1}{12} A_2 h^2 + 2A_1(d/2 - y)^2$

$S_{xx} = 2\,I_{xx}/d$

$I_{yy} = 2\,I_{xc} + \dfrac{1}{12} A_2 t^2 \qquad S_{yy} = 2\,I_{yy}/b$

$r_{xx} = \sqrt{I_{xx}/A} \qquad r_{yy} = \sqrt{I_{yy}/A}$

Note: a and b are the angle leg lengths, and b_1 is the width of the channel flange.



$A = A_a + A_c \qquad y_1 = \dfrac{A_a y_a + A_c d/2}{A} \qquad y_2 = d - y_1$

$x_1 = \dfrac{A_a(b - x_a) + A_c(b + x_c)}{A} \qquad x_2 = b_1 + b - x_1$

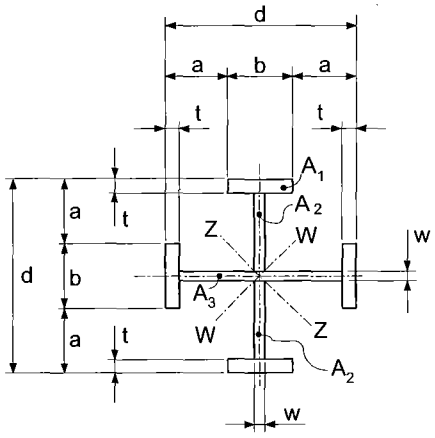
$I_{xx} = I_{ya} + I_{xc} + A_a(y_1 - y_a)^2 + A_c(\frac{d}{2} - y_1)^2$

$S_{x1} = I_{xx}/y_1 \qquad S_{x2} = I_{xx}/y_2$

$I_{yy} = I_{xa} + I_{yc} + A_a(x_1 - b + x_a)^2 + A_c(b_1 - x_2 - x_c)^2$

$S_{y1} = I_{yy}/x_1 \qquad S_{y2} = I_{yy}/x_2$

$r_{xx} = \sqrt{I_{xx}/A} \qquad r_{yy} = \sqrt{I_{yy}/A}$



$A = 4A_1 + 2A_2 + A_3 \qquad A_1 = bt$

$A_2 = (d - w - 2t)\,w/2 \qquad A_3 = 2A_2 + w^2$

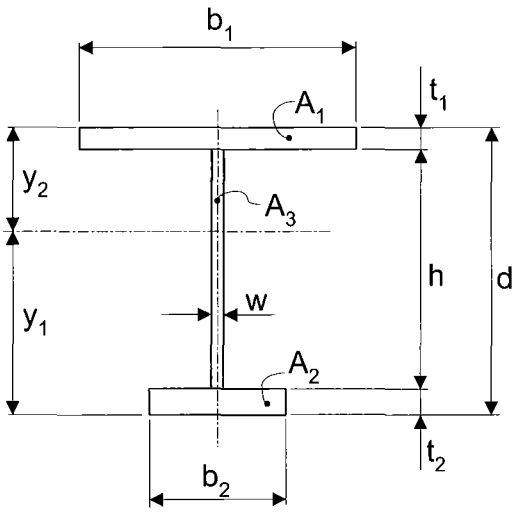
$I_x = I_y = \dfrac{1}{12}\{b(d^3 - E^3) + wE^3 + 2tb^3 + Ew^3 - w^4\}$

$E = d - 2t$

$S_x = S_y = 2\,I_x/d$

$r_x = r_y = \sqrt{I_x/A}$

BUILT-UP SECTIONS



$A_1 = b_1 t_1 \quad A_2 = b_2 t_2 \quad A_3 = w\,h$

$d = h + t_1 + t_2$

$A = A_1 + A_2 + A_3$

$$y_1 = \frac{A_1(d - t_1/2) + A_3(t_2 + h/2) + A_2 t_2/2}{A}$$

$y_2 = d - y_1$

$$J = \frac{1}{3}\left\{A_1 t_1^2 + A_3 w^2 + A_2 t_2^2\right\}$$

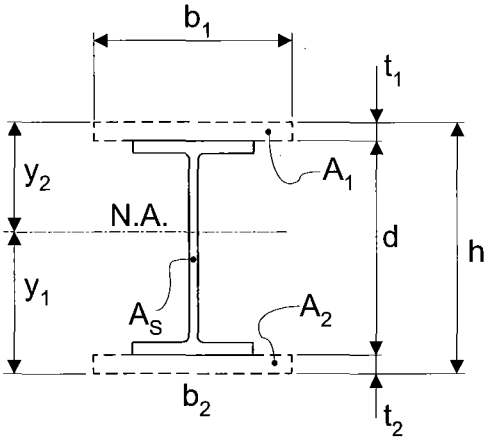
$$C_w = \frac{\left(d - \frac{t_1 + t_2}{2}\right)^2 b_1^3 t_1}{12\,[\,1 + (b_1/b_2)^3 (t_1/t_2)\,]}$$

$$I_{xx} = \frac{1}{12}[\,A_1 t_1^2 + A_2 t_2^2 + A_3 h^2\,] + A_1(y_2 - t_1/2)^2 + A_2(y_1 - t_2/2)^2 + A_3(y_1 - t_2 - h/2)^2$$

$S_{x1} = I_{xx}/y_1 \quad S_{x2} = I_{xx}/y_2$

$$I_{yy} = \frac{1}{12}[\,A_1 b_1^2 + A_2 b_2^2 + A_3 w^2\,] \quad S_{yy} = 2\,I_{yy}/b_1$$

$$^*I_{yT} = \frac{1}{12}[\,A_1 b_1^2 + (y_2 - t_1) w^3\,] \quad r_{xx} = \sqrt{I_{xx}/A} \quad r_{yy} = \sqrt{I_{yy}/A}$$



$A = A_1 + A_2 + A_S \quad h = d + t_1 + t_2$

$$y_1 = \frac{A_1(h - t_1/2) + A_S(t_2 + d/2) + A_2 t_2/2}{A}$$

$y_2 = h - y_1$

$$I_{xx} = I_{xS} + \frac{1}{12}(A_1 t_1^2 + A_2 t_2^2) + A_S(y_1 - t_2 - d/2)^2 + A_1(y_2 - t_1/2)^2 + A_2(y_1 - t_2/2)^2$$

$S_{x1} = I_{xx}/y_1 \quad S_{x2} = I_{xx}/y_2$

$r_{xx} = \sqrt{I_{xx}/A}$

$$I_{yy} = I_{yS} + \frac{1}{12}[\,A_1 b_1^2 + A_2 b_2^2\,]$$

$S_{yy} = 2\,I_{yy}/b_1$ if $b_1 > b_2$

$S_{yy} = 2\,I_{yy}/b_2$ if $b_1 \le b_2$

$r_{yy} = \sqrt{I_{yy}/A}$

*I_{yT} is the moment of inertia of the T-section above the neutral axis.

COLD-FORMED STEEL C- and Z-SECTIONS

General

While various proprietary cold-formed C- and Z-sections are available from Canadian roll formers, the sections listed on the following pages are representative of those included in CSA Standard G40.20/G40.21-13, and other products generally available. Coated sections refer to products that are typically supplied with a metallic coating such as zinc or aluminum-zinc alloy. Uncoated products do not have this coating. The metallic coating, if present, does not affect the calculated properties of the section. Both gross and effective section properties are presented in these tables. For coated sections the calculated values were based on an inside bend radius, R, taken as the greater of $R_1 = (2.381 - t/2)$ and $R_2 = 1.5t$, and for uncoated sections the inside bend radius was taken as $2t$. The effective section properties, factored shear and moment resistances were computed in accordance with the applicable sections of CSA Standard S136-12, *North American Specification for the Design of Cold-Formed Steel Structural Members*. For coated sections with a design base steel thickness less than or equal to 1.146 mm, $F_y = 230$ MPa and $F_u = 310$ MPa. For coated sections with a design base steel thickness greater than 1.146 mm, $F_y = 345$ MPa and $F_u = 450$ MPa. For all uncoated sections, $F_y = 345$ MPa and $F_u = 450$ MPa. Cold work of forming was not included. Distortional buckling calculations were based on $K_\varphi = 0$.

Material

For coated sections, steel meets the requirements of ASTM A653/A653M Grade 340 (Grade 50), $F_y = 345$ MPa, and for uncoated sections, steel meets the requirements of ASTM A1011/A1011M Grade 340 (Grade 50), $F_y = 345$ MPa.

Tables

Only some of the noteworthy terms are defined below. All others are self-explanatory.

I_{xd} = effective deflection moment of inertia about X-X axis (10^6 mm^4) at $0.6F_y$
S_{xe} = effective section modulus about X-X axis (10^3 mm^3)
I_{ye} = effective moment of inertia about Y-Y axis assuming lips in tension (10^6 mm^4)
S_{ye} = effective section modulus about Y-Y axis (10^3 mm^3)
M_{rlb} = factored moment resistance based on local buckling about X-X axis (kN·m)
L_{cr} = critical unbraced length of distortional buckling (mm)
M_{rdb} = factored moment resist. based on distortional buckling about X-X axis (kN·m)
V_r = factored shear resistance (kN)
L_u = maximum unbraced length of compression flange beyond which appropriate values in the Table must be reduced for lateral-torsional buckling (mm)
t = design base steel thickness (mm)
x_o = distance from shear centre to centroid of gross area (mm)
r_o = polar radius of gyration (mm)
J = Saint-Venant torsion constant (10^3 mm^4)
j = flexural-torsional buckling parameter (mm)
C_w = torsional warping constant (10^9 mm^6)

The minimum base steel thickness is 95% of the design base steel thickness. The design base steel thickness was used to calculate values in the tables.

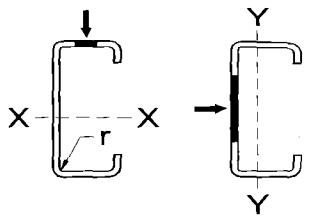
Minimum base steel thickness (mm)	Design base steel thickness (mm)
5.41	5.69
4.68	4.93
3.96	4.17
3.62	3.81
3.26	3.43
2.90	3.05
2.54	2.67
2.18	2.29
1.81	1.91
1.44	1.52

Minimum base steel thickness (mm)	Design base steel thickness (mm)
2.997	3.155
2.454	2.583
1.720	1.811
1.367	1.438
1.087	1.146

These tables have been prepared by Dr. R.M. Schuster, Professor Emeritus of Structural Engineering and Director of the Canadian Cold-Formed Steel Research Group at the University of Waterloo.

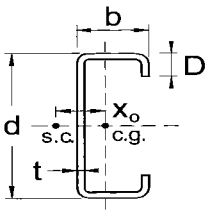
COLD-FORMED C-SECTIONS, COATED

Effective Properties



Designation	Mass	Gross Area	Effective Section Properties				M_{rlb}	L_{cr}	M_{rdb}	V_r	L_u
			X-X Axis		Y-Y Axis						
			I_{xd}	S_{xe}	I_{ye}	S_{ye}					
	kg/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	$10^6\ mm^4$	$10^3\ mm^3$	kN·m	mm	kN·m	kN	mm
1400S300-118	12.8	1 629	27.2	138	0.702	13.5	42.9	474	35.4	72.4	1 407
1400S300-97	10.6	1 345	21.7	104	0.562	11.3	32.4	527	26.5	39.4	1 418
1400S300-68	7.48	953	14.3	59.8	0.369	7.98	18.6	637	15.8	13.4	1 433
1400S250-118	12.2	1 549	24.7	129	0.443	10.1	40.1	426	33.8	72.4	1 173
1400S250-97	10.0	1 279	20.1	98.4	0.357	8.44	30.6	474	25.3	39.4	1 184
1400S250-68	7.12	907	13.5	58.1	0.237	6.04	18.1	573	15.0	13.4	1 199
1400S200-118	11.5	1 469	22.2	116	0.252	6.99	36.1	375	31.4	72.4	933
1400S200-97	9.53	1 213	18.1	91.4	0.206	5.94	28.4	417	23.6	39.4	945
1400S200-68	6.76	861	12.3	57.4	0.138	4.31	17.8	503	14.0	13.4	961
1400S162-118	10.9	1 388	19.8	103	0.133	4.33	32.0	297	27.5	72.4	714
1400S162-97	9.01	1 148	16.1	80.5	0.111	3.74	25.0	325	20.5	39.4	727
1400S162-68	6.40	815	10.9	51.4	0.076	2.78	15.9	386	12.0	13.4	745
1200S300-118	11.5	1 469	18.8	119	0.698	13.5	36.9	454	30.0	85.1	1 428
1200S300-97	9.53	1 213	15.4	95.5	0.559	11.3	29.7	506	22.6	46.3	1 437
1200S300-68	6.76	861	10.7	54.3	0.368	7.97	16.9	612	13.6	15.7	1 450
1200S250-118	10.9	1 388	17.0	107	0.441	10.0	33.3	408	28.7	85.1	1 195
1200S250-97	9.01	1 148	14.0	82.5	0.356	8.43	25.6	454	21.7	46.3	1 205
1200S250-68	6.40	815	9.53	49.2	0.236	6.03	15.3	550	13.1	15.7	1 219
1200S200-118	10.3	1 308	15.1	96.1	0.251	6.97	29.8	357	26.8	85.1	956
1200S200-97	8.50	1 082	12.5	76.3	0.205	5.93	23.7	398	20.4	46.3	967
1200S200-68	6.04	769	8.62	48.5	0.138	4.31	15.1	482	12.3	15.7	982
1200S162-118	9.64	1 228	13.4	84.7	0.132	4.32	26.3	278	23.6	85.1	736
1200S162-97	7.98	1 017	11.1	67.0	0.110	3.74	20.8	306	17.9	46.3	748
1200S162-68	5.68	723	7.60	43.3	0.076	2.78	13.5	368	10.6	15.7	765
1000S300-97	8.50	1 082	9.95	73.7	0.555	11.2	22.9	482	18.6	56.0	1 455
1000S300-68	6.04	769	6.92	45.9	0.366	7.95	14.3	585	11.3	19.0	1 467
1000S300-54	4.82	615	5.33	31.1	0.276	6.28	9.67	661	8.13	9.4	1 472
1000S250-97	7.98	1 017	9.09	69.0	0.353	8.41	21.4	433	17.9	56.0	1 226
1000S250-68	5.68	723	6.47	45.3	0.235	6.02	14.1	525	10.9	19.0	1 239
1000S250-54	4.54	578	5.08	30.8	0.177	4.78	9.56	595	7.89	9.4	1 245
1000S200-97	7.47	951	8.05	61.3	0.204	5.92	19.0	379	16.8	56.0	990
1000S200-68	5.32	677	5.66	39.6	0.137	4.30	12.3	460	10.4	19.0	1 004
1000S200-54	4.25	542	4.43	27.9	0.104	3.44	8.66	521	7.48	9.4	1 010
1000S162-97	6.95	885	7.06	53.6	0.110	3.73	16.6	289	14.9	56.0	771
1000S162-68	4.95	631	4.96	35.3	0.076	2.77	11.0	349	9.04	19.0	786
1000S162-54	3.96	505	3.87	25.7	0.058	2.24	7.99	395	6.48	9.4	794

Designation Example: 1400S300-97; where 1400 = 14 in. section depth; S = stud or joist C-section; 300 = 3 in. flange width; 97 = minimum base steel thickness in mils;



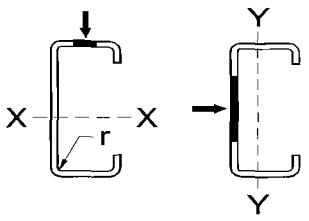
COLD-FORMED C-SECTIONS, COATED

Dimensions and Gross Properties

Depth	Flange Width	Stiff'r Depth	Thick-ness	Gross Section Properties										
				X-X Axis			Y-Y Axis			x_o	r_o	J	j	C_w
d	b	D	t	I_x	S_x	r_x	I_y	S_y	r_y					
mm	mm	mm	mm	10^6 mm^4	10^3 mm^3	mm	10^6 mm^4	10^3 mm^3	mm	mm	mm	10^3 mm^4	mm	10^9 mm^6
356	76	15.9	3.15	27.3	154	130	0.905	14.8	23.6	39.2	137	5.40	238	23.0
356	76	15.9	2.58	22.8	128	130	0.772	12.7	24.0	39.8	138	2.99	233	19.4
356	76	15.9	1.81	16.3	91.8	131	0.570	9.35	24.5	40.7	139	1.04	227	14.2
356	64	15.9	3.15	24.9	140	127	0.563	10.9	19.1	30.6	132	5.14	267	14.8
356	64	15.9	2.58	20.7	117	127	0.483	9.35	19.4	31.1	132	2.84	260	12.5
356	64	15.9	1.81	14.9	83.7	128	0.360	6.97	19.9	31.9	133	0.99	251	9.16
356	51	15.9	3.15	22.4	126	123	0.314	7.49	14.6	22.4	126	4.87	317	8.56
356	51	15.9	2.58	18.7	105	124	0.273	6.49	15.0	23.0	127	2.70	306	7.29
356	51	15.9	1.81	13.4	75.6	125	0.206	4.89	15.5	23.7	128	0.94	293	5.39
356	41	12.7	3.15	20.0	112	120	0.161	4.60	10.8	15.5	121	4.61	403	4.57
356	41	12.7	2.58	16.7	94.0	121	0.142	4.05	11.1	16.0	122	2.55	384	3.93
356	41	12.7	1.81	12.1	67.8	122	0.109	3.11	11.6	16.6	123	0.89	361	2.94
305	76	15.9	3.15	18.8	123	113	0.872	14.7	24.4	42.3	123	4.87	189	16.2
305	76	15.9	2.58	15.7	103	114	0.743	12.5	24.8	43.0	124	2.70	185	13.7
305	76	15.9	1.81	11.3	73.8	114	0.549	9.24	25.3	43.8	125	0.94	181	9.97
305	64	15.9	3.15	17.0	111	111	0.544	10.8	19.8	33.2	117	4.61	206	10.4
305	64	15.9	2.58	14.2	92.9	111	0.467	9.25	20.2	33.8	118	2.55	201	8.79
305	64	15.9	1.81	10.2	66.9	112	0.348	6.89	20.7	34.6	119	0.89	195	6.45
305	51	15.9	3.15	15.1	99.3	108	0.305	7.43	15.3	24.5	111	4.34	239	6.03
305	51	15.9	2.58	12.7	83.1	108	0.264	6.43	15.6	25.1	112	2.41	231	5.14
305	51	15.9	1.81	9.14	60.0	109	0.199	4.85	16.1	25.8	113	0.84	222	3.81
305	41	12.7	3.15	13.4	87.8	104	0.157	4.57	11.3	17.0	106	4.07	299	3.22
305	41	12.7	2.58	11.2	73.7	105	0.138	4.02	11.7	17.6	107	2.26	286	2.77
305	41	12.7	1.81	8.13	53.3	106	0.106	3.09	12.1	18.3	108	0.79	270	2.08
254	76	15.9	2.58	10.1	79.7	96.7	0.708	12.3	25.6	46.7	110	2.41	146	9.01
254	76	15.9	1.81	7.29	57.4	97.4	0.524	9.10	26.1	47.6	111	0.84	143	6.59
254	76	15.9	1.44	5.86	46.1	97.7	0.426	7.41	26.3	48.1	112	0.42	142	5.34
254	64	15.9	2.58	9.09	71.6	94.5	0.446	9.12	21.0	36.9	104	2.26	153	5.81
254	64	15.9	1.81	6.56	51.6	95.2	0.333	6.80	21.4	37.8	105	0.79	149	4.27
254	64	15.9	1.44	5.28	41.6	95.6	0.272	5.56	21.7	38.2	105	0.40	148	3.47
254	51	15.9	2.58	8.05	63.4	92.0	0.254	6.35	16.3	27.6	97	2.12	170	3.40
254	51	15.9	1.81	5.83	45.9	92.8	0.191	4.79	16.8	28.4	98	0.74	164	2.52
254	51	15.9	1.44	4.70	37.0	93.1	0.157	3.93	17.0	28.8	99	0.37	161	2.06
254	41	12.7	2.58	7.06	55.6	89.3	0.133	3.97	12.3	19.5	92	1.97	204	1.83
254	41	12.7	1.81	5.13	40.4	90.2	0.103	3.06	12.7	20.3	93	0.69	193	1.38
254	41	12.7	1.44	4.14	32.6	90.6	0.085	2.53	13.0	20.6	94	0.35	189	1.13

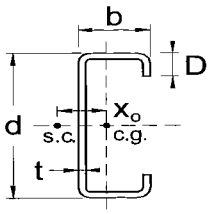
COLD-FORMED C-SECTIONS, COATED

Effective Properties



Designation	Mass	Gross Area	Effective Section Properties				M_{rlb}	L_{cr}	M_{rdb}	V_r	L_u
			X-X Axis		Y-Y Axis						
			I_{xd}	S_{xe}	I_{ye}	S_{ye}					
	kg/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	$10^6\ mm^4$	$10^3\ mm^3$	kN·m	mm	kN·m	kN	mm
800S300-97	7.47	951	5.88	54.1	0.549	11.2	16.8	456	14.4	61.9	1 473
800S300-68	5.32	677	4.10	35.1	0.363	7.93	10.9	552	8.90	24.0	1 481
800S300-54	4.25	542	3.19	25.1	0.274	6.27	7.80	625	6.45	11.9	1 486
800S250-97	6.95	885	5.32	50.4	0.350	8.37	15.7	408	13.9	61.9	1 248
800S250-68	4.95	631	3.80	33.7	0.233	6.00	10.5	496	8.62	24.0	1 257
800S250-54	3.96	505	2.98	25.0	0.176	4.77	7.75	562	6.28	11.9	1 263
800S200-97	6.44	820	4.66	45.9	0.202	5.89	14.3	357	13.0	61.9	1 015
800S200-68	4.59	585	3.39	32.6	0.136	4.29	10.1	434	8.20	24.0	1 026
800S200-54	3.68	468	2.74	24.5	0.103	3.43	7.62	492	5.99	11.9	1 031
800S162-97	5.92	754	4.04	39.8	0.108	3.72	12.4	270	11.5	61.9	796
800S162-68	4.23	539	2.94	27.3	0.075	2.77	8.46	329	7.24	24.0	808
800S162-54	3.39	432	2.32	20.1	0.058	2.24	6.25	373	5.26	11.9	815
600S300-97	4.59	585	2.11	23.7	0.359	7.89	7.35	514	6.50	30.4	1 495
600S300-68	3.68	468	1.64	18.1	0.272	6.24	5.63	582	4.75	16.0	1 498
600S300-54	2.95	376	1.37	15.5	0.218	5.05	3.20	656	2.71	8.0	1 840
600S250-97	4.23	539	1.97	24.9	0.243	6.10	5.16	461	4.76	24.9	1 570
600S250-68	3.39	432	1.59	18.9	0.185	4.86	3.92	523	3.54	15.7	1 572
600S250-54	2.72	347	1.27	15.0	0.141	3.86	3.11	590	2.62	8.0	1 574
600S200-97	3.87	493	1.71	22.4	0.142	4.36	4.64	404	4.38	24.9	1 291
600S200-68	3.10	395	1.38	18.1	0.109	3.50	3.75	458	3.33	15.7	1 294
600S200-54	2.49	318	1.12	14.3	0.083	2.79	2.96	517	2.49	8.0	1 298
600S162-97	3.51	447	1.47	19.3	0.078	2.81	3.99	305	3.77	24.9	1 023
600S162-68	2.82	359	1.19	15.6	0.061	2.28	3.23	346	2.94	15.7	1 028
600S162-54	2.26	288	0.96	12.7	0.046	1.83	2.62	392	2.19	8.0	1 032
362S250-97	3.37	430	0.62	13.0	0.232	5.99	2.69	407	2.64	16.6	1 629
362S250-68	2.71	345	0.50	9.9	0.179	4.79	2.04	461	2.01	13.5	1 622
362S250-54	2.18	278	0.41	7.8	0.137	3.81	1.61	520	1.51	9.9	1 618
362S200-97	3.01	384	0.53	11.4	0.135	4.28	2.37	356	2.24	16.6	1 357
362S200-68	2.42	309	0.43	9.3	0.105	3.45	1.93	404	1.82	13.5	1 352
362S200-54	1.95	248	0.35	7.3	0.081	2.76	1.52	456	1.41	9.9	1 350
362S162-97	2.65	338	0.44	9.7	0.075	2.76	2.00	268	1.89	16.6	1 076
362S162-68	2.14	272	0.36	7.9	0.059	2.25	1.63	305	1.54	13.5	1 073
362S162-54	1.72	219	0.30	6.4	0.045	1.81	1.33	345	1.23	9.9	1 073

Designation Example: 600S200-97; where 600 = 6 in. section depth; S = stud or joist C-section; 200 = 2 in. flange width; 97 = minimum base steel thickness in mils;



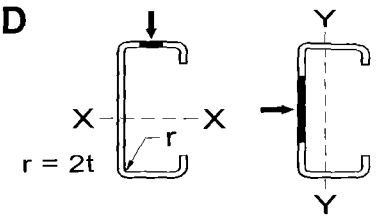
COLD-FORMED C-SECTIONS, COATED

Dimensions and Gross Properties

Depth	Flange Width	Stiff'r Depth	Thick-ness	Gross Section Properties										
				X-X Axis			Y-Y Axis			x_o	r_o	J	j	C_w
d	b	D	t	I_x	S_x	r_x	I_y	S_y	r_y					
mm	mm	mm	mm	10^6 mm^4	10^3 mm^3	mm	10^6 mm^4	10^3 mm^3	mm	mm	mm	10^3 mm^4	mm	10^9 mm^6
203	76	15.9	2.58	5.98	58.9	79.3	0.664	12.0	26.4	51.2	98	2.12	115	5.45
203	76	15.9	1.81	4.32	42.5	79.9	0.491	8.90	26.9	52.2	99	0.74	114	4.00
203	76	15.9	1.44	3.48	34.2	80.2	0.399	7.25	27.2	52.7	100	0.37	113	3.24
203	64	15.9	2.58	5.32	52.4	77.6	0.420	8.94	21.8	40.8	90	1.97	115	3.52
203	64	15.9	1.81	3.86	37.9	78.2	0.313	6.67	22.3	41.8	91	0.69	113	2.59
203	64	15.9	1.44	3.11	30.6	78.5	0.256	5.45	22.5	42.2	92	0.35	112	2.11
203	51	15.9	2.58	4.66	45.9	75.4	0.240	6.24	17.1	30.8	83	1.82	121	2.06
203	51	15.9	1.81	3.39	33.4	76.1	0.181	4.71	17.6	31.7	84	0.64	117	1.53
203	51	15.9	1.44	2.74	26.9	76.4	0.149	3.87	17.8	32.1	85	0.32	116	1.25
203	41	12.7	2.58	4.04	39.8	73.2	0.127	3.91	13.0	22.0	78	1.68	139	1.10
203	41	12.7	1.81	2.95	29.1	74.0	0.098	3.01	13.5	22.8	79	0.59	133	0.83
203	41	12.7	1.44	2.39	23.5	74.4	0.081	2.50	13.7	23.2	79	0.30	130	0.68
152	76	15.9	1.81	2.23	29.2	61.7	0.447	8.61	27.7	57.9	89	0.64	93	2.13
152	76	15.9	1.44	1.80	23.6	62.0	0.364	7.01	27.9	58.4	90	0.32	93	1.73
152	76	15.9	1.15	1.45	19.0	62.1	0.296	5.70	28.1	58.8	90	0.16	93	1.41
152	64	15.9	1.81	1.97	25.8	60.4	0.286	6.47	23.1	46.8	80	0.59	87	1.38
152	64	15.9	1.44	1.59	20.9	60.7	0.234	5.29	23.3	47.2	80	0.30	87	1.13
152	64	15.9	1.15	1.28	16.9	60.9	0.191	4.32	23.5	47.6	81	0.15	86	0.92
152	51	15.9	1.81	1.71	22.4	58.8	0.166	4.59	18.4	35.9	71	0.54	83	0.82
152	51	15.9	1.44	1.38	18.1	59.1	0.137	3.77	18.6	36.4	72	0.27	83	0.67
152	51	15.9	1.15	1.12	14.7	59.3	0.112	3.09	18.8	36.7	72	0.14	82	0.55
152	41	12.7	1.81	1.47	19.3	57.3	0.091	2.94	14.2	26.2	65	0.49	87	0.44
152	41	12.7	1.44	1.19	15.6	57.6	0.075	2.44	14.5	26.6	65	0.25	86	0.36
152	41	12.7	1.15	0.97	12.7	57.8	0.062	2.01	14.6	27.0	65	0.13	85	0.29
92	64	15.9	1.81	0.62	13.5	38.0	0.240	6.07	23.6	55.0	71	0.47	69	0.49
92	64	15.9	1.44	0.50	10.9	38.2	0.197	4.97	23.9	55.5	71	0.24	70	0.40
92	64	15.9	1.15	0.41	8.9	38.4	0.160	4.06	24.0	55.9	72	0.12	70	0.33
92	51	15.9	1.81	0.53	11.4	37.0	0.140	4.33	19.1	43.1	60	0.42	60	0.29
92	51	15.9	1.44	0.43	9.3	37.3	0.115	3.57	19.3	43.6	60	0.21	60	0.24
92	51	15.9	1.15	0.35	7.6	37.4	0.094	2.92	19.5	43.9	61	0.11	60	0.20
92	41	12.7	1.81	0.44	9.7	36.3	0.077	2.79	15.1	32.1	51	0.37	54	0.15
92	41	12.7	1.44	0.36	7.9	36.5	0.064	2.32	15.4	32.6	51	0.19	54	0.12
92	41	12.7	1.15	0.30	6.4	36.7	0.053	1.91	15.5	32.9	52	0.10	53	0.10

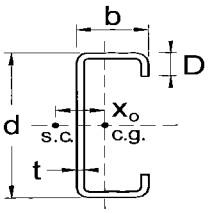
COLD-FORMED C-SECTIONS, UNCOATED

Effective Properties



Designation	Mass	Gross Area	Effective Section Properties				M_{rdb}	L_{cr}	M_{rdb}	V_r	L_u
			X-X Axis		Y-Y Axis						
			I_{xd}	S_{xe}	I_{ye}	S_{ye}					
	kg/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	$10^6\ mm^4$	$10^3\ mm^3$	kN·m	mm	kN·m	kN	mm
406S76-290M	13.9	1 771	37.2	169	0.787	15.9	52.3	659	43.3	57.2	1 489
406S76-254M	12.2	1 558	32.4	140	0.676	14.1	43.4	708	36.0	38.1	1 496
356S89-326M	15.0	1 906	33.5	183	1.34	23.2	56.9	684	47.0	94.3	1 763
356S89-290M	13.4	1 704	30.1	163	1.17	20.8	50.5	730	40.2	65.8	1 769
356S89-254M	11.8	1 499	26.6	140	1.00	18.4	43.4	785	33.5	43.8	1 774
356S89-218M	10.1	1 292	23.0	108	0.832	15.8	33.6	853	27.1	27.4	1 780
356S76-290M	12.7	1 616	27.2	144	0.783	15.9	44.8	636	37.8	65.8	1 512
356S76-254M	11.2	1 423	23.8	120	0.673	14.1	37.4	684	31.5	43.8	1 518
305S89-326M	13.6	1 732	23.1	148	1.33	23.1	45.8	658	39.5	109	1 786
305S89-290M	12.2	1 549	20.8	131	1.16	20.8	40.7	702	33.9	77.5	1 791
305S89-254M	10.7	1 364	18.4	112	0.996	18.3	34.9	755	28.4	51.5	1 796
305S89-218M	9.23	1 176	15.9	93.4	0.829	15.8	29.0	820	23.1	32.2	1 801
305S89-181M	7.74	986	13.1	71.2	0.663	13.1	22.1	904	18.0	18.5	1 806
305S76-290M	11.5	1 462	18.9	124	0.779	15.9	38.4	611	31.9	77.5	1 536
305S76-254M	10.1	1 287	16.7	107	0.670	14.0	33.3	658	26.8	51.5	1 541
305S76-218M	8.72	1 111	14.5	90.4	0.559	12.1	28.1	715	21.8	32.2	1 546
305S76-181M	7.31	932	12.3	67.8	0.449	10.1	21.0	789	17.0	18.5	1 552
254S89-326M	12.2	1 557	15.0	115	1.31	23.1	35.6	628	32.0	109	1 812
254S89-290M	10.9	1 394	13.5	102	1.15	20.7	31.7	670	27.6	86.2	1 815
254S89-254M	9.64	1 228	12.0	87.3	0.988	18.3	27.1	721	23.2	62.5	1 819
254S89-218M	8.32	1 060	10.4	72.4	0.824	15.7	22.5	783	18.9	39.0	1 822
254S89-181M	6.98	889	8.53	60.0	0.660	13.1	18.6	864	14.8	22.3	1 827
254S89-144M	5.62	716	6.76	43.0	0.501	10.4	13.4	973	10.9	11.3	1 831
254S76-290M	10.3	1 307	12.2	95.9	0.772	15.8	29.8	583	25.9	86.2	1 561
254S76-254M	9.04	1 152	10.8	83.1	0.665	14.0	25.8	628	21.9	62.5	1 565
254S76-218M	7.81	995	9.39	70.0	0.556	12.1	21.7	683	17.9	39.0	1 570
254S76-181M	6.55	835	7.94	56.6	0.447	10.1	17.6	754	14.0	22.3	1 574
254S76-144M	5.28	673	6.29	41.7	0.339	8.08	12.9	849	10.3	11.3	1 579
229S89-326M	11.5	1 470	11.7	99.4	1.31	23.0	30.9	611	28.3	109	1 827
229S89-290M	10.3	1 317	10.5	88.4	1.15	20.7	27.5	652	24.4	86.2	1 829
229S89-254M	9.11	1 160	9.35	75.7	0.983	18.2	23.5	702	20.6	66.0	1 831
229S89-218M	7.86	1 002	8.10	62.7	0.820	15.7	19.5	763	16.8	43.6	1 834
229S89-181M	6.60	841	6.67	52.0	0.658	13.1	16.1	841	13.2	25.0	1 838
203S76-290M	9.04	1 152	7.17	70.6	0.762	15.7	21.9	552	19.9	86.2	1 591
203S76-254M	7.98	1 016	6.38	61.3	0.657	13.9	19.0	594	16.9	66.0	1 593
203S76-218M	6.90	878	5.55	51.6	0.550	12.1	16.0	646	13.9	48.5	1 596
203S76-181M	5.79	738	4.70	41.6	0.443	10.1	12.9	713	11.0	28.3	1 599
203S76-144M	4.67	595	3.72	33.5	0.337	8.06	10.4	803	8.14	14.3	1 603

Designation Example: 356S89-254M; where 356 = section depth (mm); S = stud or joist C-section; 89 = flange width (mm); 254 = minimum base steel thickness x 100 (mm); M = metric designation



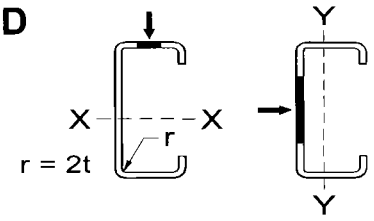
COLD-FORMED C-SECTIONS, UNCOATED

Dimensions and Gross Properties

Depth	Flange Width	Stiff'r Depth	Thick-ness	Gross Section Properties										
				X-X Axis			Y-Y Axis			x_o	r_o	J	j	C_w
d	b	D	t	I_x	S_x	r_x	I_y	S_y	r_y					
mm	mm	mm	mm	10^6 mm^4	10^3 mm^3	mm	10^6 mm^4	10^3 mm^3	mm	mm	mm	10^3 mm^4	mm	10^9 mm^6
406	76	24	3.05	38.1	188	147	1.07	17.6	24.5	40.8	154	5.49	281	36.7
406	76	24	2.67	33.7	166	147	0.956	15.8	24.8	41.2	155	3.69	277	32.7
356	89	25	3.43	33.5	188	133	1.71	25.2	30.0	53.7	146	7.47	213	44.8
356	89	25	3.05	30.1	169	133	1.56	23.0	30.2	54.1	147	5.28	211	40.5
356	89	25	2.67	26.6	150	133	1.39	20.6	30.5	54.6	147	3.55	209	36.0
356	89	25	2.29	23.1	130	134	1.22	18.0	30.7	55.0	148	2.25	206	31.4
356	76	24	3.05	27.5	154	130	1.03	17.4	25.3	43.7	140	5.01	227	27.2
356	76	24	2.67	24.3	137	131	0.926	15.6	25.5	44.1	140	3.37	223	24.2
305	89	25	3.43	23.1	152	116	1.64	24.9	30.8	57.6	133	6.79	174	31.8
305	89	25	3.05	20.8	136	116	1.49	22.7	31.0	58.0	133	4.80	173	28.8
305	89	25	2.67	18.4	121	116	1.34	20.3	31.3	58.5	134	3.23	171	25.6
305	89	25	2.29	16.0	105	117	1.17	17.8	31.6	58.9	134	2.05	170	22.3
305	89	25	1.91	13.5	88.4	117	0.997	15.2	31.8	59.4	135	1.19	169	18.9
305	76	24	3.05	18.9	124	114	0.991	17.2	26.0	47.1	126	4.53	181	19.3
305	76	24	2.67	16.7	110	114	0.890	15.4	26.3	47.5	126	3.05	178	17.2
305	76	24	2.29	14.5	95.3	114	0.782	13.6	26.5	48.0	127	1.93	176	15.0
305	76	24	1.91	12.3	80.4	115	0.668	11.6	26.8	48.4	127	1.13	174	12.8
254	89	25	3.43	15.0	118	98.1	1.55	24.5	31.6	62.2	120	6.10	143	21.3
254	89	25	3.05	13.5	106	98.4	1.41	22.3	31.8	62.6	121	4.32	142	19.3
254	89	25	2.67	12.0	94.2	98.7	1.27	19.9	32.1	63.1	121	2.91	141	17.2
254	89	25	2.29	10.4	81.8	99.0	1.11	17.5	32.3	63.6	122	1.85	140	15.0
254	89	25	1.91	8.77	69.1	99.3	0.944	14.9	32.6	64.1	123	1.08	139	12.7
254	89	25	1.52	7.11	56.0	99.6	0.772	12.2	32.8	64.5	123	0.55	139	10.4
254	76	24	3.05	12.2	95.9	96.5	0.941	16.9	26.8	51.1	112	4.05	143	12.9
254	76	24	2.67	10.8	85.1	96.9	0.845	15.2	27.1	51.6	113	2.73	142	11.5
254	76	24	2.29	9.40	74.0	97.2	0.743	13.4	27.3	52.0	114	1.73	140	10.1
254	76	24	1.91	7.94	62.5	97.5	0.635	11.4	27.6	52.5	114	1.01	139	8.56
254	76	24	1.52	6.44	50.7	97.8	0.521	9.37	27.8	52.9	115	0.52	138	6.98
229	89	25	3.43	11.7	102	89.2	1.50	24.2	32.0	64.8	115	5.76	130	17.0
229	89	25	3.05	10.5	92.2	89.5	1.37	22.0	32.2	65.3	115	4.08	129	15.4
229	89	25	2.67	9.35	81.8	89.8	1.22	19.7	32.5	65.7	116	2.75	129	13.7
229	89	25	2.29	8.13	71.1	90.1	1.07	17.3	32.7	66.2	116	1.75	128	12.0
229	89	25	1.91	6.86	60.0	90.3	0.913	14.7	33.0	66.7	117	1.02	128	10.2
203	76	24	3.05	7.17	70.6	78.9	0.878	16.5	27.6	56.0	101	3.57	114	7.99
203	76	24	2.67	6.38	62.8	79.2	0.788	14.9	27.9	56.5	101	2.41	114	7.14
203	76	24	2.29	5.55	54.7	79.5	0.693	13.1	28.1	56.9	102	1.53	113	6.25
203	76	24	1.91	4.70	46.3	79.8	0.593	11.2	28.3	57.4	102	0.89	112	5.32
203	76	24	1.52	3.82	37.6	80.1	0.486	9.17	28.6	57.9	103	0.46	112	4.35

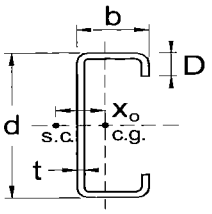
COLD-FORMED C-SECTIONS, UNCOATED

Effective Properties



Designation	Mass	Gross Area	Effective Section Properties				M_{rlb}	L_{cr}	M_{rdb}	V_r	L_u
			X-X Axis		Y-Y Axis						
			I_{xd}	S_{xe}	I_{ye}	S_{ye}					
	kg/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	$10^6\ mm^4$	$10^3\ mm^3$	kN·m	mm	kN·m	kN	mm
203S70-326M	9.83	1 252	7.57	74.5	0.719	15.8	23.1	512	21.9	104	1 496
203S70-290M	8.82	1 123	6.84	67.4	0.635	14.3	20.9	547	19.7	86.2	1 498
203S70-254M	7.78	991	6.09	59.9	0.548	12.7	18.6	589	16.8	66.0	1 500
203S70-218M	6.72	857	5.30	52.2	0.459	11.0	16.2	641	13.8	48.5	1 503
203S70-181M	5.65	720	4.49	41.9	0.370	9.25	13.0	708	10.9	28.3	1 506
203S70-144M	4.56	581	3.59	32.5	0.281	7.40	10.1	797	8.15	14.3	1 510
152S76-290M	7.83	997	3.66	48.0	0.743	15.6	14.9	513	14.1	67.7	1 636
152S76-254M	6.91	881	3.26	41.8	0.643	13.8	13.0	552	12.1	60.2	1 635
152S76-218M	5.98	762	2.84	35.2	0.541	12.0	10.9	601	9.99	48.5	1 634
152S76-181M	5.03	641	2.41	28.2	0.437	10.0	8.77	663	7.94	33.7	1 635
152S76-144M	4.06	518	1.91	22.7	0.334	8.03	7.05	747	5.94	19.4	1 637
152S70-326M	8.46	1 078	3.83	50.2	0.698	15.7	15.6	477	14.7	74.9	1 550
152S70-290M	7.60	968	3.47	45.5	0.619	14.2	14.1	509	13.4	67.7	1 549
152S70-254M	6.72	856	3.09	40.6	0.537	12.6	12.6	548	11.9	60.2	1 548
152S70-218M	5.81	741	2.70	35.4	0.451	11.0	11.0	597	9.88	48.5	1 548
152S70-181M	4.89	623	2.29	28.4	0.365	9.20	8.83	659	7.88	33.7	1 549
152S70-144M	3.95	503	1.83	22.0	0.279	7.37	6.83	742	5.92	19.4	1 550

Designation Example: 152S76-181M; where 152 = section depth (mm); S = stud or joist C-section; 76 = flange width (mm); 181 = minimum base steel thickness x 100 (mm); M = metric designation



COLD-FORMED C-SECTIONS, UNCOATED

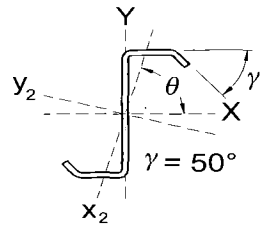
Dimensions and Gross Properties

Depth	Flange Width	Stiff'r Depth	Thick-ness	Gross Section Properties										
				X-X Axis			Y-Y Axis			x_o	r_o	J	j	C_w
d	b	D	t	I_x	S_x	r_x	I_y	S_y	r_y					
mm	mm	mm	mm	10^6 mm^4	10^3 mm^3	mm	10^6 mm^4	10^3 mm^3	mm	mm	mm	10^3 mm^4	mm	10^9 mm^6
203	70	25	3.43	7.57	74.5	77.8	0.800	16.4	25.3	51.1	96	4.91	113	7.53
203	70	25	3.05	6.84	67.4	78.1	0.732	15.0	25.5	51.6	97	3.48	112	6.84
203	70	25	2.67	6.09	59.9	78.4	0.658	13.5	25.8	52.0	98	2.35	111	6.12
203	70	25	2.29	5.30	52.2	78.7	0.579	11.9	26.0	52.5	98	1.49	110	5.36
203	70	25	1.91	4.49	44.2	79.0	0.496	10.2	26.2	53.0	99	0.87	110	4.57
203	70	25	1.52	3.65	35.9	79.3	0.407	8.37	26.5	53.4	99	0.45	109	3.74
152	76	24	3.05	3.66	48.0	60.6	0.795	16.0	28.2	62.1	91	3.09	94	4.43
152	76	24	2.67	3.26	42.8	60.8	0.714	14.4	28.5	62.6	92	2.09	94	3.97
152	76	24	2.29	2.84	37.3	61.1	0.629	12.7	28.7	63.1	92	1.33	94	3.48
152	76	24	1.91	2.41	31.7	61.3	0.538	10.8	29.0	63.6	93	0.78	94	2.97
152	76	24	1.52	1.96	25.8	61.6	0.441	8.89	29.2	64.1	94	0.40	94	2.43
152	70	25	3.43	3.83	50.2	59.6	0.724	15.9	25.9	56.9	86	4.23	90	4.21
152	70	25	3.05	3.47	45.5	59.8	0.663	14.5	26.2	57.4	87	3.00	90	3.83
152	70	25	2.67	3.09	40.6	60.1	0.596	13.1	26.4	57.9	88	2.03	90	3.44
152	70	25	2.29	2.70	35.4	60.4	0.525	11.5	26.6	58.4	88	1.29	90	3.02
152	70	25	1.91	2.29	30.1	60.6	0.450	9.89	26.9	58.9	89	0.75	89	2.58
152	70	25	1.52	1.87	24.5	60.9	0.369	8.13	27.1	59.3	89	0.39	89	2.11

COLD-FORMED Z-SECTIONS, UNCOATED

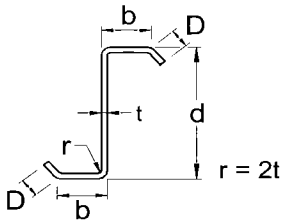
Effective Properties

F_y = 345 MPa



Designation	Mass	Gross Area	Effective Section Properties		M_{rlb}	L_{cr}	M_{rdb}	V_r	L_u
			X-X Axis						
			I_{xd}	S_{xe}					
	kg/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	kN·m	mm	kN·m	kN	mm
356Z76-326M	14.5	1 844	30.8	170	52.9	520	42.5	94.3	1 337
356Z76-290M	12.9	1 646	27.5	147	45.8	554	35.9	65.8	1 339
356Z76-254M	11.4	1 445	24.0	122	37.8	595	29.6	43.8	1 342
356Z76-218M	9.76	1 244	20.5	95.3	29.6	646	23.6	27.4	1 344
356Z76-181M	8.17	1 040	16.9	72.8	22.6	711	18.1	15.7	1 347
305Z76-326M	13.1	1 670	21.2	142	44.0	499	35.8	109	1 371
305Z76-290M	11.7	1 491	19.1	126	39.1	532	30.4	77.5	1 373
305Z76-254M	10.3	1 310	16.9	108	33.6	571	25.1	51.5	1 375
305Z76-218M	8.85	1 127	14.6	89.2	27.7	621	20.2	32.2	1 377
305Z76-181M	7.41	943	12.3	67.1	20.8	684	15.5	18.5	1 379
254Z76-326M	11.7	1 496	13.7	110	34.2	476	29.0	109	1 408
254Z76-290M	10.5	1 336	12.3	98.0	30.4	507	24.7	86.2	1 409
254Z76-254M	9.22	1 174	10.9	84.0	26.1	545	20.6	62.5	1 410
254Z76-218M	7.94	1 011	9.49	69.1	21.5	592	16.6	39.0	1 412
254Z76-181M	6.65	847	8.01	56.1	17.4	653	12.8	22.3	1 413
229Z76-326M	11.1	1 409	10.7	95.4	29.6	463	25.6	109	1 429
229Z76-290M	9.88	1 258	9.61	84.9	26.4	494	21.9	86.2	1 429
229Z76-254M	8.69	1 107	8.52	72.8	22.6	531	18.3	66.0	1 430
229Z76-218M	7.48	953	7.40	59.8	18.6	577	14.8	43.6	1 431
229Z76-181M	6.27	798	6.25	48.4	15.0	636	11.4	25.0	1 432
203Z76-326M	10.4	1 322	8.08	81.4	25.3	450	22.3	104	1 452
203Z76-290M	9.27	1 181	7.29	72.5	22.5	479	19.1	86.2	1 451
203Z76-254M	8.15	1 039	6.47	62.2	19.3	515	16.0	66.0	1 451
203Z76-218M	7.03	895	5.62	51.0	15.8	560	12.9	48.5	1 451
203Z76-181M	5.89	750	4.75	41.2	12.8	617	10.1	28.3	1 451
203Z76-144M	4.73	603	3.74	32.5	10.1	695	7.40	14.3	1 452
152Z76-326M	9.01	1 147	4.14	55.7	17.3	418	15.8	74.9	1 507
152Z76-290M	8.06	1 026	3.74	49.7	15.4	446	13.6	67.7	1 503
152Z76-254M	7.09	903	3.32	42.6	13.2	479	11.5	60.2	1 500
152Z76-218M	6.12	779	2.89	34.8	10.8	521	9.40	48.5	1 498
152Z76-181M	5.13	653	2.45	28.1	8.70	574	7.30	33.7	1 496
152Z76-144M	4.13	526	1.93	22.1	6.90	646	5.40	19.4	1 495

Designation Example: 229Z76-290M; where 229 = section depth (mm); Z = Z-section;
76 = flange width (mm); 290 = minimum base steel thickness x 100 (mm); M = metric designation



COLD-FORMED Z-SECTIONS, UNCOATED

Dimensions and Gross Properties

Depth	Flange Width	Stiff'r Depth	Thick-ness	Gross Section Properties										
				X-X Axis		Y-Y Axis		I_{xy}	I_{x2}	I_{y2}	r_{min}	θ	J	C_w
d	b	D	t	S_x	r_x	S_y	r_y							
mm	mm	mm	mm	10^3 mm^3	mm	10^3 mm^3	mm	10^6 mm^4	10^6 mm^4	10^6 mm^4	mm	deg	10^3 mm^4	10^9 mm^6
356	76	24	3.43	178	131	21.7	32.5	5.41	1.00	32.7	23.3	80.0	7.23	47.2
356	76	24	3.05	160	131	19.5	32.7	4.85	0.903	29.3	23.4	80.0	5.10	42.5
356	76	24	2.67	141	132	17.2	32.8	4.29	0.801	25.8	23.5	80.0	3.43	37.7
356	76	24	2.29	122	132	14.9	33.0	3.71	0.696	22.3	23.7	80.0	2.17	32.7
356	76	24	1.91	102	132	12.6	33.1	3.12	0.588	18.8	23.8	80.0	1.26	27.6
305	76	24	3.43	143	114	21.7	34.2	4.61	0.937	22.9	23.7	77.6	6.55	33.6
305	76	24	3.05	129	115	19.5	34.3	4.14	0.845	20.5	23.8	77.6	4.62	30.3
305	76	24	2.67	114	115	17.2	34.5	3.65	0.750	18.1	23.9	77.5	3.11	26.8
305	76	24	2.29	98.1	115	14.9	34.6	3.16	0.653	15.7	24.1	77.5	1.96	23.3
305	76	24	1.91	82.5	116	12.6	34.8	2.66	0.552	13.2	24.2	77.5	1.14	19.7
254	76	24	3.43	111	97.2	21.7	36.1	3.81	0.858	15.2	24.0	74.0	5.86	22.4
254	76	24	3.05	99.9	97.5	19.5	36.3	3.42	0.775	13.7	24.1	74.0	4.14	20.2
254	76	24	2.67	88.3	97.7	17.2	36.4	3.02	0.688	12.1	24.2	74.0	2.78	17.9
254	76	24	2.29	76.4	98.0	14.9	36.6	2.62	0.599	10.5	24.3	74.0	1.76	15.6
254	76	24	1.91	64.3	98.2	12.6	36.7	2.20	0.507	8.80	24.5	74.0	1.02	13.2
229	76	24	3.43	96.4	88.4	21.7	37.2	3.41	0.811	12.2	24.0	71.5	5.52	17.7
229	76	24	3.05	86.6	88.7	19.5	37.4	3.07	0.732	10.9	24.1	71.5	3.90	16.0
229	76	24	2.67	76.5	88.9	17.2	37.5	2.71	0.651	9.66	24.3	71.5	2.62	14.2
229	76	24	2.29	66.3	89.2	14.9	37.7	2.35	0.567	8.36	24.4	71.5	1.66	12.3
229	76	24	1.91	55.8	89.4	12.6	37.8	1.97	0.480	7.04	24.5	71.5	0.966	10.4
203	76	24	3.43	82.2	79.5	21.7	38.4	3.02	0.756	9.55	23.9	68.3	5.18	13.7
203	76	24	3.05	73.9	79.7	19.5	38.6	2.71	0.683	8.58	24.1	68.4	3.66	12.3
203	76	24	2.67	65.4	80.0	17.2	38.7	2.39	0.608	7.59	24.2	68.4	2.46	10.9
203	76	24	2.29	56.7	80.2	14.9	38.9	2.07	0.529	6.58	24.3	68.4	1.56	9.51
203	76	24	1.91	47.7	80.4	12.6	39.0	1.75	0.448	5.54	24.5	68.4	0.907	8.04
203	76	24	1.52	38.6	80.6	10.2	39.1	1.41	0.364	4.48	24.6	68.4	0.467	6.53
152	76	24	3.43	56.1	61.0	21.7	41.3	2.22	0.610	5.62	23.1	58.8	4.50	7.20
152	76	24	3.05	50.5	61.2	19.5	41.4	1.99	0.552	5.05	23.2	58.8	3.18	6.51
152	76	24	2.67	44.8	61.5	17.2	41.5	1.76	0.492	4.48	23.3	58.9	2.14	5.79
152	76	24	2.29	38.9	61.7	14.9	41.7	1.53	0.430	3.89	23.5	58.9	1.36	5.04
152	76	24	1.91	32.8	61.9	12.6	41.8	1.29	0.364	3.28	23.6	58.9	0.790	4.27
152	76	24	1.52	26.6	62.1	10.2	41.9	1.04	0.297	2.65	23.8	58.9	0.407	3.47

BARS AND PLATES

Bars

The term "bars" means:

(a) Rounds, squares and hexagons of all sizes;

(b) Flats up to 150 mm in width and over 5 mm in thickness;
flats over 150 mm to 200 mm in width and over 6 mm in thickness.

Bar-size shapes include rolled flanged sections and angles under 75 mm in maximum dimension.

Plates

The term "plate" means flat hot-rolled steel, when ordered to thickness:

(a) Over 200 mm in width and 6 mm or over in thickness;

(b) Over 1200 mm in width and 4.5 mm or over in thickness.

Slabs, sheet bars, and skelp, although frequently falling within these size ranges, are not classified as plate. The table on the following page, Standard Product Classification for Flat Hot-Rolled Steel Products and Bars, summarizes the ranges for plate, bar, strip and sheet products.

Plates may be further defined as "Universal Mill Plates" or "Sheared Plates". Sheared plates are rolled on a mill with horizontal rolls only, producing a product with uneven edges which must be sheared (or, at the option of the producer, flame cut) to ordered dimensions.

Universal mill plates are rolled to the ordered width on a mill having side rollers to control the width. Slab or ingot on a universal mill plate are not cross-rolled, but are only elongated during the rolling process. The mill order must specify universal mill plate when it is required.

Extreme plate sizes produced by mills vary greatly with the size of various mills, and individual mills should be consulted for this information.

Various extras for thickness, width, length, cutting, quality, quantity (or quantity discounts), and for other special requirements are added to the base price of plates. Particulars of these extras should be obtained from the producing mills.

Sketch Plates

Sketch plates of special or unusual shape usually require flame cutting, for which flame cutting extras apply. Some mills can supply sketch plates of certain shapes by shearing to size.

Floor Plates

Floor plates in different styles, patterns, and extreme dimensions are produced by different mills. The nominal, or ordered, thickness is that of the flat plate exclusive of the raised pattern. Individual producers should be consulted for more details.

Bearing Plates

Rolled steel bearing plates are used for column bases, and other bearing plates. Depending on the thickness required by design, bearing plates may require additional thickness for machining to ensure proper bearing. According to CSA S16-14 Clause 25.4.1.3, column base plates up to and including 55 mm in thickness are rolled flat with surfaces sufficiently smooth to receive, without machining or flattening, the milled or machine-cut ends of column shafts. Bearing plates over 55 mm in thickness may be flattened by pressing or machining to achieve the required flatness tolerances.

Tables

The following Tables are included in this section:

Standard Product Classification of Flat Hot-Rolled Steel Products and Bars

Flat Metal Products – Plate

SI Wire Size – Wire Gauges Comparison

SI Thickness – Imperial Gauge Comparisons

STANDARD PRODUCT CLASSIFICATION

Flat Hot-Rolled Steel Products and Bars

Width, w (mm)	Thickness, t (mm)					
	t > 6	6 ≥ t > 5	5 ≥ t > 4.5	4.5 ≥ t > 1.2	1.2 ≥ t > 0.9	0.9 ≥ t > 0.65
w ≤ 100	BAR	BAR	STRIP	STRIP	STRIP	STRIP
100 < w ≤ 150	BAR	BAR	STRIP	STRIP	STRIP	
150 < w ≤ 200	BAR	STRIP	STRIP	STRIP		
200 < w ≤ 300	PLATE	STRIP	STRIP	STRIP		
300 < w ≤ 1200	PLATE	SHEET*	SHEET*	SHEET*		
1200 < w	PLATE	PLATE	PLATE	SHEET		

* For alloy steels, sheet begins at widths over 600 mm.

FLAT METAL PRODUCTS* – PLATE

If metric plate thicknesses are desired

Nominal Thickness,** mm		Mass†	Dead Load
First Preference	Second Preference	kg/m²	kN/m²
4.5		35.3	0.347
	4.8	37.7	0.370
5.0		39.3	0.385
	5.5	43.2	0.424
6.0		47.1	0.462
7.0		55.0	0.539
8.0		62.8	0.616
	9.0	70.7	0.693
10		78.5	0.770
	11	86.4	0.847
12		94.2	0.924
	14	110	1.08
16		126	1.23
	18	141	1.39
20		157	1.54
	22	173	1.69
25		196	1.93
	28	220	2.16
30		236	2.31
	32	251	2.46
35		275	2.70
	38	298	2.93
40		314	3.08
	45	353	3.47
50		393	3.85
	55	432	4.24
60		471	4.62
	70	550	5.39
80		628	6.16
	90	707	6.93
100		785	7.70
	110	864	8.47
120		942	9.24
	130	1020	10.0
140		1100	10.8
	150	1180	11.6
160		1260	12.3
180		1410	13.9
200		1570	15.4
250		1960	19.3
300		2360	23.1

* Sizes are those listed in CAN3-G312.1-75. Metric plate thickness preferences apply mostly to bridge structures.

** For coated structural sheet, the nominal thickness applies to the base metal. For metric thickness dimensions for zinc coated structural quality sheet steel, see Part 7, Structural Sheet Steel Products.

† Computed using steel density of 7 850 kg/m³.

SI WIRE SIZE – WIRE GAUGES COMPARISON

SI Wire Size Preferred Diam.* (mm)	United States Steel Wire Gauge	American or Brown & Sharpe Wire Gauge	British Imperial or English Legal Standard Wire Gauge	Birmingham or Stubs Iron Wire Gauge
25.0				
24.0				
23.0				
22.0				
21.0				
20.0				
19.0				
18.0				
17.0				
16.0				
15.0				
		6/0		
14.0				
		5/0		
13.0				
			7/0	5/0
12.5				
	7/0			
12.0				
11.8				
	6/0	4/0	6/0	4/0
11.2				
11.0				
	5/0		5/0	3/0
10.6				
		3/0	4/0	
10.0				
	4/0			2/0
9.5				
	3/0	2/0	3/0	
9.0				
			2/0	1/0
8.5				
	2/0	1/0	1/0	
8.0				
	1/0		1	1
7.5				
	1	1	2	2
7.0				
6.7				
	2	2		3
6.5				
			3	
6.3				
	3			4
6.0				

SI Wire Size Preferred Diam.* (mm)	United States Steel Wire Gauge	American or Brown & Sharpe Wire Gauge	British Imperial or English Legal Standard Wire Gauge	Birmingham or Stubs Iron Wire Gauge
6.0				
	4	3	4	
5.6				
			5	5
5.3				
	5	4		6
5.0				
	6		6	
4.8				
		5		
4.6				
	7		7	7
4.4				
4.2				
	8	6	8	8
4.0				
3.8				
	9	7	9	9
3.6				
	10			10
3.4				
		8	10	
3.2				
	11			11
3.0				
		9	11	
2.8				
	12		12	12
2.6				
		10		13
2.4				
	13	11	13	
2.3				
2.2				
				14
2.1				
	14	12	14	
2.0				
1.90				
	15	13	15	15
1.80				
1.70				
		14	16	16
1.60				
	16			
1.50				

* From CAN3-G312.2-M76

SI THICKNESS – IMPERIAL GAUGE COMPARISONS†

SI Preferred Thickness		United States Standard Gauge*				Birmingham Sheet Gauge		
		Weight	Ga. No.	Approximate Thickness		Gauge Number	Thickness	
First mm	Second mm	Oz. per sq. ft.		Inches	mm		Inches	mm
	18							
						7/0	0.6666	16.932
16								
						6/0	0.6250	15.875
						5/0	0.5883	14.943
	14							
						4/0	0.5416	13.757
						3/0	0.5000	12.700
12								
						2/0	0.4452	11.308
	11							
						0	0.3964	10.069
10								
	9.0							
						1	0.3532	8.971
8.0								
						2	0.3147	7.993
						3	0.2804	7.122
7.0								
		160	3	0.2391	6.073	4	0.2500	6.350
6.0								
		150	4	0.2242	5.695	5	0.2225	5.652
	5.5							
		140	5	0.2092	5.314	6	0.1981	5.032
5.0								
		130	6	0.1943	4.935			
	4.8							
		120	7	0.1793	4.554			
4.5								

† Preferred thicknesses are as per CAN3-G312.1-75

* U.S. Standard Gauge is officially a weight gauge, in oz. per sq. ft. as tabulated. The Approx. thickness shown is the "Manufacturers' Standard" of the AISI based on a steel density of 501.81 lb. per ft.^{3}

CRANE RAILS

General

Crane rails are designated by their mass in pounds per yard, with bolt sizes, hole diameters, and washer sizes dimensioned in inches. The SI metric dimensions and properties for crane rails and their accessories given on the following pages are soft-converted from manufacturers' catalogs. For ordering information, refer to ASTM standards A1 and A759 for tee rails (60 lb/yd and over) and crane rails (104 to 175 lb/yd), respectively.

Rails listed in this handbook are the most popular sizes used for crane runways. For dimensions and properties not provided in the tables, consult the supplier.

Rails are typically supplied in lengths ranging from 9140 mm for the lighter rails up to 23 800 mm for the heavier sections. Consult the supplier for further information.

If bolted rail bar splices are to be used, the number of rail lengths required, plus one short length in each run, should be specified to permit staggering of the joints. Orders must clearly specify that "*These Rails Are Intended for Crane Service*".

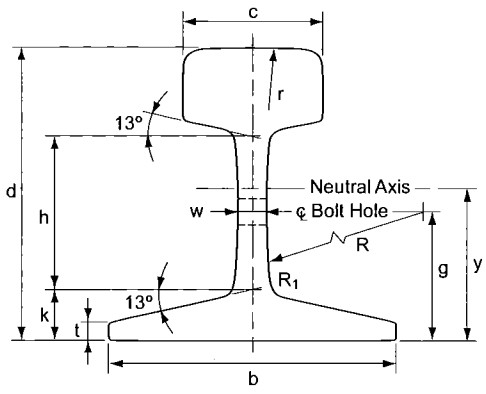
Most manufacturers will chamfer the top and sides of the rail head at the ends, unless specified otherwise by the purchaser. Chamfering permits mild deformations to occur and minimizes chipping of the running surfaces.

When selecting a rail for crane service, the characteristics of operation must be considered. Some common variables which affect service life are:

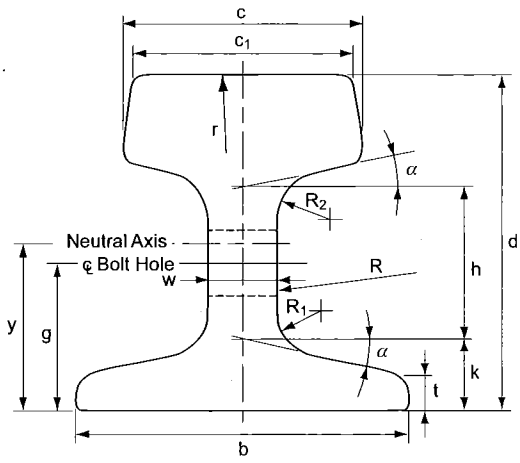
- Frequency of operation
- Crane carriage speed and impact – rate of loading and unloading
- Corrosion – acidic mill conditions
- Abrasion
- Alignment of crane and supporting members
- Crane operating procedures

Crane rails are joined together end-to-end by either mechanical fasteners or welding. When bolting is used, special joint bars are employed, as shown on the following pages. If welded, manual arc welding is usually used and joint bars are not required. Welding has the advantage of eliminating mechanical joints, thus reducing the problem of aligning the top of rails.

CRANE RAILS – PROPERTIES AND DIMENSIONS



30 to 104 lb/yd



135 to 175 lb/yd

Dimensions

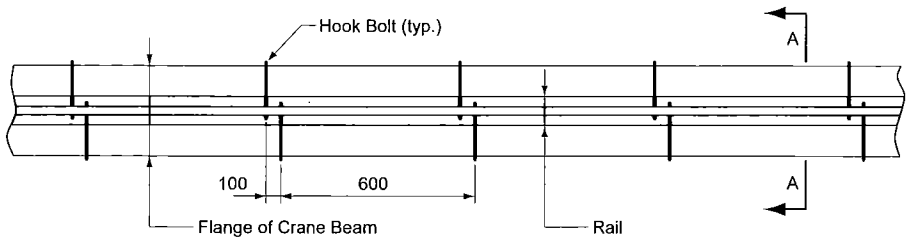
Rail type		Depth	Head		Base		Web		k	h	r	R	R_1	R_2	α
		d	c	c_1	b	t	w	Gauge g							
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	deg
ASCE	30	79	43	43	79	4.4	8.3	35	13	44	305	305	6.4	6.4	13
	40	89	48	48	89	5.6	9.9	39	16	47	305	305	6.4	6.4	13
	60	108	60	60	108	7.1	12	48	19	58	305	305	6.4	6.4	13
	80	127	64	64	127	7.5	14	56	22	67	305	305	6.4	6.4	13
	85	132	65	65	132	7.5	14	58	23	70	305	305	6.4	6.4	13
	100	146	70	70	146	7.9	14	64	25	53	305	305	6.4	6.4	13
ASTM A759	104	127	64	64	127	13	25	62	27	62	305	89	13	13	13
	135	146	87	76	132	12	32	63	27	71	356	305	19	19	13
	171	152	109	102	152	16	32	67	32	70	Flat	Vert.	19	22	12
	175	152	108	102	152	13	38	67	29	79	457	Vert.	29	51	12

Properties

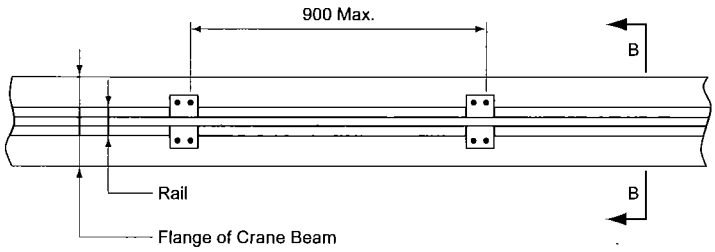
Rail type		Mass	Dead Load	Area	I_x	S_x	S_x	y
						Head	Base	
		kg/m	kN/m	mm^2	$10^6\ mm^4$	$10^3\ mm^3$	$10^3\ mm^3$	mm
ASCE	30	14.9	0.146	1 940	1.71	41.8	—	—
	40	19.8	0.195	2 540	2.72	58.8	63.7	42.7
	60	29.8	0.292	3 830	6.08	109	117	52.1
	80	39.7	0.389	5 070	11.0	166	182	60.5
	85	42.2	0.413	5 370	12.5	182	200	62.7
	100	49.6	0.486	6 350	18.3	239	264	69.3
ASTM A759	104	51.6	0.506	6 650	12.4	175	221	56.1
	135	67.0	0.657	8 580	21.1	283	297	71.4
	171	84.8	0.832	10 800	30.6	401	400	76.5
	175	86.8	0.851	11 000	29.3	383	387	75.7

Rail Fasteners

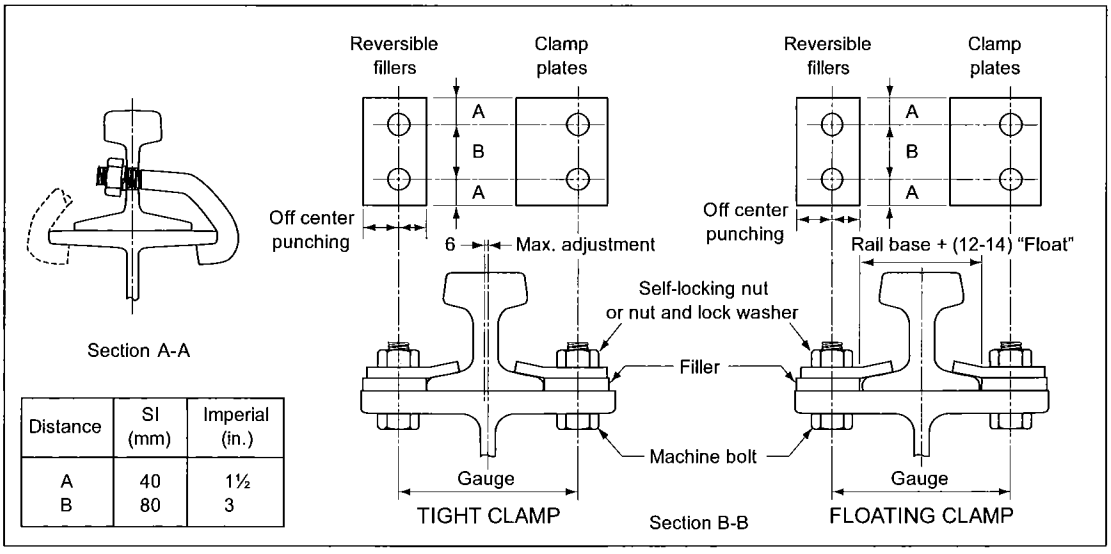
Hook bolts are primarily used when the flange of the crane beam is too narrow to permit the use of rail clamps. Hook bolts are used in groups of 2, located about 100 mm to 140 mm apart, at 600 mm centres, and may be adjusted plus or minus 12 mm. Suggested dimensions are shown in Section A-A. Rails require special preparation either in the fabricator's shop or by the crane rail supplier.



Suggested rail clamp dimensions are shown in Section B-B. For prefabricated rail clamps, reference should be made to manufacturers' catalogs of track accessories. Two types of clamps are available: the tight clamp and the floating clamp. Floating clamps are used when longitudinal and controlled transverse movement is required for thermal expansion and alignment. Rail clamps are fabricated from pressed or forged steel and usually have single or double bolts.

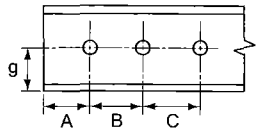


RAIL FASTENERS

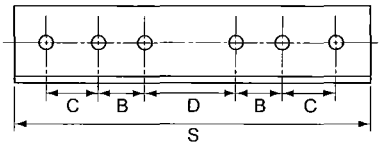


Distance	SI (mm)	Imperial (in.)
A	40	1½
B	80	3

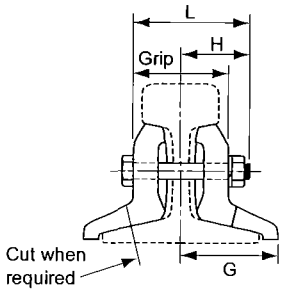
RAIL SPLICES



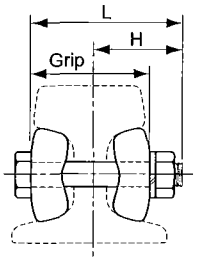
Rail End



Joint Bar



40 to 104 lbs.



135 to 175 lbs.

Rail Type	Rail					Joint Bar					
	g	Hole dia.	A	B	C	Hole dia.	D	B	C	S	G
	mm	inch.	mm	mm	mm	inch.	mm	mm	mm	mm	mm
40	39.5	*13/16	63.5	127	–	*13/16	125	127	–	508	55.6
60	48.2	*13/16	63.5	127	–	*13/16	125	127	–	610	68.3
85	57.5	*15/16	63.5	127	–	*15/16	125	127	–	610	84.9
104	61.9	1-1/16	102	127	152	1-1/16	202	127	152	864	88.9
135	62.7	1-3/16	102	127	152	1-3/16	202	127	152	864	–
171	66.7	1-3/16	102	127	152	1-3/16	202	127	152	864	–
175	67.5	1-3/16	102	127	152	1-3/16	202	127	152	864	–

* Special rail drilling and joint bar punching.

Rail Type	Bolt				Spring Washer		Mass of Ass'y	
	diam.	Grip	L	H	Hole dia.	Thk. & width	With Flg.	Without Flg.
	in.	mm	mm	mm	in.	in. in.	kg.	kg.
40	3/4	49.2	88.9	63.5	13/16	7/16 x 3/8	9.07	7.48
60	3/4	65.9	102	68.3	13/16	7/16 x 3/8	16.56	13.43
85	7/8	80.2	121	81.0	15/16	7/16 x 3/8	25.67	20.55
104	1	88.9	133	88.9	1-1/16	7/16 x 1/2	33.34	25.13
135	1-1/8	92.1	140	93.7	1-3/16	7/16 x 1/2	–	34.16
171	1-1/8	113	159	103	1-3/16	7/16 x 1/2	–	41.19
175	1-1/8	105	152	100	1-3/16	7/16 x 1/2	–	39.78

Splices

Rail drilling and joint bar punching as supplied for track work is not recommended for crane rails, since oversize holes may allow too much movement at the rail ends and result in failure. Tight joints which require special rail and joint bar drilling (see table on previous page) and squaring of the rail ends are recommended.

Light rails are not finished at the mill and are usually finished at the fabricator's shop or at the erection site. This may require reaming of holes for proper fit of bolts if dimensional tolerances are cumulative.

Joint bars are provided for crane service to match the rails ordered and may be ordered blank. Under no circumstances should these joint bars be used as welding straps. Manufacturer's catalogs should be consulted for joint bar specifications, dimensions and identification necessary to match the crane rail specified.

Joint bar bolts for crane service are readily identified from those used for track work, as they have straight shanks and are manufactured to ASTM A449 specification. Matching nuts are manufactured to ASTM A563 Grade B. The bolted assembly includes an alloy spring washer which is furnished to American Railway Engineering and Maintenance of Way Association (AREMA) specifications. Bolts and nuts manufactured to ASTM A325 may also be acceptable.

To prolong the life of the runway, bolts should be retightened within 30 days after installation and every 3 months thereafter.

FASTENERS

General

The information on fasteners provided herein is based on standards, specifications and publications of the:

Canadian Standards Association (CSA Group)

American National Standards Institute (ANSI)

American Society of Mechanical Engineers (ASME)

Industrial Fasteners Institute (IFI)

Research Council on Structural Connections (RCSC)

Additional fastener information can be obtained from the various manufacturers and from the Canadian Fasteners Institute (CFI).

Availability

The more commonly used fasteners for structural purposes in Canada have included the following:

⅝-inch ASTM A307 bolts for light steel framing such as girts, purlins, etc.

¾-inch ASTM A325 bolts for building structures

⅞-inch ASTM A325 bolts for bridge structures

While other diameters and types of bolts have been used on specific projects in Canada, larger sizes of ASTM A325 bolts, all sizes of ASTM A490 bolts, and all sizes of metric bolts (A325M and A490M) have not been in common use in Canada, and designers contemplating their use should first check for their availability.

Definitions

Body Length: Distance from the underside of the head bearing surface to either the last scratch of thread or the top of the extrusion angle, whichever is the closest to the head.

Bolt Length: Length from the underside of the head bearing surface to the extreme point.

Finished Fastener: Fastener made to close tolerances and having surfaces other than the threads and bearing surface finished to provide a general high-grade appearance.

Grip: Total thickness of the plies of a joint through which the bolt passes, exclusive of washers or direct-tension indicators.

Height of Bolt Head: Overall distance, measured parallel to the fastener axis, from the extreme top (excluding raised identification marks) to the bearing surface and including the thickness of the washer face where provided.

Natural Finish: As-processed finish, unplated or uncoated, of the bolt or nut.

Nominal Size: Designation used for the purpose of general identification.

Proof Load: Specified test load which a fastener must withstand without any indication of significant deformation or failure.

Thickness of Nut: Overall distance from the top of the nut to the bearing surface, measured parallel to the axis of the nut.

Thread Length of a Bolt: Distance from the extreme point to the last complete thread.

Transition Thread Length: Distance from the last complete thread to either the last scratch of thread or the top of the extrusion angle, whichever is the closest to the head.

Washer Face: Circular boss on the bearing surface of a bolt or nut.

Tables

The following tables are included in this section:

- Markings – ASTM High-Strength Bolts, Nuts and Assemblies
- High-Strength Bolts, Nuts and Assemblies – Dimensions
- High-Strength Bolts, Nuts and Assemblies – Acceptable ASTM A563 Nut Grade and Finish, and ASTM F436 Washer Type and Finish
- Bolt Lengths for Various Grips – ASTM A325 and A490 Bolts
- Weight of ASTM A325 Bolts, Nuts and Washers
- ASTM F436 Washer Dimensions
- ASTM A307 Hex Bolts and Heavy Hex Nuts – Dimensions
- High-Strength Bolts – Purchase Order Information
- Fasteners – Miscellaneous Detailing Data (Diagonal Distance for Staggered Fasteners, Bolt Length Tolerances, and Minimum Edge Distance for Bolt Holes)
- Usual Gauges – W, M, S, C shapes, and Angles
- Installation Clearances

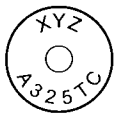
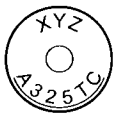
Metric Fasteners

Archival material on metric-size bolts found in previous editions of the Handbook is provided in *Metric Fastener Data* at the end of this section.

Anchor Rods

See *Anchor Rods* in Part 4.

MARKINGS – ASTM HIGH-STRENGTH BOLTS, NUTS AND ASSEMBLIES [1]

Bolt Head [2]		
Designation / Grade	**Type 1**	**Type 3**
A325 Bolt [3]	 Three radial lines 120° apart are optional.	
F1852 Bolt Assembly [4]	 Three radial lines 120° apart are optional.	
A490 Bolt		
F2280 Bolt Assembly [4]		

Nut [2]	
A563 Nut	 Arcs indicate Grade C  Arcs with "3" indicate Grade C3  Grade D  Grade DH  Grade DH3

Notes:

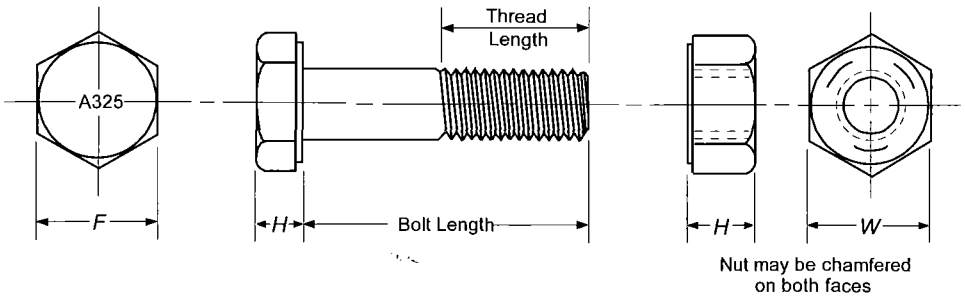
1. Adapted from the Specification for Structural Joints Using High-Strength Bolts, Research Council on Structural Connections (RCSC), 2014.
2. XYZ represents the manufacturer's indentification mark.
3. For A325 bolts threaded full length and their bolt head markings, see next page.
4. For F1852 and F2280 twist-off-type tension-control bolt assemblies, the letters "TC" are optional, in accordance with ASTM Standard F3125. These assemblies are also produced with a heavy-hex head that has similar markings.

Dimensions

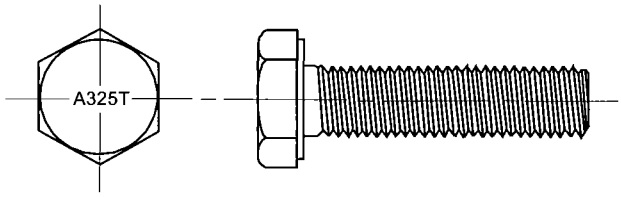
Imperial Dimensions					Nominal Bolt Size	Metric Dimensions (Soft)				
Bolt Dimensions* Heavy Hex Structural Bolts in.			Nut Dimensions* Heavy Hex Nuts in.			Bolt Dimensions* Heavy Hex Structural Bolts mm			Nut Dimensions* Heavy Hex Nuts mm	
Width across flats F	Height H	Thread length†	Width across flats W	Height H	D in.	Width across flats F	Height H	Thread length†	Width across flats W	Height H
7/8	5/16	1	7/8	31/64	1/2	22.2	7.9	25.4	22.2	12.3
1 1/16	25/64	1 1/4	1 1/16	39/64	5/8	27.0	9.9	31.8	27.0	15.5
1 1/4	15/32	1 3/8	1 1/4	47/64	3/4	31.8	11.9	34.9	31.8	18.7
1 7/16	35/64	1 1/2	1 7/16	55/64	7/8	36.5	13.9	38.1	36.5	21.8
1 5/8	39/64	1 3/4	1 5/8	63/64	1	41.3	15.5	44.5	41.3	25.0
1 13/16	11/16	2	1 13/16	1 7/64	1 1/8	46.0	17.5	50.8	46.0	28.2
2	25/32	2	2	1 7/32	1 1/4	50.8	19.8	50.8	50.8	31.0
2 3/16	27/32	2 1/4	2 3/16	1 11/32	1 3/8	55.6	21.4	57.2	55.6	34.1
2 3/8	15/16	2 1/4	2 3/8	1 15/32	1 1/2	60.3	23.8	57.2	60.3	37.3

* Dimensions according to ASME B18.2.6.

† Certain A325 bolts may be ordered threaded full length. See notes and figure below.



A325 Bolt with Standard Thread Length



A325 Bolt Threaded Full Length

Note: A325 bolts threaded full length are permitted under Supplementary Requirement S1 of ASTM A325. They are restricted to bolts with nominal lengths no greater than four times the nominal diameter.

Acceptable ASTM A563 Nut Grade and Finish and ASTM F436 Washer Type and Finish

ASTM Desig.	Bolt Type	Bolt Finish [d]	ASTM A563 Nut Grade and Finish [d]	ASTM F436 Washer Type and Finish [a, d]
A325	1	Plain (uncoated)	C, C3, D, DH [c] and DH3; plain	1; plain
		Galvanized	DH [c]; galvanized and lubricated	1; galvanized
		Zn/Al Inorganic, per ASTM F1136 Grade 3	DH [c]; Zn/Al Inorganic, per ASTM F1136 Grade 5	1; Zn/Al Inorganic, per ASTM F1136 Grade 3
	3	Plain	C3 and DH3; plain	3; plain
F1852	1	Plain (uncoated)	C, C3, DH [c] and DH3; plain	1; plain [b]
		Mechanically Galvanized	DH [c]; mechanically galvanized and lubricated	1; mechanically galvanized [b]
	3	Plain	C3 and DH3; plain	3; plain [b]
A490	1	Plain	DH [c] and DH3; plain	1; plain
		Zn/Al Inorganic, per ASTM F1136 Grade 3	DH [c]; Zn/Al Inorganic, per ASTM F1136 Grade 5	1; Zn/Al Inorganic, per ASTM F1136 Grade 3
	3	Plain	DH3; plain	3; plain
F2280	1	Plain	DH [c] and DH3; plain	1; plain [b]
	3	Plain	DH3; plain	3; plain [b]

[a] Applicable only if washer is required.

[b] Required in all cases under nut.

[c] The substitution of ASTM A194 grade 2H nuts in place of ASTM A563 grade DH nuts is permitted.

[d] "Galvanized" as used in this table refers to hot-dip galvanizing in accordance with ASTM F2329 or mechanical galvanizing in accordance with ASTM B695.

[e] "Zn/Al Inorganic" as used in this table refers to application of a Zn/Al Corrosion Protective Coating in accordance with ASTM F1136 which has met all the requirements of IFI-144.

Source: Specification for Structural Joints Using High-Strength Bolts, Research Council on Structural Connections (RCSC), 2014.

BOLT LENGTHS* FOR VARIOUS GRIPS**
ASTM A325 AND A490 BOLTS

Grip		Bolt diameter, in.								
mm	in.	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
19	3/4	1 1/2	1 3/4		2			2 1/2		2 3/4
21	13/16			2		2 1/4	2 1/2		2 3/4	
22	7/8	1 3/4			2 1/4			2 3/4		3
24	15/16		2	2 1/4		2 1/2	2 3/4		3	
25	1				2 1/2			3		3 1/4
27	1 1/16	2	2 1/4	2 1/2		3	3.		3 1/4	
29	1 1/8				2 3/4			3 1/4		3 1/2
30	1 3/16		2 1/2	2 3/4	3	3 1/4	3 1/2		3 1/2	
32	1 1/4	2 1/4						3 1/2		3 3/4
33	1 5/16			2 3/4		3 1/2			3 3/4	
35	1 3/8		2 3/4		3		3 1/2	3 3/4		4
37	1 7/16	2 1/2		3		3 1/4			4	
38	1 1/2		3		3 1/4		3 3/4	4		4 1/4
40	1 9/16	2 3/4		3 1/4		3 1/2			4 1/4	
41	1 5/8		3 1/4		3 1/2		3 3/4	4 1/4		4 1/2
43	1 11/16	3		3 1/2		3 3/4			4 1/2	
44	1 3/4		3 1/2		3 3/4		4	4 1/2		4 3/4
46	1 13/16	3 1/4		3 3/4		4	4 1/4		4 3/4	
48	1 7/8		3 3/4		4	4 1/4		4 3/4		5
49	1 15/16	3 1/2		4	4 1/4		4 1/2		5	
51	2		4	4 1/4		4 1/2		5		5 1/4
52	2 1/16	3 3/4	4 1/4		4 1/2		4 3/4		5 1/4	
54	2 1/8			4 1/2		4 3/4		5		5 1/2
56	2 3/16	4			4 3/4		5	5 1/4		5 3/4
57	2 1/4		4 1/4	4 3/4		5	5 1/4		5 3/4	
59	2 5/16	4 1/4			5	5 1/4		5 1/2		6
60	2 3/8			5		5 1/2	5 3/4		6	
62	2 7/16		4 1/2		5 1/4			5 3/4		6 1/4
64	2 1/2	4 1/2		5 1/4		5 3/4	6		6 1/4	
65	2 9/16		4 3/4		5 1/2			6		6 1/2
67	2 5/8	4 3/4		5 1/2		6	6 1/4		6 1/2	
68	2 11/16		5		5 3/4			6 1/4		6 3/4
70	2 3/4	5		5 3/4		6 1/4	6 3/4		7	
71	2 13/16		5 1/4		6			6 3/4		7 1/4
73	2 7/8	5 1/4		6		6 1/2	7		7 1/4	
75	2 15/16		5 1/2		6 1/4			7		7 1/2
76	3	5 1/2		6 1/4		6 3/4	7 1/4		7 1/2	
78	3 1/16		5 3/4		6 1/2			7 1/2		7 3/4

Grip		Bolt diameter, in.								
mm	in.	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
76	3		4		4 1/4			4 3/4		5
78	3 1/16			4 1/4		4 1/2	4 3/4		5	
79	3 1/8	4			4 1/2			5		5 1/4
81	3 3/16		4 1/4	4 1/2		4 3/4	5		5 1/4	
83	3 1/4				4 3/4			5 1/4		5 1/2
84	3 5/16	4 1/4	4 1/2	4 3/4		5	5 1/4		5 1/2	
86	3 3/8				5			5 1/2		5 3/4
87	3 7/16			5		5 1/4	5 1/2		5 3/4	
89	3 1/2	4 1/2	4 3/4		5 1/4			5 3/4		6
90	3 9/16			5 1/4		5 1/2	5 3/4		6	
92	3 5/8		5		5 1/2			6		6 1/4
94	3 11/16	4 3/4		5 1/2		5 3/4	6		6 1/4	
95	3 3/4		5 1/4		5 3/4			6 1/4		6 1/2
97	3 13/16	5		5 3/4		6	6 1/4		6 1/2	
98	3 7/8				6			6 1/2		6 3/4
100	3 15/16		5 3/4		6 1/4			6 3/4		7
102	4	5 1/4		6		6 1/2	6 3/4		7	
103	4 1/16		6		6 1/2			7		7 1/2
105	4 1/8			6 1/4		6 3/4	7		7 1/2	
106	4 3/16	5 1/2			6 3/4			7 1/4		7 3/4
108	4 1/4		6 1/4	6 3/4		7	7 1/4		7 3/4	
110	4 5/16				7			7 1/2		8
111	4 3/8			7		7 1/4	7 1/2		8	
113	4 7/16	5 3/4	6 1/2		7 1/4			7 3/4		8 1/4
114	4 1/2			7 1/4		7 1/2	7 3/4		8 1/4	
116	4 9/16		6 3/4		7 1/2			8		8 1/2
117	4 5/8	6		7 1/2		7 3/4	8		8 1/2	
119	4 11/16		7		7 3/4			8 1/4		8 3/4
121	4 3/4	6 1/4		7 3/4		8	8 1/4		8 3/4	
122	4 13/16		7 1/4		8			8 1/2		9
124	4 7/8	6 1/2		8		8 1/4	8 1/2		9	
125	4 15/16		7 1/2		8 1/4			8 3/4		9 1/4
127	5	6 3/4		8 1/4		8 1/2	8 3/4		9 1/4	
129	5 1/16		7 3/4		8 1/2			9		9 1/2
130	5 1/8	7		8 1/2		8 3/4	9		9 1/2	
132	5 3/16		8		8 3/4			9 1/4		9 3/4
133	5 1/4	7 1/4		8 3/4		9	9 1/4		9 3/4	
135	5 5/16		8 1/4		9			9 1/2		10

* Bolt lengths must be specified in inches for ASTM A325 and A490 bolts.

** Grip is thickness of material to be connected exclusive of washers.

For each flat washer, add 4 mm (5/32 inch) to grip.

For each beveled washer, add 8 mm (5/16 inch) to grip.

For information on A325 bolts threaded full length, see *High-Strength Bolts, Nuts and Assemblies* .

WEIGHT OF ASTM A325 BOLTS, NUTS AND WASHERS

WEIGHT IN POUNDS PER 100 UNITS

HEAVY HEX STRUCTURAL BOLTS WITH HEAVY HEX NUTS (WITHOUT WASHERS)									
Length Under Head, Inches	**Bolt Diameter, Inches**								
	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
1	16.5	29.4	47.0						
1 1/4	17.8	31.1	49.6	74.4	104				
1 1/2	19.2	33.1	52.2	78.0	109	148	197		
1 3/4	20.5	35.3	55.3	81.9	114	154	205	261	333
2	21.9	37.4	58.4	86.1	119	160	212	270	344
2 1/4	23.3	39.8	61.6	90.3	124	167	220	279	355
2 1/2	24.7	41.7	64.7	94.6	130	174	229	290	366
2 3/4	26.1	43.9	67.8	98.8	135	181	237	300	379
3	27.4	46.1	70.9	103	141	188	246	310	391
3 1/4	28.8	48.2	74.0	107	146	195	255	321	403
3 1/2	30.2	50.4	77.1	111	151	202	263	332	416
3 3/4	31.6	52.5	80.2	116	157	209	272	342	428
4	33.0	54.7	83.3	120	162	216	280	353	441
4 1/4	34.3	56.9	86.4	124	168	223	289	363	453
4 1/2	35.7	59.0	89.5	128	173	230	298	374	465
4 3/4	37.1	61.2	92.7	133	179	237	306	384	478
5	38.5	63.3	95.8	137	184	244	315	395	490
5 1/4	39.9	65.5	98.9	141	190	251	324	405	503
5 1/2	41.2	67.7	102	146	196	258	332	416	515
5 3/4	42.6	69.8	105	150	201	265	341	426	527
6	44.0	71.9	108	154	207	272	349	437	540
6 1/4		74.1	111	158	212	279	358	447	552
6 1/2		76.3	114	163	218	286	367	458	565
6 3/4		78.5	118	167	223	293	375	468	577
7		80.6	121	171	229	300	384	479	589
7 1/4		82.8	124	175	234	307	392	489	602
7 1/2		84.9	127	179	240	314	401	500	614
7 3/4		87.1	130	183	246	321	410	510	626
8		89.2	133	187	251	328	418	521	639
8 1/4				192	257	335	427	531	651
8 1/2				196	262	342	435	542	664
8 3/4							444	552	676
9							453	563	689
Per inch additional	5.5	8.6	12.4	16.9	22.1	28.0	34.4	42.5	49.7

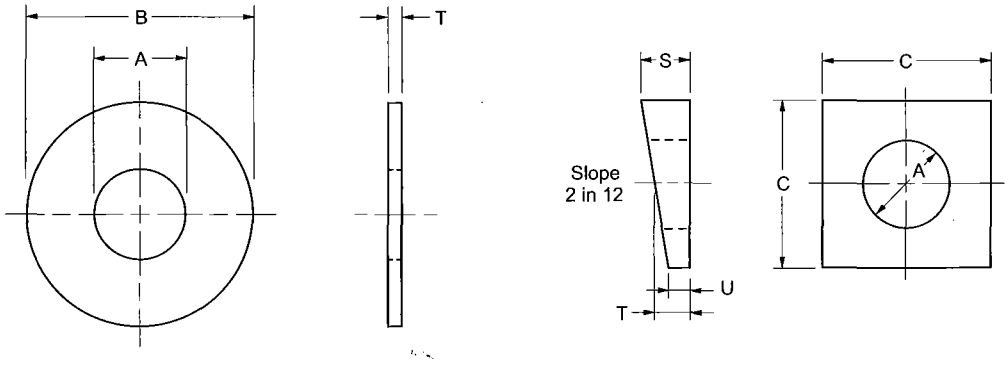
Plain round washers	2.1	3.6	4.8	7.0	9.4	11.3	13.8	16.8	20.0
Beveled square washers	23.1	22.4	21.0	20.2	19.2	34.0	31.6	31.2	32.9

ASTM F436 WASHER DIMENSIONS

PLAIN CIRCULAR WASHERS

Bolt Size	B		A		T	
	Outside Diameter mm		Hole Diameter mm		Thickness mm	
in.	Max	Min	Max	Min	Max	Min
½	27.8	26.2	14.3	13.5	4.5	2.5
⅝	34.2	32.5	18.3	17.5	4.5	3.1
¾	38.1	36.5	21.5	20.7	4.5	3.1
⅞	45.3	43.6	24.6	23.8	4.5	3.5
1	52.4	49.2	28.6	27.0	4.5	3.5
1⅛	58.8	55.5	31.8	30.2	4.5	3.5
1¼	65.1	61.9	36.5	34.9	4.5	3.5
1⅜	71.5	68.2	39.7	38.1	4.5	3.5
1½	77.8	74.6	42.9	41.3	4.5	3.5

Note: Minimum thickness 7.7 mm and maximum thickness 9.5 mm for extra thick washers
Metric dimensions have been soft-converted. For official dimensions, refer to ASTM F436.

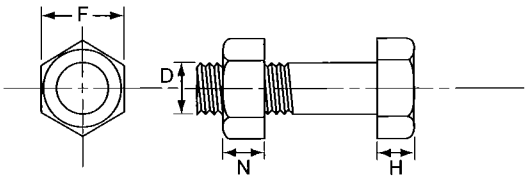


BEVELLED SQUARE WASHERS

Bolt Size	C		A		S	T	U
	Width mm		Hole Diameter mm		Thickness, mm		
					Thick Side	Mean Nom.	Thin Side
in.	Max	Min	Max	Min			
½	45.3	43.6	14.3	13.5	11.6	7.9	4.2
⅝	45.3	43.6	18.3	17.5	11.6	7.9	4.2
¾	45.3	43.6	21.5	20.6	11.6	7.9	4.2
⅞	45.3	43.6	24.6	23.8	11.6	7.9	4.2
1	46.1	42.8	30.2	28.6	11.6	7.9	4.2
1⅛	58.8	55.5	33.4	31.8	12.7	7.9	3.2
1¼	58.8	55.5	36.5	34.9	12.7	7.9	3.2
1⅜	58.8	55.5	39.7	38.1	12.7	7.9	3.2
1½	58.8	55.5	42.9	41.3	12.7	7.9	3.2

Note: Metric dimensions have been soft-converted. For official dimensions, refer to ASTM F436.

ASTM A307 HEX BOLTS AND HEAVY HEX NUTS



DIMENSIONS

Imperial Dimensions						Nominal Bolt Size	Metric Dimensions (Soft-Converted)					
Bolt Dimensions Hex Structural Bolts in.				Nut Dimensions Heavy Hex Nuts in.			Bolt Dimensions Hex Structural Bolts mm				Nut Dimensions Heavy Hex Nuts mm	
Width across flats	Height	Minimum Thread Length		Width across flats	Height	D	Width across flats	Height	Minimum Thread Length		Width across flats	Height
F	H	L ≤ 6 in.	L >.6 in.	F	N	in.	F	H	L ≤ 152	L > 152	F	N
3/4	11/32	1 1/4	1 1/2	7/8	31/64	1/2	19	9	32	38	22	12
15/16	27/64	1 1/2	1 3/4	1 1/16	39/64	5/8	24	11	38	44	27	15
1 1/8	1/2	1 3/4	2	1 1/4	47/64	3/4	29	13	44	51	32	19
1 5/16	37/64	2	2 1/4	1 7/16	55/64	7/8	33	15	51	57	37	22
1 1/2	43/64	2 1/4	2 1/2	1 5/8	63/64	1	38	17	57	64	41	25
1 11/16	3/4	2 1/2	2 3/4	1 13/16	1 7/64	1 1/8	43	19	64	70	46	28
1 7/8	27/32	2 3/4	3	2	1 7/32	1 1/4	48	21	70	76	51	31
2 1/16	29/32	3	3 1/4	2 3/16	1 11/32	1 3/8	52	23	76	83	56	34
2 1/4	1	3 1/4	3 1/2	2 3/8	1 15/32	1 1/2	57	25	83	89	60	37

Note: ASTM A307 bolts shall be Grade A hex bolts with heavy hex nuts as per ASTM A563, according to S16-14 Clause 13.12.1.2

Imperial dimensions for Hex Structural Bolts and Heavy Hex Nuts conform to ASME B18.2.1 and B18.2.2, respectively. Metric dimensions in millimetres have been soft-converted and rounded to the nearest millimetre.

The minimum thread lengths are in agreement with the requirements of ASME B18.2.1 In general, these requirements are as follows:

- Bolts 6 inches or less in length – twice diameter plus ¼-inch.
- Bolts longer than 6 inches – twice diameter plus ½-inch.
- Bolts too short for the above thread lengths shall be threaded as close to the head as practicable.

Note: A307 bolts and nuts are manufactured in imperial units only.

HIGH-STRENGTH BOLTS – PURCHASE ORDER INFORMATION

ASTM F3125, a consolidation and replacement of six standards (A325, A325M, A490, A490M, F1852, and F2280) was published in January 2015. In this "umbrella" standard, the name of each bolt standard becomes a bolt grade (e.g. A490 becomes F3125 Grade A490). The traditional bolt type designations remain, i.e. Type 3 for weathering steel and Type 1 for bolts of other high-strength steel compositions. There are two bolt styles: F1852 and F2280 are referred to as Twist-off Style bolts, while the others are Heavy Hex Style bolts. All bolts manufactured after the publication date of F3125 must comply with the requirements of F3125. The bolt head markings, however, remain essentially unchanged, as shown in the table entitled *Markings – ASTM High-Strength Bolts, Nuts and Assemblies* above.

The design of bolted connections must comply with CSA S16-14, which specifies the bolt strength and resistances, and references the ASTM bolt standards prior to the consolidation. New purchase orders, however, may be placed in accordance with the ordering requirements in ASTM F3125 as summarized below:

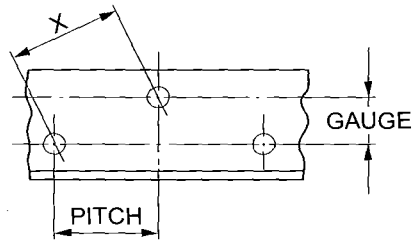
- ASTM designation
- Quantity: Number of bolts or assemblies, including washers, if required
- Size: Including nominal bolt diameter and bolt length, and thread pitch if other than standard
- Grade: A325, A325M, A490, A490M, F1852 or F2280
- Type: Type 1 or Type 3. When the Type is not specified, either Type 1 or Type 3 may be furnished at the supplier's option
- Style: Heavy Hex or Twist-Off Style

Additional ordering information may include, if required: coatings or finishes, test reports, details of other assembly components such as nuts and washers, rotational capacity testing, special observations or inspection requirements, and country of origin requirements. Heavy hex bolts may be ordered individually, packaged with nuts, packaged with nuts and washers, or as assemblies. See ASTM F3125 for further information.

A typical description: 1000 pieces ¾" × 3" ASTM F3125–15, Grade A325 heavy hex bolt, Type 1, each with one hardened ASTM F436 Type 1 washer and one A563 Grade DH heavy hex nut

FASTENERS - MISCELLANEOUS DETAILING DATA

Diagonal Distance for Staggered Fasteners



Pitch	Gauge, mm																	
mm	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
5	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
10	27	32	36	41	46	51	56	61	66	71	76	81	86	91	96	100	105	110
15	29	34	38	43	47	52	57	62	67	72	76	81	86	91	96	101	106	111
20	32	36	40	45	49	54	59	63	68	73	78	82	87	92	97	102	107	112
25	35	39	43	47	51	56	60	65	70	74	79	84	89	93	98	103	108	113
30	39	42	46	50	54	58	63	67	72	76	81	85	90	95	100	104	109	114
35	43	46	49	53	57	61	65	69	74	78	83	87	92	97	101	106	111	115
40	47	50	53	57	60	64	68	72	76	81	85	89	94	98	103	108	112	117
45	51	54	57	60	64	67	71	75	79	83	87	92	96	101	105	110	114	119
50	56	58	61	64	67	71	74	78	82	86	90	94	99	103	107	112	116	121
55	60	63	65	68	71	74	78	81	85	89	93	97	101	105	110	114	119	123
60	65	67	69	72	75	78	81	85	88	92	96	100	104	108	112	117	121	125
65	70	72	74	76	79	82	85	88	92	96	99	103	107	111	115	119	123	128
70	74	76	78	81	83	86	89	92	96	99	103	106	110	114	118	122	126	130
75	79	81	83	85	87	90	93	96	99	103	106	110	113	117	121	125	129	133
80	84	85	87	89	92	94	97	100	103	106	110	113	117	120	124	128	132	136
85	89	90	92	94	96	99	101	104	107	110	113	117	120	124	127	131	135	139
90	93	95	97	98	101	103	105	108	111	114	117	120	124	127	131	135	138	142

BOLT LENGTH TOLERANCES

Nominal Length	Nominal size, in.					
mm	⅝	¾	⅞	1	1⅛	1¼
Up to 25	+0.5	+0.5	- - -	- - -	- - -	- - -
	-0.8	-0.8	- - -	- - -	- - -	- - -
Over 25 to 64	+1.5	+1.5	+2.0	+2.0	+3.0	+3.0
	-2.0	-2.0	-2.5	-2.5	-3.0	-3.0
Over 64 to 102	+2.0	+2.0	+2.5	+2.5	+4.1	+4.1
	-2.5	-2.5	-3.6	-3.6	-4.1	-4.1
Over 102 to 152	+2.5	+2.5	+3.0	+3.0	+4.6	+4.6
	-2.5	-2.5	-4.1	-4.1	-4.6	-4.6
Over 152	+3.6	+3.6	+4.1	+4.1	+5.6	+5.6
	-4.6	-4.6	-5.1	-5.1	-5.6	-5.6

Note: Metric dimensions have been soft-converted.
Refer to ASME B18.2.1 for further information.

MINIMUM EDGE DISTANCE FOR BOLT HOLES

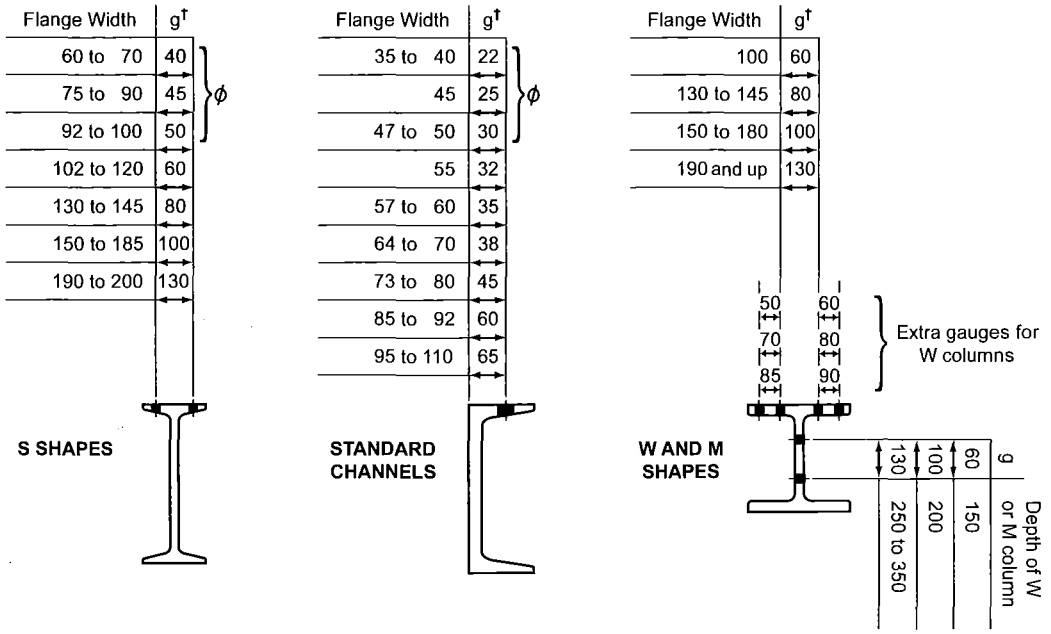
Bolt diameter in.	At sheared edge mm	At rolled or sawn edges, or edges cut by gas*, plasma, laser or water jet, mm
⅝	28	22
¾	32	25
⅞	38†	28
1	44†	32
1⅛	51	38
1¼	57	41
Over 1¼	1.75 × diameter	1.25 × diameter

* Gas-cut edges shall be smooth and free from notches. The edge distance in this column may be decreased by 3 mm when the hole is at a point where the calculated stress under factored loads is not more than 0.3 of the yield stress.

† At the ends of beam-framing angles, this distance may be 32 mm.

USUAL GAUGES

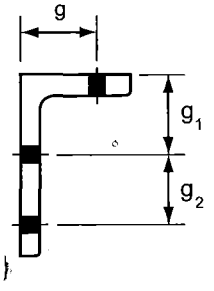
Usual Gauges for W, M, S and C Shapes, Millimetres



ø Holes usually drilled due to size of punch die block

† Some of the gauge and flange width combinations may not meet edge distance requirements in S16-14 Table 6.

Usual Gauges for Angles, Millimetres



Notes:

$g_2 \geq 2.7$ bolt diameters

(See CSA S16-14 Clause 22.3.1)

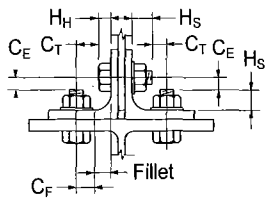
Leg	Gauge	
	g	g_1
203	115	75
178	100	65
152	90	60
127	75	50
102	65	
89	50	
76	45	
64	35	
51	29	
44	25	

Note: Bolt gauges shown do not necessarily comply with S16 installation clearances. Clearance and edge distance limitations should be verified for the selected bolt size.

INSTALLATION CLEARANCES, MILLIMETRES

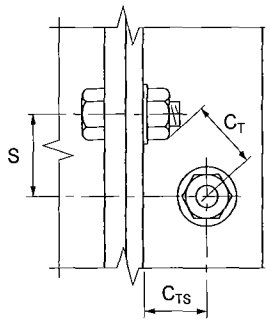
STRUCTURAL ASTM A325 and A490 Bolts

Aligned Bolts



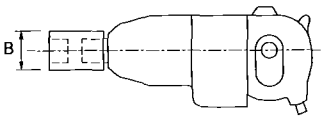
D	B	H_H	H_S	C_T	C_E	C_F	
						Circular	Clipped
5/8	44.5	9.9	31.8	25.4	17.5	17.5	14.3
3/4	57.2	11.9	34.9	31.8	19.1	19.1	17.5
7/8	63.5	13.9	38.1	34.9	22.2	22.2	20.6
1	66.7	15.5	41.3	36.5	23.8	25.4	22.2
1 1/8	73.0	17.5	47.6	39.7	27.0	28.6	25.4
1 1/4	79.4	19.8	50.8	42.9	28.6	31.8	28.6
1 3/8	82.6	21.4	54.0	44.5	31.8	34.9	31.8
1 1/2	88.9	23.8	57.2	47.6	33.3	38.1	33.3

Staggered Bolts



- D = Nominal Bolt Diameter
- B = Socket Diameter
- H_H = Height of Head
- H_S = Maximum Shank Extension*
- C_T = Clearance for Tightening
- C_E = Clearance for Entering
- C_F = Clearance for Fillet*
- S = Bolt Stagger
- C_{TS} = Clearance for Tightening Staggered Bolts

* Based on the use of one ASTM F436 washer



C_{TS}	Stagger, S — Nominal Bolt Diameter, D							
	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
26	41							
28	41							
30	40							
32	39	50						
34	38	49						
36	36	48	56					
38	34	47	55	60				
40	33	46	54	60	67			
42	32	45	53	59	66			
44	31	43	52	58	66	72		
46	30	41	51	57	65	72	77	
48	28	39	49	56	64	71	77	83
50	27	38	48	55	63	71	76	83
52	24	37	46	54	62	70	75	82
54	21	36	43	52	61	69	75	82
56	16	34	42	50	60	68	74	81
58		32	41	48	58	67	73	81
60		30	39	45	56	65	72	80
62		27	38	44	54	64	71	79
64		23	36	42	52	62	70	78
66		17	33	41	50	60	68	77
68			30	39	49	58	66	76
70			26	36	48	56	65	74
72			21	33	47	54	62	73
74				30	45	53	60	71
76				25	43	52	57	69
78					41	50	56	67
80					38	48	55	64
82					35	46	53	61
84					31	44	51	59
86					25	41	49	58
88						38	47	56
90						34	45	55

METRIC FASTENER DATA

General

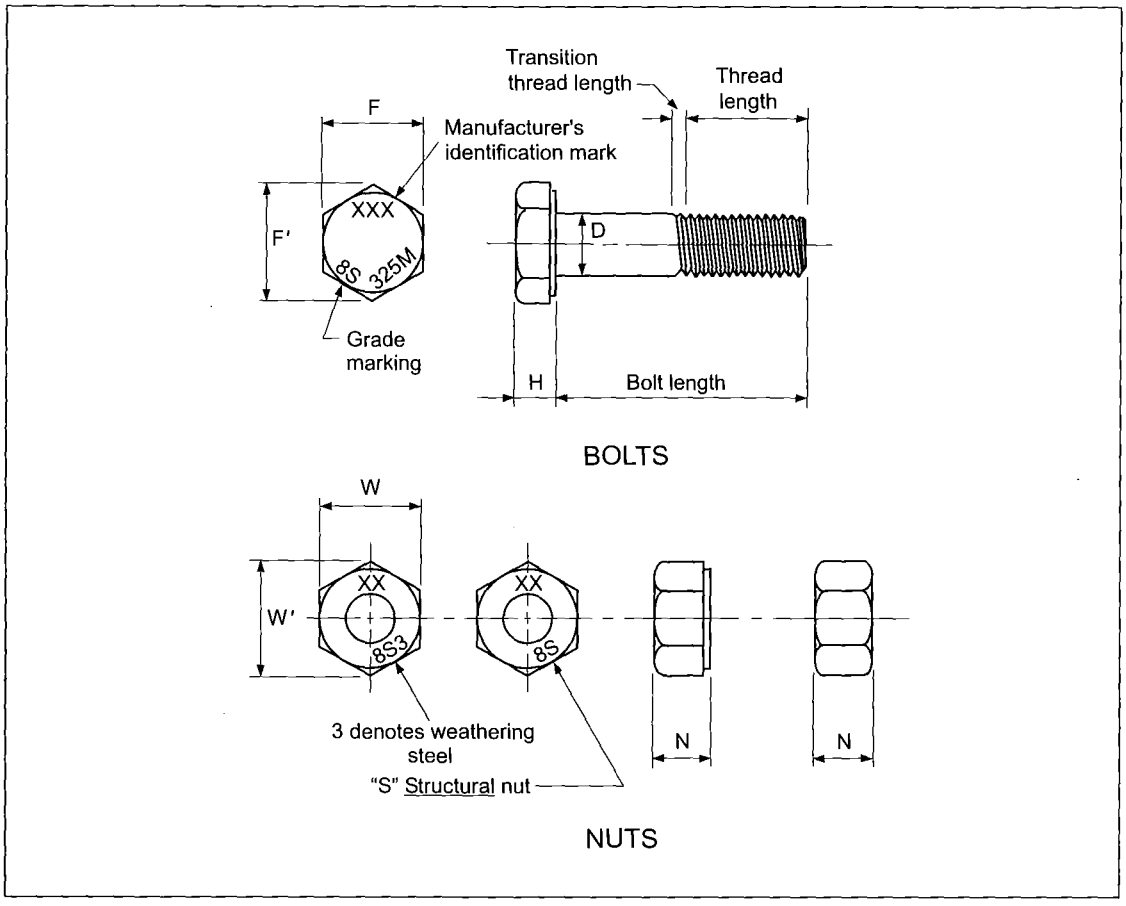
The tables on the following pages contain design data on metric-size high-strength bolts (ASTM A325M and A490M) and accessories (ASTM F436M washers) found in the 10th edition of the Handbook. This material is reprinted herein without revision for historical reference. Metric bolt sizes have not been in common use in Canada, and designers considering their use should first check for their availability.

Tables

The following tables are included in this section:

- ASTM A325M and ASTM A490M – High-Strength Bolts and Nuts
- Minimum and Maximum Grips for Metric Heavy Hex Structural Bolts
- Mass of ASTM A325M Bolts, Nuts and Washers
- ASTM F436M Metric Washer Dimensions
- Fasteners – Miscellaneous Detailing Data:
  - Thread Data, Designations, and Slotted Hole Dimensions
  - Bolt Length Tolerances, Minimum Edge Distance for Bolt Holes, and Usual Gauges
- Erection Clearances – Bolt Impact Wrenches

ASTM A325M AND ASTM A490M**
HIGH-STRENGTH BOLTS AND NUTS



DIMENSIONS

Nominal Bolt Size	Heavy Hex Bolt or Nut Dimension				Heavy Hex Nut Max. Height	Heavy Hex Structural Bolt			
	Across Flats F or W		Across Corners F' or W'			Max Head Height	Thread Length*		Max. Transition Thread Length
							Bolt Lengths ≤100	Bolt Lengths >100	
	Max.	Min.	Max.	Min.	N	H			
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
M16 x 2	27.00	26.16	31.18	29.56	17.1	10.75	31	38	6.0
M20 x 2.5	34.00	33.00	39.26	37.29	20.7	13.40	36	43	7.5
M22 x 2.5	36.00	35.00	41.57	39.55	23.6	14.90	38	45	7.5
M24 x 3	41.00	40.00	47.34	45.20	24.2	15.90	41	48	9.0
M27 x 3	46.00	45.00	53.12	50.85	27.6	17.90	44	51	9.0
M30 x 3.5	50.00	49.00	57.74	55.37	30.7	19.75	49	56	10.5
M36 x 4	60.00	58.80	69.28	66.44	36.6	23.55	56	63	12.0

* Does not include transition thread length.

** Strength requirements are based on ASTM Specifications A325M and A490M. See page 3—5.

Bolt dimensions conform to those listed in ANSI B18.2.3.7M-1979 (R2001) "Metric Heavy Hex Structural Bolts", and the nut dimensions conform to those listed in ANSI B18.2.4.6M-1979 (R1998) "Metric Heavy Hex Nuts".

MINIMUM AND MAXIMUM GRIPS FOR METRIC HEAVY HEX. STRUCTURAL BOLTS, IN MILLIMETRES

Nominal Bolt Size	M16		M20		M22		M24		M27		M30		M36	
L Nominal Length (mm)	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip
45	14	26		23		20								
50	19	31	14	28		25		24						
55	24	36	19	32	17	29		29		25				
60	29	41	24	37	22	34	19	34		30		27		
65	34	46	29	42	27	39	24	39	21	35		32		
70	39	51	34	47	32	44	29	44	26	40	21	37		31
75	44	56	39	52	37	49	34	49	31	45	26	42		36
80	49	61	44	57	42	54	39	54	36	50	31	47	24	41
85	54	66	49	62	47	59	44	59	41	55	36	52	29	46
90	59	71	54	67	52	64	49	64	46	60	41	57	34	51
95	64	76	59	72	57	69	54	69	51	65	46	62	39	56
100	69	81	64	77	62	74	59	74	56	70	51	67	44	61
110	72	91	67	87	65	84	62	84	59	80	54	77	47	71
120	82	101	77	97	75	94	72	94	69	90	64	87	57	81
130	92	110	87	107	85	104	82	103	79	100	74	97	67	91
140	102	120	97	117	95	114	92	113	89	110	84	107	77	101
150	112	130	107	127	105	124	102	123	99	120	94	117	87	111
160	122	138	117	135	115	132	112	131	109	128	104	125	97	119
170	132	148	127	145	125	142	122	141	119	138	114	135	107	129
180	142	158	137	155	135	152	132	151	129	148	124	145	117	139
190	152	168	147	165	145	162	142	161	139	158	134	155	127	149
200	162	178	157	175	155	172	152	171	149	168	144	165	137	159
210	172	188	167	185	165	182	162	181	159	178	154	175	147	169
220	182	198	177	195	175	192	172	191	169	188	164	185	157	179
230	192	208	187	205	185	202	182	201	179	198	174	195	167	189
240	202	218	197	215	195	212	192	211	189	208	184	205	177	199
250	212	228	207	225	205	222	202	221	199	218	194	215	187	209
260	222	238	217	235	215	232	212	231	209	228	204	225	197	219
270	232	248	227	245	225	242	222	241	219	238	214	235	207	229
280	242	258	237	255	235	252	232	251	229	248	224	245	217	239
290	252	268	247	265	245	262	242	261	239	258	234	255	227	249
300	262	278	257	275	255	272	252	271	249	268	244	265	237	259

1. This table is based on ANSI B18.2.3.7M-1979 (R2006).
2. Bolts with lengths above the heavy solid line are threaded full length.

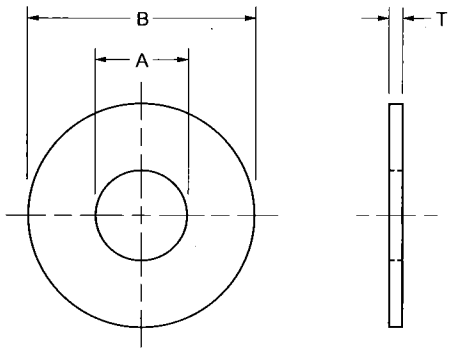
MASS OF ASTM A325M BOLTS, NUTS AND WASHERS

MASS IN KILOGRAMS PER 100 UNITS

HEAVY HEX STRUCTURAL BOLTS WITH HEAVY HEX NUTS (WITHOUT WASHERS)							
Length Under Head, mm	**Bolt Diameter, mm**						
	M16	M20	M22	M24	M27	M30	M36
45	16.3						
50	17.1	30.4					
55	17.8	31.6	39.2				
60	18.6	32.9	40.7	53.7			
65	19.4	34.1	42.2	55.4	76.8		
70	20.2	35.3	43.7	57.2	79.0	98.0	
75	21.0	36.6	45.2	59.0	81.3	101	
80	21.8	37.8	46.7	60.7	83.5	104	167
85	22.6	39.0	48.1	62.5	85.8	106	171
90	23.4	40.3	49.6	64.3	88.0	109	175
95	24.1	41.5	51.1	66.1	90.2	112	179
100	24.9	42.7	52.6	67.8	92.5	114	183
110	26.3	44.9	55.3	71.0	96.7	120	191
120	27.9	47.4	58.2	74.5	101	125	199
130	29.5	49.8	61.2	78.0	106	131	207
140	31.1	52.3	64.2	81.6	110	136	214
150	32.6	54.7	67.2	85.1	115	142	222
160	34.2	57.2	70.2	88.7	119	147	230
170	35.8	59.7	73.1	92.2	124	153	238
180	37.3	62.1	76.1	95.8	128	158	246
190	38.9	64.6	79.1	99.3	132	164	254
200	40.5	67.0	82.1	103	137	169	262

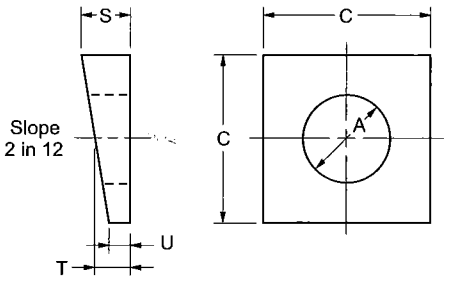
Plain round washers	1.8	2.9	3.2	4.3	5.2	5.9	8.6
Beveled square washers	10.5	9.7	9.3	8.8	15.9	14.9	12.8

ASTM F436M METRIC WASHER DIMENSIONS



PLAIN CIRCULAR WASHERS

Metric Bolt Size	B		A		T	
	Outside Diameter		Hole Diameter		Thickness	
	Max	Min	Max	Min	Max	Min
M16 x 2	34.0	32.4	18.4	18.0	4.6	3.1
M20 x 2.5	42.0	40.4	22.5	22.0	4.6	3.1
M22 x 2.5	44.0	42.4	24.5	24.0	4.6	3.4
M24 x 3	50.0	48.4	26.5	26.0	4.6	3.4
M27 x 3	56.0	54.1	30.5	30.0	4.6	3.4
M30 x 3.5	60.0	58.1	33.6	33.0	4.6	3.4
M36 x 4	72.0	70.1	39.6	39.0	4.6	3.4



BEVELLED SQUARE WASHERS

Metric Bolt Size	C		A		S	T	U
	Width		Hole Diameter		Thickness		
					Thick Side	Mean Nom.	Thin Side
	Max	Min	Max	Min			
M16 x 2	45.0	43.0	18.4	18.0	11.7	8	4.3
M20 x 2.5	45.0	43.0	22.5	22.0	11.7	8	4.3
M22 x 2.5	45.0	43.0	24.5	24.0	11.7	8	4.3
M24 x 3	45.0	43.0	26.5	26.0	11.7	8	4.3
M27 x 3	58.0	56.0	30.5	30.0	12.8	8	3.3
M30 x 3.5	58.0	56.0	33.6	33.0	12.8	8	3.3
M36 x 4	58.0	56.0	39.6	39.0	12.8	8	3.3

FASTENERS – MISCELLANEOUS DETAILING DATA

Metric Fastener Designations

THREAD DATA

Diameter Pitch Combinations

Nominal dia. (mm)	Thread pitch (mm)	Nominal dia. (mm)	Thread pitch (mm)
1.6	0.35	20	2.5
2	0.4	22	2.5
2.5	0.45	24	3
3	0.5	27	3
3.5	0.6	30	3.5
4	0.7	36	4
5	0.8	42	4.5
6.0	1.0	48	5
8	1.25	56	5.5
10	1.5	64	6
12	1.75	72	6
14	2	80	6
16	2	90	6
		100	6

Basic Metric Thread Designation: Metric screw threads are designated by the letter "M" followed by the nominal size (basic major diameter) in millimetres and the pitch in millimetres separated by the symbol "X".

M12	**X**	**1.75**	**– 6g**
Size (mm)		Thread (pitch in mm)	Standard class of fit

Note: In the metric system, the pitch of the thread is given in mm instead of threads per inch – thus a M12 x 1.75 thread has a nominal diameter of 12 mm and the pitch of the thread is 1.75 mm.

PRODUCT DESIGNATION

Metric Bolt Designation: The standard method of designating a metric bolt is by specifying (in sequence) the product name, nominal diameter and thread pitch, nominal length, type, steel property class, and protective coating (if required).

Heavy Hex Structural Bolt, M22x2.5x160,
Type 2, ASTM A325M-09, Zinc Galvanized

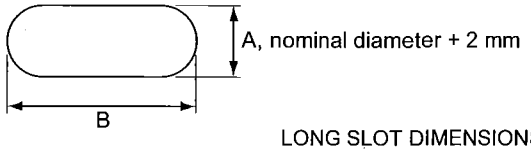
Metric Nut Designation: The standard method of designating a metric nut is by specifying (in sequence) the product name, nominal diameter and pitch, steel property class or material identification, and protective coating (if required).

Heavy Hex Nut, M30x3.5, ASTM A563M
class 105, hot dipped galvanized

Note: It is common practice to omit the thread pitch from the product designation.

Slotted Hole Dimensions

See S16-14 Clause 22.3.5.2 regarding provisions.



SHORT SLOT DIMENSIONS

Nominal Bolt Diameter	Slot Dimensions	
	Width, A	Length, B
mm	mm	mm
16	18	22
20	22	26
22	24	28
24	26	32
27	29	37
30	32	40
36	38	46

LONG SLOT DIMENSIONS

Nominal Bolt Diameter	Slot Dimensions	
	Width, A	Length, B
mm	mm	mm
16	18	40
20	22	50
22	24	55
24	26	60
27	29	67.5
30	32	75
36	38	90

FASTENERS - MISCELLANEOUS DETAILING DATA

Metric-Size Bolt Data

BOLT LENGTH TOLERANCES

Nominal Length	Nominal Bolt Dia.
	M16 thru 36
to 50 mm	± 1.2
over 50 to 80 mm	± 1.5
over 80 to 120 mm	± 1.8
over 120 to 150 mm	± 2.0
over 150 mm	± 4.0

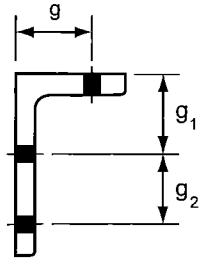
MINIMUM EDGE DISTANCE FOR BOLT HOLES

Bolt Diameter mm	At Sheared Edge mm	At Rolled or Gas Cut Edge† mm
16	28	22
20	34	26
22	38	28
24	42	30
27	48	34
30	52	38
36	64	46
over 36	1¾ x Diameter	1¼ x Diameter

† Gas cut edges shall be smooth and free from notches. Edge distance in this column may be decreased 3 mm when hole is at a point where computed stress under factored loads is not more than 0.3 of the yield stress.

USUAL GAUGES

USUAL GAUGES for Angles, Millimetres



Notes:

Those values shown above the dashed line allow for full socket wrench clearance requirements.

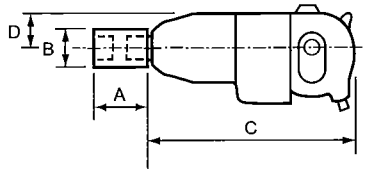
The bolt sizes shown in italics to the left of g and g_1 are the maximum bolt sizes permissible for the dimensions shown.

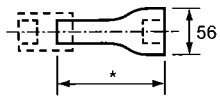
$g_2 \geq 2\frac{2}{3}$ bolt diameters.

Gauge / Leg	g		g_1		g_2	
200	*M36*	115	*M30*	80		80
150	*M36*	90	*M24*	55		65
125	*M30*	80	*M20*	45		54
100	*M27*	65				
90	*M24*	60				
80	*M24*	50				
75	*M24*	45				
65	*M24*	35				
60	*M24*	30				
55	*M22*	27				
50	*M16*	28				
45	*M16*	23				

ERECTION CLEARANCES
Bolt Impact Wrenches

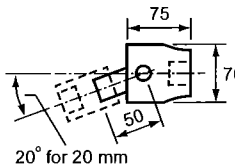
METRIC





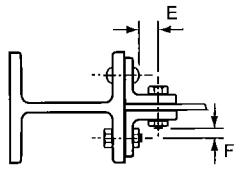
EXTENSION BAR

* Available in lengths 160 to 380 mm



UNIVERSAL JOINT

(for bolts up to 24 mm)



MINIMUM CLEARANCES

	Size	C	D
Light Wrenches	16 to 24	337 to 356	54
Heavy Wrenches	24 to 36	375 to 438	64

Sockets			Min. Clearance	
Bolt size	A	B	E	F
16	80	45	25	28
20	85	54	30	34
22	90	57	32	36
24	95	60	34	38
27	100	70	38	42
30	110	75	41	45
36	130	90	48	52

WELDING

The welding of steel shapes and plates for structural purposes is governed by CSA S16, Design of Steel Structures, and CSA Standard W59, Welded Steel Construction (Metal Arc Welding). In case of conflict between the requirements of CSA W59 and S16, however, S16 shall take precedence (see CSA S16-14 Clause 24.1).

While both standards provide design information on the resistance of welds, CSA Standard W59 extensively covers workmanship, inspection, and acceptance criteria for welded joints in both statically and dynamically loaded structures.

Welding is a process used to join two or more pieces of material together. Arc welding is a process which produces coalescence of metals by heating them with an arc, with or without the application of pressure, and with or without the use of filler metal.

Welding processes used primarily for structural steelwork are:

Shielded Metal Arc Welding	SMAW
Flux Cored Arc Welding	FCAW
Metal Cored Arc Welding	MCAW
Gas Metal Arc Welding	GMAW
Gas Tungsten Arc Welding	GTAW
Submerged Arc Welding	SAW
Electroslag Welding	ESW
Electrogas Welding	EGW
Stud Welding	SW

Welding Definitions

Arc Cutting: a group of cutting processes which melts the metal to be cut with the heat of an arc between an electrode and the base metal.

Arc Spot Weld: a weld made by arc welding between or upon overlapping members in which coalescence may start and occur on the faying surfaces or may proceed from the surface of one member. This is commonly used for thin materials, such as roof and floor deck attachment.

Base Metal: the metal to be welded or cut.

Bevel Angle: the angle formed between the prepared edge of a member and a plane perpendicular to the surface of the member.

Chain Intermittent Welds: intermittent welds on both sides of a joint in which the weld increments on one side are approximately opposite those on the other side.

Coalescence: the growing together or growth into one body of the materials being welded.

Complete Joint Penetration (CJP): a joint welded from both sides or from one side on a backing, having complete penetration and fusion of weld and base metal throughout the thickness of the joint. (Refer to figures in W59)

Edge Joint: a joint between the edges of two or more parallel or nearly parallel members.

Effective Weld Length: the length of weld throughout which the correctly proportioned cross section exists. In a curved weld, it is measured along the axis of the weld.

Effective Throat: the minimum distance from the root of a weld to its face, less any reinforcement.

End Return (Boxing): the continuation of a fillet weld around a corner of a member, as an extension of the principal weld.

Face of Weld: the exposed surface of a weld on the side from which the welding was done.

Fillet Weld: a weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, T-joint, or corner joint.

Groove Angle: the included angle between the weld groove faces.

Groove Weld: a weld made in a groove between two members to be joined.

Intermittent Weld: a weld in which the continuity is broken by recurring unwelded spaces.

Joint Design: the joint geometry together with the required dimensions of the welded joint.

Joint Penetration: the minimum depth a groove weld extends from its face into a joint, exclusive of reinforcement, but including, if present, root penetration.

Leg of a Fillet Weld: the distance from the root of the joint to the toe of the fillet weld.

Partial Joint Penetration (PJP): a groove weld condition in which weld metal extends through a part of joint thickness.

Procedure Qualification: a demonstration that welds made by a specific procedure can meet prescribed standards.

Root of Joint: that portion of a joint to be welded where the members approach closest to each other. In cross section, the root of the joint may be a point, a line or an area.

Root of Weld: the points, as shown in cross section, at which the weld metal intersects the base metal and extends furthest into the weld joint.

Root Penetration: the depth that a weld extends into the root of a joint measured on the centreline of the root cross section.

Size of Weld:

It should be noted that weld symbols and sizes used in North America generally comply with American Welding Society A2.4 "Standard Symbols for Welding, Brazing and Nondestructive Examination". Care should be taken when interpreting other symbol systems.

Groove Weld: See Complete Joint Penetration and Partial Joint Penetration definitions above.

Fillet Weld:

For equal-leg fillet welds, the leg lengths of the largest isosceles right triangle which can be inscribed within the fillet weld cross section.

For unequal-leg fillet welds, the leg lengths of the largest right triangle which can be inscribed within the fillet weld cross section.

The preceding definition applies to right-angle connections only. See figure in W59 for the definition of effective size of a fillet weld for connections in which the fusion faces form an angle between 60° and 135°.

Note: When one member makes an angle with the other member greater than 105 degrees, the leg length (size) is of less significance than the effective throat which is the controlling factor for the strength of a weld.

Staggered Intermittent Welds: an intermittent weld on both sides of a joint in which the weld increments on one side are alternated with respect to those on the other side.

Tack Weld: a weld made to hold parts of a weldment in proper alignment until the final welds are made. (Care should be taken to ensure the compatibility of weld metals.)

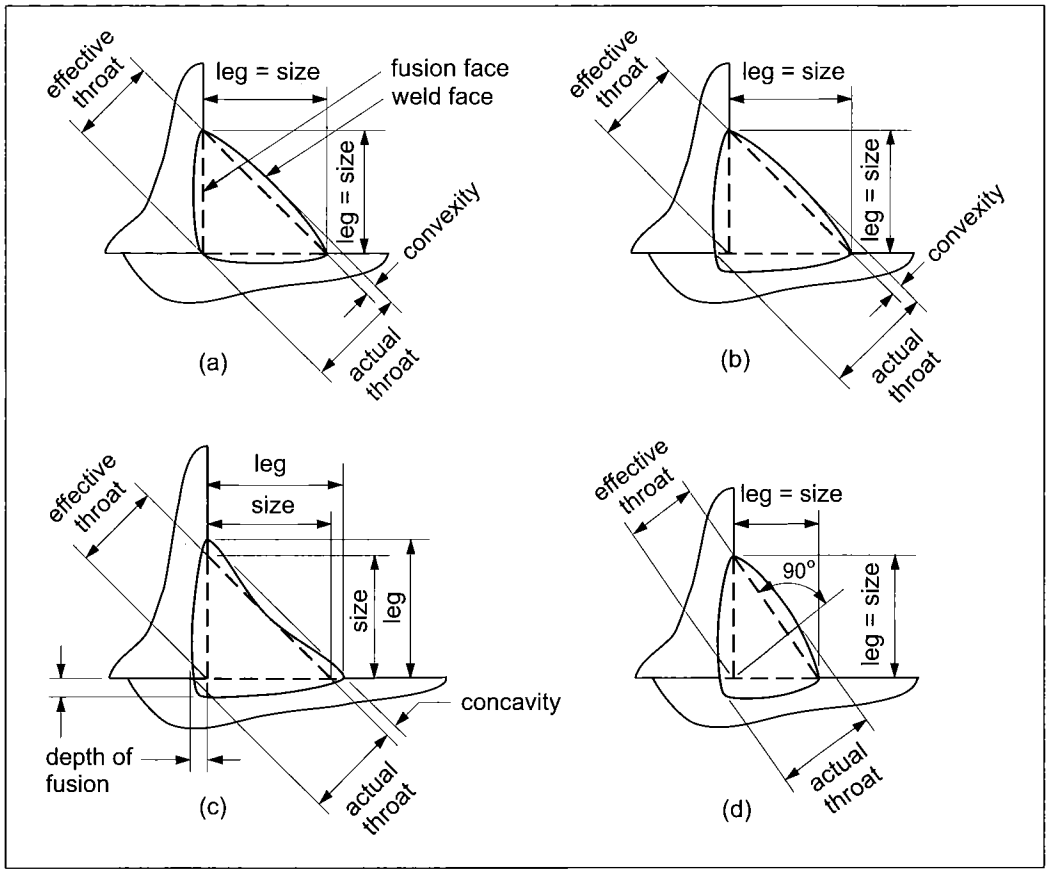
Throat of a Fillet Weld:

Theoretical Throat: the distance from the beginning of the root of the joint perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the fillet weld cross section. This dimension is based on the assumption that the root opening is equal to zero.

Actual Throat: the shortest distance from the root of weld to its face.

Effective Throat: the minimum distance minus any reinforcement or convexity, from the root of weld to its face.

Fillet Welds



Minimum Size

The minimum size of a fillet weld as measured should not be less than the values shown on the right, except that it need not exceed the thickness of the thinner part joined, unless a larger size is required by calculated stress. For this exception, particular care shall be taken to provide sufficient heat input to ensure weld soundness.

Material thickness, t, of thicker part joined (mm)	Minimum size of fillet weld (mm)
$t \leq 6$	3
$6 < t \leq 12$	5
$12 < t \leq 20$	6
$20 < t$	8

When welding attachments to non-load-carrying members, the values on the right need not apply.

The minimum effective length of a fillet weld should be 38 mm or 4 times the size of the fillet, whichever is larger. Where the geometry of the joint makes it impossible to deposit the minimum effective length, the effective fillet size shall be 0.25 times its effective length.

Maximum Size of Weld

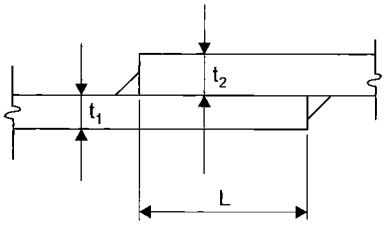
The maximum fillet weld size, D_{max}, recommended by good practice along a sheared edge is:

$D_{max} = t$ when $t < 6$ mm

$D_{max} = t - 2$ when $t \geq 6$ mm

When fillet welds are used in holes or slots, the diameter of the hole or the width of the slot should not be less than the thickness (t) of the member containing it plus 8 mm. The maximum diameter or width shall be t + 12 mm or 2.25 t, whichever is greater.

Lap Joints



$L_{min} = 5\,t_1 \geq 25$ mm when $t_1 \leq t_2$

$L_{min} = 5\,t_2 \geq 25$ mm when $t_2 < t_1$

Partial Penetration Groove Welds

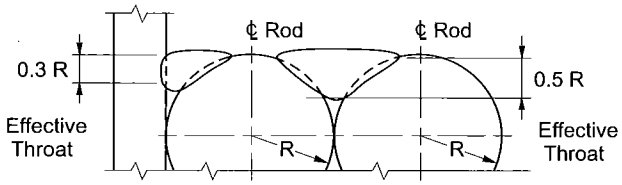
Minimum Groove Depth for Partial Joint Penetration V-, and Bevel Groove Welds †

Thickness, t of Thicker Part Joined (mm)	Minimum Groove Depth, mm	
	Groove Angle, α, at Root $45° \leq \alpha < 60°$	Groove Angle, α, at Root $\alpha \geq 60°$
$t \leq 12$	8	5
$12 < t \leq 20$	10	6
$20 < t \leq 40$	11	8
$40 < t \leq 60$	12	10
$60 < t$	16	12

† Not combined with fillet welds

Effective Throats

Flare Bevel and Flare V-Welds
(Flush Welds Only)



Solid or hollow sections with weld filled flush to the curved surface:

Not applicable to flare V-welds using GMAW process except when $R \geq 12$ mm, in which case the effective throat = 0.375R.

Flare Bevel Groove Weld:

When $R > 10$ mm, the effective throat for a joint between a curved and a planar surface shall be 0.3 R. When $R \leq 10$ mm, design as a fillet weld unless an effective throat has been previously qualified as a Flare Bevel (See W59 Clause 4.3.1.6.2.2)

Flare Vee Groove Weld:

When $R > 10$ mm, the effective throat for a joint between two curved surfaces shall be 0.5 R.

WELDED JOINTS
Standard Symbols

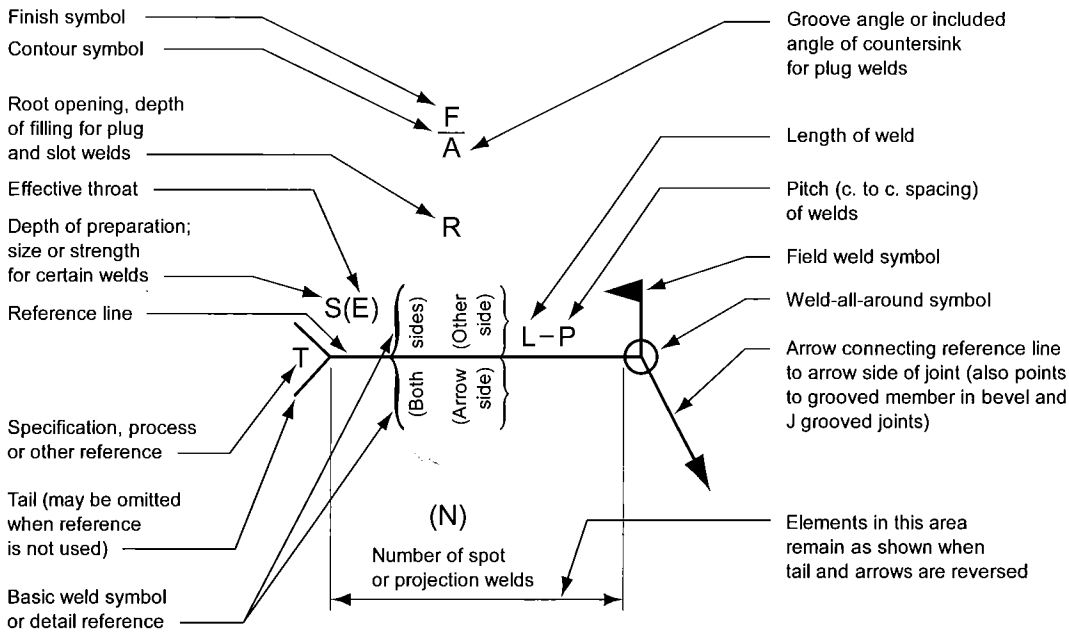
BASIC WELD SYMBOLS

BACK	FILLET	PLUG OR SLOT	GROOVE OR BUTT						
			SQUARE	V	BEVEL	U	J	FLARE V	FLARE BEVEL
									

SUPPLEMENTARY WELD SYMBOLS

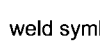
WELD ALL AROUND	* FIELD WELD	CONTOUR		
		FLUSH	CONVEX	CONCAVE
				

STANDARD LOCATION OF ELEMENTS OF A WELDING SYMBOL



Notes:

Size, weld symbol, length of weld and spacing must read in that order from left to right along the reference line. Neither orientation of reference line nor location of the arrow alter this rule.

The perpendicular leg of  weld symbols must be at left.

Size and spacing of fillet welds must be shown on both the Arrow Side and the Other Side Symbol.

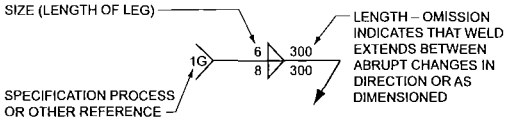
Symbols apply between abrupt changes in direction of welding unless governed by the "all around" symbol or otherwise dimensioned.

These symbols do not explicitly provide for the case that frequently occurs in structural work, where duplicate material (such as stiffeners) occurs on the far side of a web or gusset plate. The fabricating industry has adopted this convention: when the billing of the detail material discloses the identity of far side with near side, the welding shown for the near side shall also be duplicated on the far side.

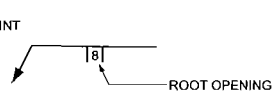
* Pennant points away from arrow.

WELDING SYMBOLS

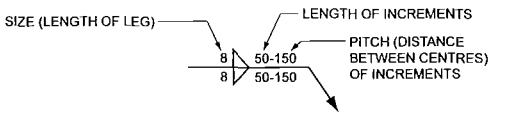
DOUBLE-FILLET WELDING SYMBOL



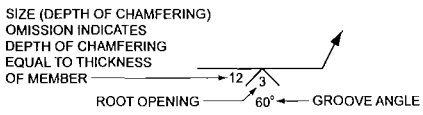
SQUARE-GROOVE WELDING SYMBOL



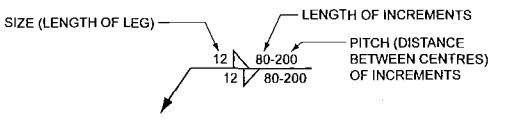
CHAIN-INTERMITTENT-FILLET WELDING SYMBOL



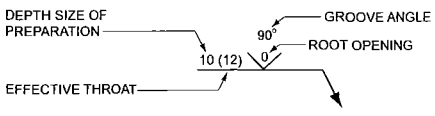
SINGLE-V GROOVE WELDING SYMBOL



STAGGERED INTERMITTENT-FILLET WELDING SYMBOL

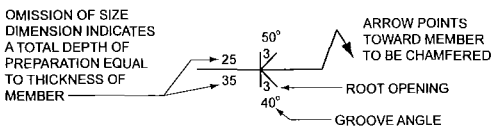


SINGLE-V GROOVE WELDING SYMBOL INDICATING ROOT PENETRATION

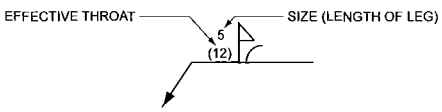


BEAD WELD SYMBOL INDICATING BEAD-TYPE BACK WELD

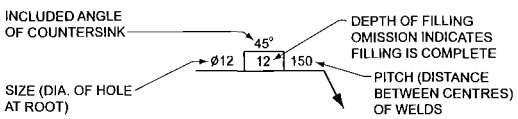
DOUBLE-BEVEL GROOVE WELDING SYMBOL



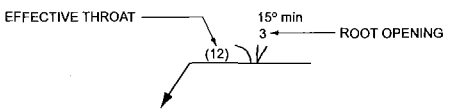
FLARE BEVEL FILLET WELDING SYMBOL



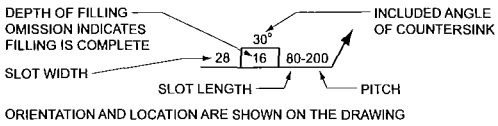
PLUG WELDING SYMBOL



FLARE GROOVE WELDING SYMBOL

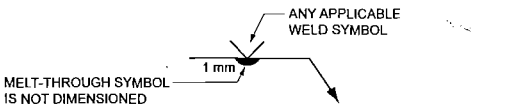


SLOT WELDING SYMBOL

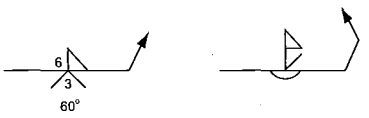


ORIENTATION AND LOCATION ARE SHOWN ON THE DRAWING

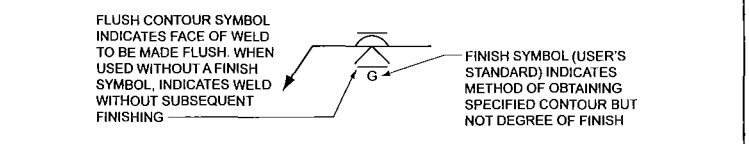
MELT-THROUGH SYMBOL



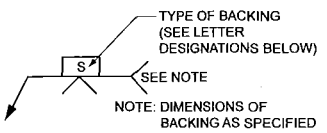
WELDING SYMBOLS FOR COMBINED WELDS



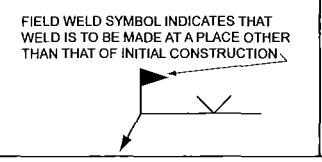
FLUSH CONTOUR SYMBOL



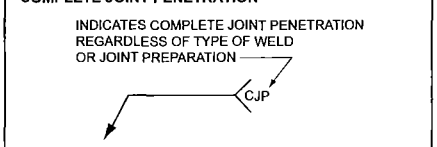
JOINT WITH BACKING



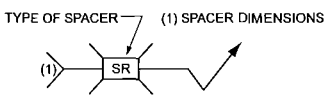
FIELD WELD SYMBOL



COMPLETE JOINT PENETRATION

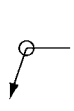
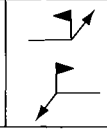
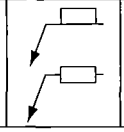
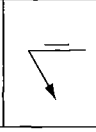
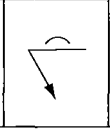
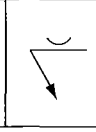


JOINT WITH SPACER

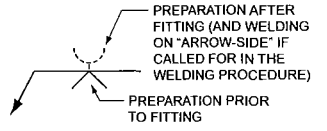


LETTER DESIGNATIONS:
S – STEEL OR OTHER MATERIAL AS SPECIFIED
SR – SAME AS "S" BUT REMOVE AFTER WELDING
T – TAPE
F – FLUX

SUPPLEMENTARY SYMBOLS

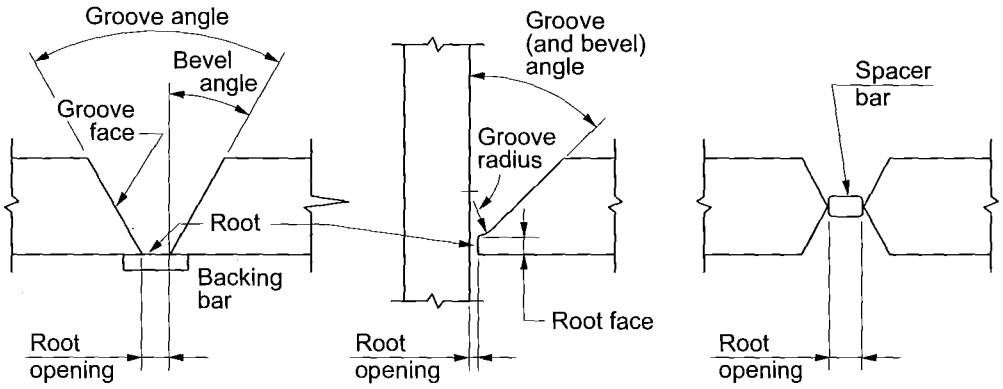
WELD-ALL-AROUND	FIELD WELD	MELT THROUGH	BACKING, SPACER	CONTOUR		
				FLUSH	CONVEX	CONCAVE
						

JOINT PREPARATION



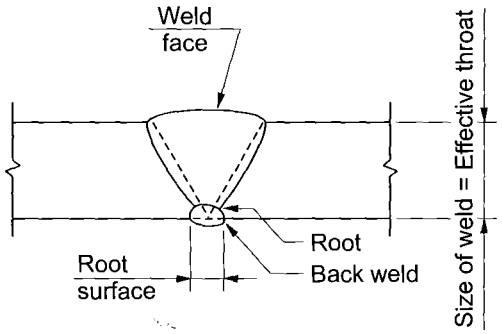
SAMPLE GROOVE WELDS

PREPARATION



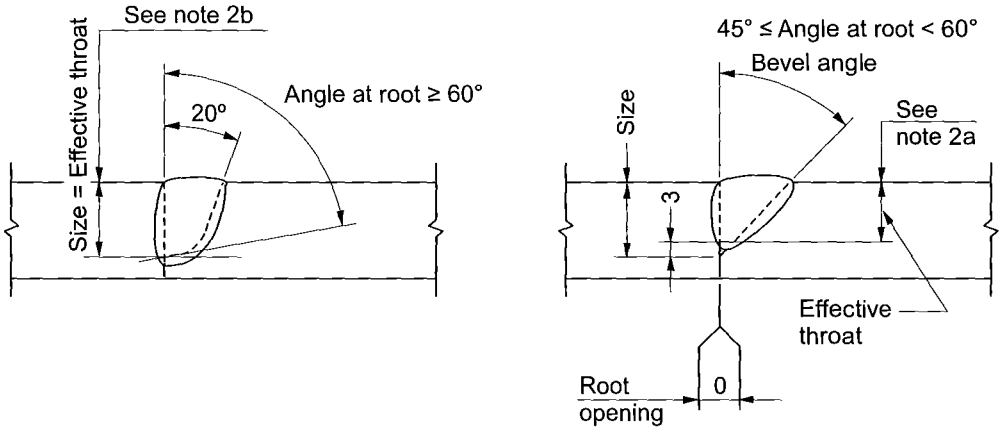
Note 1: For bevel and V-grooves, the groove angle equals the angle at the root. (Does not apply to J and U grooves.)

COMPLETE PENETRATION



See CSA W59 for more details.

PARTIAL PENETRATION



Note 2a: Effective throat = depth of preparation – 3 mm when 45° ≤ Angle at root < 60° *
2b: Effective throat = depth of preparation when angle at root of groove ≥ 60° *
* Applies only to PJPG welds

STEEL PRODUCTS – RECORD OF CHANGES

Following is a chronological record of changes to the list of steel sections included in the CISC Handbook of Steel Construction since the first printing of the Third Edition.

1983 No longer produced by Algoma are:

M100x19
S150x26, 19; S130x22, 15; S100x11; S75x11, 8
All angles except 8" x 8" leg sizes

1985 No longer produced by Algoma are:

WWF550x217; WWF350x385

New shapes and sections produced by Algoma:

WWF1800x632, 548; WWF1600x579, 495
WWF1400x491, 407; WWF550x280

Welded Reduced Flange (WRF) shapes with top flanges narrower than the bottom flanges and intended primarily for composite bridge girders:

WRF1800x543, 480, 416; WRF1600x491, 427, 362
WRF1400x413, 348, 284; WRF1200x373, 309, 244
WRF1000x340, 275, 210

1986 New shapes and sections produced by Algoma:

W610x91, 84; W530x72; W310x31; W250x24; W200x21

1989 Sections produced by Algoma

Sections deleted:

WWF1800x632, 548; WWF1600x579, 495
WWF1400x491, 407; WWF1200x403, 364
WWF1100x335, 291, 255, 220; WWF1000x324, 280, 244
WWF900x293, 249, 213; WWF800x332–154; WWF700x222–141

Sections added:

WWF2000x732–542; WWF1800x700–510; WWF1600x622–431
WWF1400x597–358; WWF1200x418, 380, 333
WWF1100x351, 304, 273, 234; WWF1000x340, 293, 262, 223
WWF900x309, 262, 231; WWF800x339–161; WWF700x245–152
WWF650x864–400; WWF600x793–369

Sections not available from Canadian mills added:

W1000–All sizes
W920x1262–488; W840x922–392; W760x865–350; W760x134
W690x802–289; W610x732–262; W530x599–248; W460x464–193

1991 Sections no longer available from Canadian mills:

W310x283, 253
C380x74–50; C310x45–31

1993 The following shapes are no longer produced:

HP330x149–89
M150x29.8–6.5; M100x19

1995 Sections deleted:

W1000x488–286, 976, 790–483; W920x1072, 876, 722; W840x922–577
W760x865, 783, 644, 531; W690x735, 605, 500, 419
W610x670, 551, 455; W530x599–331
HP330x149–89
M150x29.8, 6.5; M100x19
S180x30, 22.8; S130x22
C130x17
MC250x9.7; MC180x26.2; MC150x22.8
L152x102x4.8; L127x127x4.8; L127x89x11, 4.8; L127x76x16, 4.8
L102x102x4.8; L102x89x16, 11, 4.8; L102x76x4.8; L89x89x16, 4.8
L89x76x16, 11; L89x64x16, 11; L76x76x16; L76x64x16, 11
L76x51x16, 11; L64x64x3.2; L64x51x3.2; L51x38x9.5, 3.2
L32x32x9.5; L25x25x9.5, 7.9
L200–L25 (All metric angles)

Sections added:

W1100x499–342; W1000x749–478, 259, 693–314; W920x381, 345
W840x251; W760x220; W690x192; W610x153; W360x1202
M310x16.1; M250x11.9; M100x8.9
SLB100x5.4, 4.8; SLB75x4.5, 4.3
L203x102x22, 16, 11; L178x102x11; L19x19x3.2

1997 Sections deleted:

W1000x478, 259, 693; W920x1262; W760x710; W690x667
W610x732, 608; W460x464–286; W360x1202
L203x203x14; L203x152x22, 16, 14; L203x102x22, 16, 14, 11
L152x102x6.4; L152x89x6.4; L89x76x4.8; L89x64x4.8; L64x38x7.9–4.8
L51x38x7.9; L44x44x9.5, 7.9; L38x38x9.5, 7.9, 4.0; L32x32x7.9
HSS51x51x2.5; HSS38x38x2.5; HSS32x32x3.8–2.5; HSS25x25x3.2, 2.5
HSS127x64x9.5–4.8; HSS127x51x9.5–4.8; HSS51x25x2.5
HSS48x2.8; HSS42x3.2, 2.5; HSS33x3.2, 2.5; HSS27x3.2, 2.5

Sections added:

W1000x591, 539, 486, 483; W840x576; W760x531; W690x500, 419
W610x551, 455; W150x13
L152x152x6.4

HSS127x127x13; HSS102x102x3.8, 3.2; HSS89x89x3.8, 3.2
HSS76x76x9.5, 3.8, 3.2
HSS152x102x13; HSS152x76x9.5–4.8; HSS127x76x3.8
HSS102x76x3.8, 3.2; HSS76x51x3.2
HSS610x13–6.4; HSS559x13–6.4; HSS508x13–6.4

2000 Sections deleted:

HP310x174, 152, 132

2004 Sections deleted:

W840x576; W760x531
WT230x33.5, 30.5
L203x152x11
HSS305x305x11; HSS254x254x11; HSS203x203x11; HSS178x178x11
HSS152x152x11; HSS127x127x11; HSS102x102x3.8; HSS89x89x3.8
HSS76x76x3.8; HSS64x64x3.8; HSS51x51x3.8; HSS38x38x3.8
HSS305x203x11; HSS254x152x11; HSS203x152x11; HSS203x102x11
HSS178x127x11; HSS152x102x11; HSS127x76x3.8; HSS102x76x3.8
HSS102x51x3.8; HSS89x64x3.8; HSS76x51x3.8
HSS610x13, 11, 9.5, 8.0, 6.4; HSS559x13, 11, 9.5, 8.0, 6.4
HSS508x13, 11, 9.5, 8.0, 6.4; HSS406x11, 8.0; HSS356x11, 8.0
HSS324x11, 8.0; HSS273x11, 9.5, 8.0; HSS219x11, 8.0; HSS141x8.0
HSS114x8.0, 6.4; HSS102x3.8; HSS89x3.8; HSS73x3.8; HSS60x3.8
HSS48x3.8

Sections added:

M310x14.9; M250x11.2; M200x9.2; M150x6.6, 5.5
SLB100x5.1; SLB75x5.6, 3.8; SLB55x6.4
C100x7, C75x5
MC150x22.8
L203x203x14; L203x152x22, 16, 14; L102x89x11; L51x38x3.2
HSS305x305x16; HSS254x254x16; HSS203x203x16; HSS178x178x16
HSS114x114x13, 9.5, 8.0, 6.4, 4.8, 3.2; HSS102x102x13; HSS64x64x8.0
HSS356x254x16, 13, 9.5; HSS305x203x16; HSS254x152x16
HSS152x76x13; HSS102x51x9.5; HSS51x25x4.8
HSS356x16; HSS273x4.8; HSS219x16; HSS178x13, 9.5, 8.0, 6.4, 4.8
HSS168x13, 3.2; HSS152x9.5, 8.0, 6.4, 4.8, 3.2
HSS127x13, 9.5, 8.0, 6.4, 4.8, 3.2; HSS114x9.5, 3.2; HSS102x3.2
HSS89x3.2; HSS76x6.4, 4.8; HSS64x6.4, 4.8, 3.2

2006 Sections deleted:

W920x1188, 967, 784, 653, 585, 534, 488, 446, 417, 387, 365, 342

Sections added:

W1000x438; W920x1191, 970, 787, 725, 656, 588, 537, 491, 449, 420, 390, 368, 344; W840x576; W760x531; W460x464, 421, 384, 349, 315, 286

2010 Sections deleted:

W920x1191, 970, 787, 725; W690x802; W310x31; W250x24; W200x21
WT460x223, 208.5, 193.5, 182.5, 171
M200x9.2, M150x5.5, M130x28.1

Sections added:

WT460x224.5, 210, 195, 184, 172

2016 Sections deleted:

WRF1800x543–416; WRF1600x491–362; WRF1400x413–284
WRF1200x373–244; WRF1000x340-210
WWF2000x732–542; WWF1800x700–510; WWF1600x622–431
WWF1400x597–358; WWF1200x487–263; WWF1100x458–234
WWF1000x447–200; WWF900x417–169; WWF800x339–161
WWF700x245–152; WWF650x864–400; WWF600x793–369
WWF550x721–280; WWF500x651–197; WWF450x503–177
WWF400x444–157; WWF350x315–137
W610x91, 84; W460x67, 61
SLB100x5.4–4.8; SLB75x5.6–3.8; SLB55x6.4
L152x152x6.4, L152x89x16, L127x127x6.4, L102x89x11, L102x76x11
HSS114x114x13, 9.5, 8.0, 6.4, 4.8, 3.2; HSS89x89x3.2; HSS64x64x8.0
HSS356x254x16, 13, 9.5; HSS89x64x8.0, 3.2
HSS356x16; HSS219x16; HSS178x8.0, 6.4, 4.8
HSS168x8.0, 3.2; HSS152x9.5, 8.0, 6.4, 4.8, 3.2; HSS141x4.8
HSS127x13, 8.0, 4.8, 3.2; HSS114x9.5, 4.8, 3.2
HSS102x8.0, 6.4, 4.8, 3.2; HSS89x8.0

Sections added:

W1000x976; W920x1377, 1269, 1194, 1077, 970, 787, 725; W690x802
W530x409, 369, 332; W360x1299, 1202
M318x18.5, 17.3; M200x9.2; M150x5.5; M130x28.1; M100x6.1; M75x4.3
HP460x304, 269, 234, 202; HP410x272, 242, 211, 181, 151, 131
HP310x132
MC310x21.3; MC250x9.7; MC150x10.4, 9.7; MC100x20.5; MC75x10.6
L254x254x32, 29, 25, 22, 19; L203x152x11; L203x102x22, 16, 14, 11
L89x76x11; L76x64x11; L64x38x6.4, 4.8; L38x38x4.0
HSS559x559x19; HSS508x508x22, 19, 16, 13
HSS457x457x22, 19, 16, 13; HSS406x406x22, 19, 16, 13, 9.5
HSS356x356x16, 13, 9.5, 7.9; HSS254x254x4.8; HSS203x203x4.8
HSS127x127x3.2
HSS305x152x16, 13, 9.5, 7.9, 6.4; HSS254x203x16, 13, 9.5, 7.9, 6.4
HSS254x152x4.8; HSS203x152x16; HSS152x102x3.2
HSS152x76x3.2; HSS127x76x13, 3.2; HSS76x38x6.4, 4.8, 3.2
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HSS273x9.5, 7.9; HSS245x9.5, 6.4; HSS141x13; HSS76x3.2; HSS42x3.2