

Aluminum Design Manual

PART V

Section Properties



V
Section Properties

TABLE OF CONTENTS

Table 1	Nomenclature	4
Table 2	Section Designations	5
Table 3	Weights Per Square Foot	6
Table 4	Aluminum Association Standard Channels	7
Table 5	American Standard Channels	8
Table 6	Car and Shipbuilding Channels	10
Table 7	Canadian Channels	11
Table 8	Aluminum Association Standard I Beams	12
Table 9	Wide Flange Beams	13
Table 10	Wide Flange Beams—Army-Navy Series	14
Table 11	American Standard I Beams	15
Table 12	Canadian I Beams	16
Table 13	Canadian Wide Flange Beams	17
Table 14	Angles—Equal Legs	18
Table 15	Square End Angles—Equal Legs	20
Table 16	Angles—Unequal Legs	21
Table 17	Square End Angles—Unequal Legs	24
Table 18	Tees	25
Table 19	Army-Navy and Special Tees	26
Table 20	Zees	27
Table 21	Round Tubes	28
Table 22	Pipes	32
Table 23	Square Tubes	34
Table 24	Rectangular Tubes	36
Table 25	Roofing and Siding—Dimensions and Weights	38
Table 26	Roofing and Siding—Section Properties	39
Table 27	Decimal Equivalents in Inches of Sheet Metal and Wire Gauges	40
Table 28	Geometric Shapes	41

Table 1
NOMENCLATURE

Symbol	Property	Units
A	area	in ²
b	width	in.
C_w	warping constant	in ⁶
d	depth	in.
I	moment of inertia	in ⁴
J	torsion constant	in ⁴
r	radius of gyration	in.
r_o	polar radius of gyration about the shear center	in.
R	fillet radius	in.
R_b	mid-thickness radius of a pipe or tube	in.
S	section modulus	in ³
t	thickness	in.
t_f	flange thickness	in.
t_w	web thickness	in.
Wt	weight per unit length	lb/ft
x	location of the major axis	in.
x_o	x coordinate of shear center	in.
y	location of the minor axis	in.
y_o	y coordinate of shear center	in.

x and y subscripts denote the axis about which the property is taken.
The x axis is the major axis. The y axis is the minor axis.

Table 2
SECTION DESIGNATIONS

Section	Designation	Example	Description
Channels	<i>CS Depth × Wt</i>	CS 4 × 2.33	C shapes with flat flanges; includes Canadian Channels
Car and Shipbuilding Channels	<i>CS Depth × Wt</i>	CS 3 × 2.23	C shapes; some have flanges with a slope on the inner surface
American Standard Channels	<i>C Depth × Wt</i>	C 2 × 1.22	C shapes with flanges with a 1:6 slope on the inner surface
I-Beams	<i>I Depth × Wt</i>	I 12 × 11.7	I shapes with flat flanges; includes Canadian I-Beams
American Standard I-Beams	<i>S Depth × Wt</i>	S 10 × 12.1	I shapes with flanges with a 1:6 slope on the inner surface
Wide Flange Beams	<i>WF Nominal Depth × Wt</i>	WF 12 × 13.8	I shapes with a flange width approximately equal to the depth
Army-Navy Wide Flange Beams	<i>WF(A-N) Depth × Wt</i>	WF(A-N) 4 × 4.14	I shapes with flat flanges and a radius on the inside corner of the flanges
Angles	<i>L long leg × short leg × thickness</i>	L 3 × 2 × ¼	L shaped product with a fillet at the junction of the legs and radii on the inside tips of the legs
Square End Angles	<i>LS long leg × short leg × thickness</i>	LS 3 × 3 × ⅛	L shaped product with small radii at the corners
Tees	<i>T Depth × Width × Wt</i>	T 2.50 × 2.50 × 1.91	T shapes
Zees	<i>Z Depth × Width × Wt</i>	Z 4.00 × 3.19 × 4.32	Z shapes
Plates	<i>PL Thickness × Width</i>	PL 0.375 × 60	Rolled product with a rectangular cross section at least 0.25 in. thick
Rods	<i>RD Diameter</i>	RD 0.500	Solid product with a circular cross section at least 0.375 in. in diameter
Square Bars	<i>SQ Side dimension</i>	SQ 4	Solid product with a square cross section at least 0.375 in. on a side
Pipes	<i>NPS size × SCH schedule no.</i>	NPS 4 × SCH 40	Tube in standardized outside diameters and wall thicknesses
Round Tubes	<i>Outside diameter OD × wall thickness WALL</i>	4 OD × 0.125 WALL	Hollow product with a circular cross section
Rectangular Tubes	<i>RT short side × long side × wall thickness</i>	RT 4 × 6 × ¼	Hollow product with a rectangular cross section (including square tube)

Table 3
WEIGHTS PER SQUARE FOOT

The weight per square foot for an alloy with density of 0.100 lb/in³ is shown for each thickness. The weights for other alloys can be calculated using the density given in Part IV Table 8. Commonly used thicknesses are shown **BOLD**.

Thickness (in.)			Thickness (in.)			Thickness (in.)		
Decimal	Fraction	Weight (lb/ft ²)	Decimal	Fraction	Weight (lb/ft ²)	Decimal	Fraction	Weight (lb/ft ²)
.006		0.086	.132		1.90	1.625	1 5/8	23.40
.007		0.101	.140		2.02	1.750	1 3/4	25.20
.008		0.115	.150		2.16	1.875	1 7/8	27.00
.009		0.130	.160		2.30	2.000	2	28.80
.010		0.144	.170		2.45	2.125	2 1/8	30.60
.011		0.158	.180		2.59	2.250	2 1/4	32.40
.012		0.173	.1875	3/16	2.70	2.375	2 3/8	34.20
.013		0.187	.190		2.74	2.500	2 1/2	36.00
.014		0.202	.200		2.88	2.625	2 5/8	37.80
.016	1/64	0.230	.212		3.05	2.750	2 3/4	39.60
.018		0.259	.224		3.23	2.875	2 7/8	41.40
.019		0.274	.236		3.40	3.000	3	43.20
.020		0.288	.250	1/4	3.60	3.250	3 1/4	46.80
.021		0.302	.266	17/64	3.83	3.500	3 1/2	50.40
.022		0.317	.281	9/32	4.05	3.750	3 3/4	54.00
.024		0.346	.297	19/64	4.28	4.000	4	57.60
.025		0.360	.313	5/16	4.51	4.250	4 1/4	61.20
.026		0.374	.328	21/64	4.72	4.500	4 1/2	64.80
.028		0.403	.344	11/32	4.95	4.750	4 3/4	68.40
.030		0.432	.359	23/64	5.17	5.000	5	72.00
.032		0.461	.375	3/8	5.40	5.250	5 1/4	75.60
.034		0.490	.391	25/64	5.63	5.500	5 1/2	79.20
.036		0.518	.406	13/32	5.85	5.750	5 3/4	82.80
.038		0.547	.422	27/64	6.08	6.000	6	86.40
.040		0.576	.438	7/16	6.31			
.042		0.605	.453	29/64	6.52			
.045		0.648	.469	15/32	6.75			
.048		0.691	.484	31/64	6.97			
.050		0.720	.500	1/2	7.20			
.053		0.763	.531	17/32	7.65			
.056		0.806	.562	9/16	8.09			
.060		0.864	.594	19/32	8.55			
.063	1/16	0.907	.625	5/8	9.00			
.067		0.965	.656	21/32	9.45			
.071		1.02	.688	11/16	9.91			
.075		1.08	.719	23/32	10.35			
.080		1.15	.750	3/4	10.80			
.085		1.22	.812	13/16	11.69			
.090		1.30	.875	7/8	12.60			
.095		1.37	.938	15/16	13.51			
.100		1.44	1.000	1	14.40			
.106		1.53	1.125	1 1/8	16.20			
.112		1.61	1.250	1 1/4	18.00			
.118		1.70	1.375	1 3/8	19.80			
.125	1/8	1.80	1.500	1 1/2	21.60			

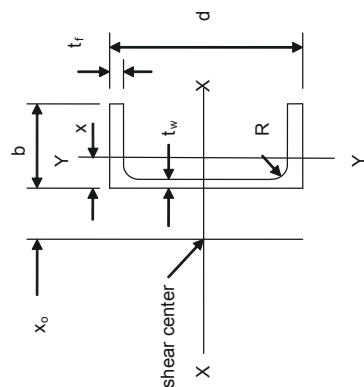


Table 4
ALUMINUM ASSOCIATION STANDARD CHANNELS

Designation	Depth <i>d</i> in.	Width <i>b</i> in.	Flange Thickness <i>t_f</i> in.	Web Thickness <i>t_w</i> in.	Fillet Radius <i>R</i> in.	Area <i>A</i> in ²	Axis x-x			Axis y-y					<i>x_o</i> in.	<i>C_w</i> in ⁶	<i>J</i> in ⁴	<i>r_o</i> in.
							<i>I_x</i> in ⁴	<i>S_x</i> in ³	<i>r_x</i> in.	<i>I_y</i> in ⁴	<i>S_y</i> in ³	<i>r_y</i> in.	<i>x</i> in.					
CS 2 × 0.577	2.000	1.000	0.130	0.130	0.100	0.490	0.288	0.288	0.766	0.0450	0.0639	0.303	0.296	0.626	0.0324	0.00274	1.03	
CS 2 × 1.07	2.000	1.250	0.260	0.170	0.150	0.911	0.546	0.546	0.774	0.139	0.178	0.390	0.471	0.904	0.0894	0.0171	1.25	
CS 3 × 1.14	3.000	1.500	0.200	0.130	0.250	0.965	1.41	0.940	1.21	0.217	0.215	0.474	0.494	1.02	0.332	0.00990	1.65	
CS 3 × 1.60	3.000	1.750	0.260	0.170	0.250	1.36	1.97	1.31	1.20	0.417	0.368	0.554	0.617	1.25	0.626	0.0246	1.82	
CS 4 × 1.74	4.000	2.000	0.230	0.150	0.250	1.48	3.91	1.95	1.63	0.601	0.446	0.638	0.653	1.38	1.65	0.0202	2.22	
CS 4 × 2.33	4.000	2.250	0.290	0.190	0.250	1.98	5.21	2.60	1.62	1.02	0.692	0.717	0.775	1.60	2.76	0.0444	2.39	
CS 5 × 2.21	5.000	2.250	0.260	0.150	0.300	1.88	7.88	3.15	2.05	0.975	0.642	0.720	0.731	1.54	4.17	0.0314	2.66	
CS 5 × 3.09	5.000	2.750	0.320	0.190	0.300	2.63	11.1	4.45	2.06	2.05	1.14	0.884	0.955	1.98	8.70	0.0700	2.99	
CS 6 × 2.83	6.000	2.500	0.290	0.170	0.300	2.41	14.4	4.78	2.44	1.53	0.896	0.798	0.788	1.67	9.52	0.0495	3.06	
CS 6 × 4.03	6.000	3.250	0.350	0.210	0.300	3.43	21.0	7.01	2.48	3.76	1.76	1.05	1.12	2.34	23.1	0.109	3.57	
CS 7 × 3.21	7.000	2.750	0.290	0.170	0.300	2.73	22.1	6.31	2.85	2.10	1.10	0.878	0.842	1.81	17.8	0.0552	3.49	
CS 7 × 4.72	7.000	3.500	0.380	0.210	0.300	4.01	33.8	9.65	2.90	5.13	2.23	1.13	1.20	2.52	43.0	0.147	4.01	
CS 8 × 4.15	8.000	3.000	0.350	0.190	0.300	3.53	37.4	9.35	3.26	3.25	1.57	0.959	0.934	1.99	36.0	0.102	3.94	
CS 8 × 5.79	8.000	3.750	0.410	0.250	0.350	4.92	52.7	13.2	3.27	7.12	2.82	1.20	1.22	2.59	78.5	0.210	4.34	
CS 9 × 4.98	9.000	3.250	0.350	0.230	0.350	4.24	54.4	12.1	3.58	4.40	1.89	1.02	0.928	2.02	62.8	0.127	4.24	
CS 9 × 6.97	9.000	4.000	0.440	0.290	0.350	5.93	78.3	17.4	3.63	9.60	3.49	1.27	1.25	2.68	135	0.293	4.69	
CS 10 × 6.14	10.000	3.500	0.410	0.250	0.350	5.22	83.2	16.6	3.99	6.33	2.55	1.10	1.02	2.20	111	0.209	4.69	
CS 10 × 8.36	10.000	4.250	0.500	0.310	0.400	7.11	116	23.2	4.04	13.0	4.46	1.35	1.34	2.84	226	0.444	5.12	
CS 12 × 8.27	12.000	4.000	0.470	0.290	0.400	7.04	160	26.6	4.77	11.0	3.85	1.25	1.14	2.47	281	0.367	5.51	
CS 12 × 11.8	12.000	5.000	0.620	0.350	0.450	10.1	240	39.9	4.88	25.7	7.59	1.60	1.61	3.40	639	0.948	6.16	
CS 14 × 13.9 ¹	14.000	6.000	0.640	0.320	0.450	11.8	401	57.3	5.82	44.7	11.2	1.94	2.00	4.25	1510	1.19	7.46	

1. New shape; check availability with suppliers.
2. Tolerances for extruded shapes are given in *Aluminum Standards and Data*.

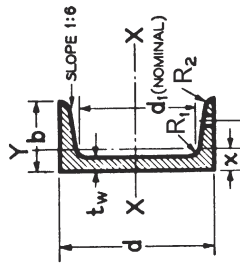


Table 5
AMERICAN STANDARD CHANNELS

Designation	Depth <i>d</i> in.	Width <i>b</i> in.	Flange Tip Thickness <i>t_f</i> in.	Average Flange Thickness <i>t</i> in.	Web Thickness <i>t_w</i> in.	Fillet Radius <i>R₁</i> in.	Tip Radius <i>R₂</i> in.	<i>d₁</i> in.	Area <i>A</i> in ²	Axis x-x			Axis y-y			y-axis Location <i>x</i> in.
										<i>I_x</i> in ⁴	<i>S_x</i> in ³	<i>r_x</i> in.	<i>I_y</i> in ⁴	<i>S_y</i> in ³	<i>r_y</i> in.	
C 2 × 122	2.000	1.410	0.170	0.273	0.170	0.270	0.100	0.75	1.04	0.622	0.622	0.774	0.172	0.188	0.407	0.49
C 3 × 142	3.000	1.410	0.170	0.273	0.170	0.270	0.100	1.75	1.21	1.66	1.10	1.17	0.20	0.20	0.40	0.44
C 3 × 173	3.000	1.498	0.170	0.273	0.258	0.270	0.100	1.75	1.47	1.85	1.24	1.12	0.21	0.21	0.41	0.44
C 3 × 207	3.000	1.596	0.170	0.273	0.356	0.270	0.100	1.75	1.76	2.07	1.38	1.08	0.31	0.27	0.42	0.46
C 4 × 185	4.000	1.580	0.180	0.297	0.180	0.280	0.110	2.75	1.57	3.83	1.92	1.56	0.32	0.28	0.45	0.46
C 4 × 216	4.000	1.647	0.180	0.297	0.247	0.280	0.110	2.75	1.84	4.19	2.10	1.51	0.37	0.31	0.45	0.45
C 4 × 250	4.000	1.720	0.180	0.297	0.320	0.280	0.110	2.75	2.13	4.58	2.29	1.47	0.43	0.34	0.45	0.46
C 5 × 232	5.000	1.750	0.190	0.320	0.190	0.290	0.110	3.75	1.97	7.49	3.00	1.95	0.48	0.38	0.49	0.48
C 5 × 311	5.000	1.885	0.190	0.320	0.325	0.290	0.110	3.75	2.64	8.90	3.56	1.83	0.63	0.45	0.49	0.48
C 5 × 397	5.000	2.032	0.190	0.320	0.472	0.290	0.110	3.75	3.38	10.4	4.17	1.76	0.81	0.53	0.49	0.51
C 6 × 283	6.000	1.920	0.200	0.343	0.200	0.300	0.120	4.50	2.40	13.1	4.37	2.34	0.69	0.49	0.54	0.51
C 6 × 300	6.000	1.945	0.200	0.343	0.225	0.300	0.120	4.50	2.55	13.6	4.52	2.31	0.73	0.51	0.54	0.51
C 6 × 363	6.000	2.034	0.200	0.343	0.314	0.300	0.120	4.50	3.09	15.2	5.06	2.22	0.87	0.56	0.50	0.50
C 6 × 450	6.000	2.157	0.200	0.343	0.438	0.300	0.120	4.50	3.83	17.4	5.80	2.13	1.05	0.64	0.52	0.51
C 7 × 354	7.000	2.110	0.210	0.367	0.230	0.310	0.130	5.50	3.01	21.8	6.24	2.69	1.01	0.64	0.58	0.54
C 7 × 423	7.000	2.194	0.210	0.367	0.314	0.310	0.130	5.50	3.60	24.2	6.93	2.60	1.17	0.70	0.57	0.52
C 7 × 510	7.000	2.299	0.210	0.367	0.419	0.310	0.130	5.50	4.33	27.2	7.78	2.51	1.38	0.78	0.56	0.53
C 7 × 596	7.000	2.404	0.210	0.367	0.524	0.310	0.130	5.50	5.07	30.3	8.64	2.44	1.59	0.86	0.56	0.55

Designation	Depth d in.	Width b in.	Flange Tip		Average Flange Thickness t in.	Web Thickness t_w in.	Fillet Radius R_f in.	Tip Radius R_2 in.	d_1 in.	Area A in ²	Axis x-x			Axis y-y			y-axis Location x in.
			Thickness t_f in.	Thickness t in.							I_x in ⁴	S_x in ³	r_x in.	I_y in ⁴	S_y in ³	r_y in.	
C 8 x 4.25	8.000	2.290	0.220	0.390	0.390	0.250	0.320	0.130	6.25	3.62	33.9	8.46	3.06	1.40	0.81	0.62	0.56
C 8 x 4.75	8.000	2.343	0.220	0.390	0.390	0.303	0.320	0.130	6.25	4.04	36.1	9.03	2.99	1.53	0.85	0.61	0.55
C 8 x 5.62	8.000	2.435	0.220	0.390	0.390	0.395	0.320	0.130	6.25	4.78	40.0	10.0	2.90	1.75	0.93	0.61	0.55
C 8 x 6.48	8.000	2.527	0.220	0.390	0.390	0.487	0.320	0.130	6.25	5.51	44.0	11.0	2.82	1.98	1.01	0.60	0.57
C 9 x 4.60	9.000	2.430	0.230	0.413	0.413	0.230	0.330	0.140	7.25	3.91	47.7	10.6	3.49	1.75	0.96	0.67	0.60
C 9 x 5.19	9.000	2.485	0.230	0.413	0.413	0.285	0.330	0.140	7.25	4.41	51.0	11.3	3.40	1.93	1.01	0.66	0.59
C 9 x 6.91	9.000	2.648	0.230	0.413	0.413	0.448	0.330	0.140	7.25	5.88	60.9	13.5	3.22	2.42	1.17	0.64	0.58
C 9 x 8.65	9.000	2.812	0.230	0.413	0.413	0.612	0.330	0.140	7.25	7.35	70.9	15.8	3.11	2.94	1.34	0.63	0.61
C 10 x 5.28	10.000	2.600	0.240	0.437	0.437	0.240	0.340	0.140	8.25	4.49	67.4	13.5	3.87	2.28	1.16	0.71	0.63
C 10 x 6.91	10.000	2.739	0.240	0.437	0.437	0.379	0.340	0.140	8.25	5.88	79.0	15.8	3.66	2.81	1.32	0.69	0.61
C 10 x 8.64	10.000	2.886	0.240	0.437	0.437	0.526	0.340	0.140	8.25	7.35	91.2	18.2	3.52	3.36	1.48	0.68	0.62
C 10 x 10.4	10.000	3.033	0.240	0.437	0.437	0.673	0.340	0.140	8.25	8.82	104	20.7	3.43	3.95	1.66	0.67	0.65
C 12 x 7.41	12.000	2.960	0.280	0.502	0.502	0.300	0.380	0.170	10.0	6.30	132	22.0	4.57	3.99	1.76	0.80	0.69
C 12 x 8.64	12.000	3.047	0.280	0.502	0.502	0.387	0.380	0.170	10.0	7.35	144	24.1	4.43	4.47	1.89	0.78	0.67
C 12 x 10.4	12.000	3.170	0.280	0.502	0.502	0.510	0.380	0.170	10.0	8.82	162	27.0	4.29	5.14	2.06	0.76	0.67
C 12 x 12.1	12.000	3.292	0.280	0.502	0.502	0.632	0.380	0.170	10.0	10.3	180	29.9	4.18	5.82	2.24	0.75	0.69
C 15 x 11.7	15.000	3.400	0.400	0.650	0.650	0.400	0.500	0.240	12.4	9.96	315	42.0	5.62	8.13	3.11	0.90	0.79
C 15 x 17.3	15.000	3.716	0.400	0.650	0.650	0.716	0.500	0.240	12.4	14.7	404	53.8	5.24	11.0	3.78	0.87	0.80

1. Users are encouraged to check availability with suppliers.

2. Tolerances for extruded shapes are given in *Aluminum Standards and Data*.

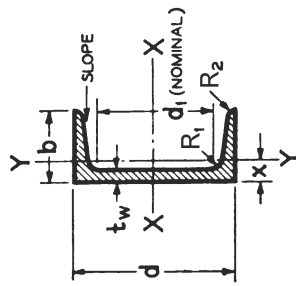


Table 6
CAR AND SHIPBUILDING CHANNELS

Designation	Depth d in.	Width b in.	Avg Flange Thickness t_f in.	Web Thickness t_w in.	Flange Slope	Fillet Radius R_1 in.	Tip Radius R_2 in.	d_1 in.	Area A in ²	Axis x-x			Axis y-y			
										I_x in. ⁴	S_x in. ³	r_x in.	I_y in. ⁴	S_y in. ³	r_y in.	x in.
CS 3 × 2.23	3.000	2.000	0.320	0.250	1:12.1	0.250	0	1.75	1.90	2.61	1.74	1.17	0.68	0.52	0.60	0.68
CS 3 × 2.70	3.000	2.000	0.375	0.375	0	0.188	0.375	0.875	2.30	2.89	1.92	1.12	0.78	0.59	0.58	0.67
CS 4 × 3.32	4.000	2.500	0.344	0.318	1:34.9	0.375	0.125	2.38	2.82	6.84	3.42	1.56	1.62	0.95	0.76	0.81
CS 5 × 5.82	5.000	2.875	0.562	0.438	1:9.8	0.250	0.094	3.00	4.95	18.1	7.25	1.91	3.57	1.87	0.85	0.96
CS 6 × 5.77	6.000	3.000	0.375	0.500	0	0.375	0.250	4.50	4.91	24.1	8.02	2.21	3.52	1.61	0.85	0.81
CS 6 × 5.93	6.000	3.500	0.442	0.375	1:49.6	0.480	0.420	4.00	5.04	28.2	9.41	2.37	5.58	2.31	1.05	1.09
CS 8 × 6.59	8.000	3.000	0.468	0.380	1:14.43	0.550	0.220	5.75	5.60	54.2	13.5	3.11	4.10	1.88	0.86	0.81
CS 8 × 7.86	8.000	3.500	0.524	0.425	1:28.5	0.525	0.375	5.75	6.68	63.8	15.9	3.09	7.06	2.84	1.03	1.01
CS 10 × 8.58	10.000	3.500	0.544	0.375	1:9	0.625	0.188	7.50	7.30	110	21.9	3.88	7.19	2.80	0.99	0.93
CS 10 × 9.32	10.000	3.563	0.544	0.438	1:9	0.625	0.188	7.50	7.93	115	24.0	3.81	7.73	2.93	0.99	0.92
CS 10 × 10.1	10.000	3.625	0.544	0.500	1:9	0.625	0.188	7.50	8.55	120	24.0	3.75	8.25	3.04	0.98	0.91

1. Users are encouraged to check availability with suppliers.

2. Tolerances for extruded shapes are given in *Aluminum Standards and Data*.