C7-8 formulas

Y-bar

$$y_c = \frac{\sum Ay}{A}$$

The moment of inertia I_c about the composite centroidal axis

$$I_c = I_x + Ad^2$$

C9-10 formulas (see C9-10 notes)

$$s = \frac{P}{A}$$

$$where\ s = stress, P = load, A = area$$

$$other\ forms: P = s_{all} * A; \quad A = \frac{P}{s_{all}} \quad note: \ s_{all} = allowable\ stress$$

$$\epsilon = \frac{\delta}{L}$$

$$\epsilon = strain, \ \ \delta = total\ deformation, \ \ L = original\ length$$

Hooke's law – Young's Modulus (i.e. modulus of elasticity, represented by E)

$$E = \frac{s}{\epsilon}$$

$$unit\ notes: \delta\ (inches), P\ (lb\ or\ kips), L\ (inches), A\ (in2), E\ (psi, ksi)$$

$$\delta = \frac{PL}{AE}$$

$$A = \frac{\pi d^2}{4}$$

APPENDIX C

Selected Channels: Dimensions and Properties

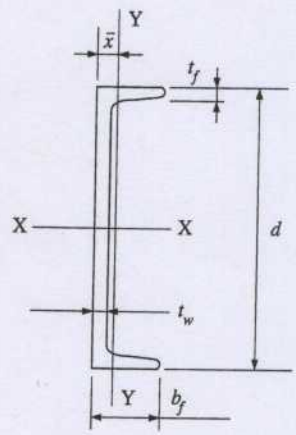

TABLE C-1 U.S. Customary

Designation	A in.^{2}	d in.	t_w in.	b_f in.	Avg. t_f in.	$\bar{x}$ in.	I_x in.^{4}	S_x in.^{3}	r_x in.	I_y in.^{4}	S_y in.^{3}	r_y in.
C15 × 50	14.7	15.00	0.716	3.716	0.650	0.798	404	53.8	5.24	11.0	3.78	0.867
C15 × 40	11.8	15.00	0.520	3.520	0.650	0.777	349	46.5	5.44	9.23	3.37	0.886
C12 × 30	8.82	12.00	0.510	3.170	0.501	0.674	162	27.0	4.29	5.14	2.06	0.763
C12 × 25	7.35	12.00	0.387	3.047	0.501	0.674	144	24.1	4.43	4.47	1.88	0.780
C12 × 20.7	6.09	12.00	0.282	2.942	0.501	0.698	129	21.5	4.61	3.88	1.73	0.799
C10 × 30	8.82	10.00	0.673	3.033	0.436	0.649	103	20.7	3.42	3.94	1.65	0.669
C10 × 20	5.88	10.00	0.379	2.739	0.436	0.606	78.9	15.8	3.66	2.81	1.32	0.692
C10 × 15.3	4.49	10.00	0.240	2.600	0.436	0.634	67.4	13.5	3.87	2.28	1.16	0.713
C6 × 10.5	3.09	6.00	0.314	2.034	0.343	0.499	15.2	5.06	2.22	0.866	0.564	0.529

TABLE C-2 SI

Designation mm × kg/m	A mm^2	d mm	b_f mm	Avg. t_f mm[a]	t_w mm[a]	$\bar{x}$ mm	I_x 10^6 mm^4	S_x 10^3 mm^3	r_x mm	I_y 10^6 mm^4	S_y 10^3 mm^3	r_y mm
C310 × 31	3930	305	74	12.7	7.2	17.6	53.1	348	117	1.58	28.0	20.1
C200 × 17	2180	203	57	9.9	5.6	14.5	13.34	131.5	78.7	0.544	12.79	15.9
C130 × 13	1700	127	47	8.1	8.3	12.0	3.62	57.0	46.4	0.252	7.19	12.2

[a]Flange and web thicknesses may vary due to mill rolling practices.

APPENDIX D

Selected Angles: Properties for Designing

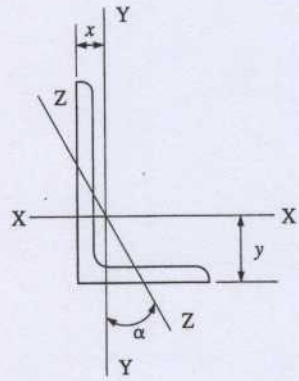

TABLE D-1 U.S. Customary

Designation	Wt. lb/ft	A in.^{2}	I_x in.^{4}	S_x in.^{3}	r_x in.	y in.	I_y in.^{4}	S_y in.^{3}	r_y in.	x in.	r_z in.	Tan α
L6 × 6 × 1	37.4	11.0	35.5	8.57	1.80	1.86	35.5	8.57	1.80	1.86	1.17	1.000
L6 × 4 × 3/4	23.6	6.94	24.5	6.25	1.88	2.08	8.68	2.97	1.12	1.08	0.860	0.428
L6 × 4 × 3/8	12.3	3.61	13.5	3.32	1.93	1.94	4.90	1.60	1.17	0.941	0.877	0.446
L5 × 5 × 1/2	16.2	4.75	11.3	3.16	1.54	1.43	11.3	3.16	1.54	1.43	0.983	1.000
L4 × 4 × 3/8	9.8	2.86	4.36	1.52	1.23	1.14	4.36	1.52	1.23	1.14	0.788	1.000
L4 × 3 × 1/4	5.8	1.69	2.77	1.00	1.28	1.24	1.36	0.599	0.896	0.736	0.651	0.558
L$2\frac{1}{2} \times 2\frac{1}{2} \times 1/4$	4.1	1.19	0.703	0.394	0.769	0.717	0.703	0.394	0.769	0.717	0.491	1.000

TABLE D-2 SI

Designation mm × mm × mm	Mass kg/m	A mm^2	I_x 10^6 mm^4	S_x 10^3 mm^3	r_x mm	y mm	I_y 10^6 mm^4	S_y 10^3 mm^3	r_y mm	x mm
L127 × 89 × 12.7	20.2	2580	4.16	49.0	40.1	42.1	1.691	25.6	25.6	23.1
L102 × 76 × 6.4	8.6	1090	1.17	16.6	32.7	31.6	0.564	9.83	22.7	18.6
L64 × 64 × 6.4	6.1	768	0.302	6.62	19.7	18.4	0.302	6.62	19.7	18.4

C9 notes:

$$s = \frac{P}{A}$$

$$where\ s = stress, P = load, A = area$$

$$other\ forms: P = s_{all} * A; \quad A = \frac{P}{s_{all}} \quad note:\ s_{all} = allowable\ stress$$

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$$\delta = \frac{PL}{AE}$$

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C10 terminology...

Nominal stress/nominal strain

Proportional limit/elastic limit

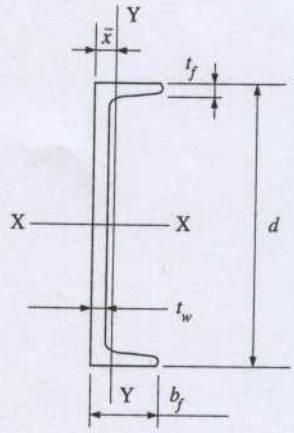
Yield stress/ultimate strength/plastic range/necking/rupture strength/true stress

Stiffness/strength/elasticity/ductility/brittleness/malleability/toughness/resilience

Factor of safety

APPENDIX C

Selected Channels: Dimensions and Properties



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C10 × 15.3	4.49	10.00	0.240	2.600	0.436	0.634	67.4	13.5	3.87	2.28	1.16	0.713
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TABLE C-2 SI

Designation mm × kg/m	A mm^2	d mm	b_f mm	Avg. t_f mm[a]	t_w mm[a]	$\bar{x}$ mm	I_x 10^6 mm^4	S_x 10^3 mm^3	r_x mm	I_y 10^6 mm^4	S_y 10^3 mm^3	r_y mm
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C200 × 17	2180	203	57	9.9	5.6	14.5	13.34	131.5	78.7	0.544	12.79	15.9
C130 × 13	1700	127	47	8.1	8.3	12.0	3.62	57.0	46.4	0.252	7.19	12.2

[a]Flange and web thicknesses may vary due to mill rolling practices.

APPENDIX D

Selected Angles: Properties for Designing

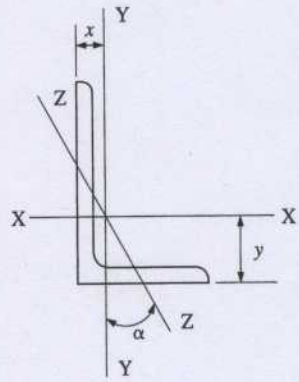

TABLE D-1 U.S. Customary

Designation	Wt. lb/ft	A in.^{2}	I_x in.^{4}	S_x in.^{3}	r_x in.	y in.	I_y in.^{4}	S_y in.^{3}	r_y in.	x in.	r_z in.	Tan α
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L6 × 4 × 3/4	23.6	6.94	24.5	6.25	1.88	2.08	8.68	2.97	1.12	1.08	0.860	0.428
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L5 × 5 × 1/2	16.2	4.75	11.3	3.16	1.54	1.43	11.3	3.16	1.54	1.43	0.983	1.000
L4 × 4 × 3/8	9.8	2.86	4.36	1.52	1.23	1.14	4.36	1.52	1.23	1.14	0.788	1.000
L4 × 3 × 1/4	5.8	1.69	2.77	1.00	1.28	1.24	1.36	0.599	0.896	0.736	0.651	0.558
L$2\frac{1}{2} \times 2\frac{1}{2} \times 1/4$	4.1	1.19	0.703	0.394	0.769	0.717	0.703	0.394	0.769	0.717	0.491	1.000

TABLE D-2 SI

Designation mm × mm × mm	Mass kg/m	A mm^2	I_x 10^6 mm^4	S_x 10^3 mm^3	r_x mm	y mm	I_y 10^6 mm^4	S_y 10^3 mm^3	r_y mm	x mm
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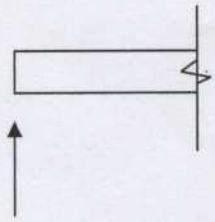
L64 × 64 × 6.4	6.1	768	0.302	6.62	19.7	18.4	0.302	6.62	19.7	18.4

Formulas for C13-14-15

C13

Notes: shear (V) is positive if load tends to lift left edge of beam upward with respect to right edge



Appendix H abridged…

Simple beam – distributed load ***w***

Bending moment max

$$M = \frac{wl^2}{8}$$

Delta max

$$\Delta = \frac{5wl^4}{384EI}$$

Simple beam – concentrated load **P** at center

Bending moment max

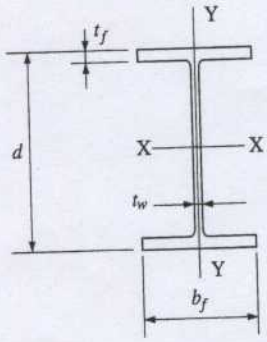
$$M = \frac{Pl}{4}$$

Delta max

$$\Delta = \frac{Pl^3}{48EI}$$

APPENDIX A

Selected W Shapes: Dimensions and Properties



BLE A-1 U.S. Customary

Designation	A in.^{2}	d in.	t_w in.	b_f in.	t_f in.	I_x in.^{4}	S_x in.^{3}	r_x in.	Z_x in.^{3}	I_y in.^{4}	S_y in.^{3}	r_y in.
W40 × 268	78.8	39.37	0.750	17.750	1.415	21500	1090	16.5	1220	1320	149	4.09
W36 × 300	88.3	36.74	0.945	16.655	1.680	20300	1110	15.2	1260	1300	156	3.83
W36 × 194	57.0	36.49	0.765	12.115	1.260	12100	664	14.6	767	375	61.9	2.56
W36 × 150	44.2	35.85	0.625	11.975	0.940	9040	504	14.3	581	270	45.1	2.47
W33 × 118	34.7	32.86	0.550	11.480	0.740	5900	359	13.0	415	187	32.6	2.32
W30 × 108	31.7	29.83	0.545	10.475	0.760	4470	299	11.9	346	146	27.9	2.15
W30 × 99	29.1	29.65	0.520	10.450	0.670	3990	269	11.7	312	128	24.5	2.10
W27 × 114	33.5	27.29	0.570	10.070	0.930	4090	299	11.0	343	159	31.5	2.18
W27 × 94	27.7	26.92	0.490	9.990	0.745	3270	243	10.9	278	124	24.8	2.12
W24 × 162	47.7	25.00	0.705	12.955	1.220	5170	414	10.4	468	443	68.4	3.05
W24 × 104	30.6	24.06	0.500	12.750	0.750	3100	258	10.1	289	259	40.7	2.91
W24 × 84	24.7	24.10	0.470	9.020	0.770	2370	196	9.79	224	94.4	20.9	1.95
W24 × 76	22.4	23.92	0.440	8.990	0.680	2100	176	9.69	200	82.5	18.4	1.92
W21 × 83	24.3	21.43	0.515	8.355	0.835	1830	171	8.67	196	81.4	19.5	1.83
W21 × 73	21.5	21.24	0.455	8.295	0.740	1600	151	8.64	172	70.6	17.0	1.81
W21 × 62	18.3	20.99	0.400	8.240	0.615	1330	127	8.54	144	57.5	13.9	1.77
W21 × 50	14.7	20.83	0.380	6.530	0.535	984	94.5	8.18	110	24.9	7.64	1.30
W18 × 71	20.8	18.47	0.495	7.635	0.810	1170	127	7.50	145	60.3	15.8	1.70
W18 × 60	17.6	18.24	0.415	7.555	0.695	984	108	7.47	123	50.1	13.3	1.69
W18 × 50	14.7	17.99	0.355	7.495	0.570	800	88.9	7.38	101	40.1	10.7	1.65
W18 × 40	11.8	17.90	0.315	6.015	0.525	612	68.4	7.21	78.4	19.1	6.35	1.27