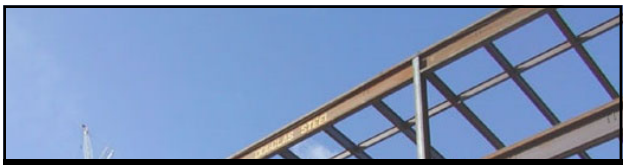

Chapter 4
Compression Members

1

Chapter 4 – Tables for Members

- The ***Manual*** contains many useful tables for analysis and design.
- For compression members whose strength is governed by ***flexural buckling*** (that is, not ***local buckling***), **Table 4-14** in Part 4 of the Manual, "Design of Compression Members," can be used.
- This table gives values of $\phi_c F_n$ (for ***LRFD***) and F_n/Ω_c (for ***ASD***) as a function of L_c/r for various values of F_y.
- This table stops at the recommended upper limit of $L_c/r = 200$.

2

Chapter 4 – Tables for Members

Table 4-14
Available Nominal Stress for Compression Members

L_c/r	F_y = 35 ksi		F_y = 36 ksi		F_y = 46 ksi		F_y = 50 ksi		F_y = 65 ksi		F_y = 70 ksi	
	F_n/Ω_c ksi	$\phi_c F_n$ ksi	F_n/Ω_c ksi	$\phi_c F_n$ ksi	F_n/Ω_c ksi	$\phi_c F_n$ ksi	F_n/Ω_c ksi	$\phi_c F_n$ ksi	F_n/Ω_c ksi	$\phi_c F_n$ ksi	F_n/Ω_c ksi	$\phi_c F_n$ ksi
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
1	21.0	31.5	21.6	32.4	27.5	41.4	29.9	45.0	38.9	58.5	41.9	63.0
2	21.0	31.5	21.6	32.4	27.5	41.4	29.9	45.0	38.9	58.5	41.9	63.0
3	20.9	31.5	21.5	32.4	27.5	41.4	29.9	45.0	38.9	58.4	41.9	62.9
4	20.9	31.5	21.5	32.4	27.5	41.4	29.9	44.9	38.9	58.4	41.8	62.9
5	20.9	31.5	21.5	32.4	27.5	41.3	29.9	44.9	38.8	58.4	41.8	62.8
6	20.9	31.4	21.5	32.3	27.5	41.3	29.9	44.9	38.8	58.3	41.8	62.8
7	20.9	31.4	21.5	32.3	27.5	41.3	29.8	44.8	38.7	58.2	41.7	62.7
8	20.9	31.4	21.5	32.3	27.4	41.2	29.8	44.8	38.7	58.1	41.6	62.6
9	20.9	31.4	21.5	32.3	27.4	41.2	29.8	44.7	38.6	58.1	41.6	62.5
10	20.9	31.3	21.4	32.2	27.4	41.1	29.7	44.7	38.6	57.9	41.5	62.4
11	20.8	31.3	21.4	32.2	27.3	41.1	29.7	44.6	38.5	57.8	41.4	62.2
12	20.8	31.3	21.4	32.2	27.3	41.0	29.6	44.5	38.4	57.7	41.3	62.1
13	20.8	31.2	21.4	32.1	27.2	40.9	29.6	44.4	38.3	57.6	41.2	61.9
14	20.7	31.2	21.3	32.1	27.2	40.9	29.5	44.4	38.2	57.4	41.1	61.7
15	20.7	31.1	21.3	32.0	27.1	40.8	29.5	44.3	38.1	57.3	41.0	61.6
16	20.7	31.1	21.3	32.0	27.1	40.7	29.4	44.2	38.0	57.1	40.8	61.4
17	20.7	31.0	21.2	31.9	27.0	40.6	29.3	44.1	37.9	56.9	40.7	61.2
18	20.6	31.0	21.2	31.9	27.0	40.5	29.2	43.9	37.7	56.7	40.5	60.9

3

Chapter 4 – Tables for Members

- The available strength tables, however, are the ***most useful***.
- These tables, which we will refer to as the "***column load tables***," give the available strengths of selected shapes, both $\phi_c F_n$ (for ***LRFD***) and F_n/Ω_c (for ***ASD***), as a function of the effective length L_c.
- There are three tables for ***W-shapes***:

  Table 4-1a gives compressive strengths for F_y = 50 *ksi*,

  Table 4-1b is for F_y = 65 *ksi*, and

  Table 4-1c is for F_y = 70 *ksi*.

4

Chapter 4 – Tables for Members

Table 4-1a
Available Strength in Axial Compression, kips
W-Shapes
F_y = 50 ksi

W14

Shape		W14×							
lb/ft		873[h]		808[h]		730[h]		665[h]	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length, L_c (ft), with respect to least radius of gyration, r_y	0	7690	11600	7130	10700	6440	9670	5870	8820
	11	7300	11000	6750	10100	6070	9130	5530	8310
	12	7220	10900	6680	10000	6010	9030	5470	8220
	13	7140	10700	6600	9920	5940	8920	5400	8110
	14	7060	10600	6520	9800	5860	8810	5330	8010
	15	6970	10500	6440	9680	5780	8690	5250	7890
	16	6880	10300	6350	9540	5690	8560	5170	7770
	17	6780	10200	6250	9400	5610	8430	5090	7650
	18	6680	10000	6160	9250	5510	8290	5000	7520
	19	6570	9870	6050	9100	5420	8140	4910	7380
	20	6460	9700	5950	8940	5320	7990	4820	7240
	22	6220	9350	5730	8610	5110	7670	4620	6950
	24	5980	8980	5490	8260	4890	7340	4420	6640
	26	5720	8600	5250	7890	4660	7000	4200	6320
	28	5460	8200	5000	7520	4420	6650	3990	5990
	30	5190	7790	4750	7130	4180	6290	3760	5660
	32	4910	7380	4490	6750	3940	5930	3540	5320
	34	4630	6970	4230	6360	3700	5560	3320	4990
	36	4360	6550	3970	5970	3460	5200	3100	4650
	38	4080	6140	3710	5580	3220	4850	2880	4330
	40	3810	5730	3460	5200	2990	4500	2670	4010
	42	3550	5340	3210	4830	2770	4160	2460	3690
	44	3290	4950	2970	4470	2550	3830	2260	3390
	46	3040	4570	2740	4120	2330	3510	2060	3100
	48	2800	4200	2520	3780	2140	3220	1900	2850
	50	2580	3870	2320	3480	1970	2970	1750	2630

5

Chapter 4 – Tables for Members

Table 4-1a
Available Strength in Axial Compression, kips
W-Shapes
F_y = 50 ksi

W14

Shape		W14×							
lb/ft		873[h]		808[h]		730[h]		665[h]	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length, L_c (ft), with respect to least radius of gyration, r_y	0	7690	11600	7130	10700	6440	9670	5870	8820
	11	7300	11000	6750	10100	6070	9130	5530	8310
	12	7220	10900	6680	10000	6010	9030	5470	8220
	13	7140	10700	6600	9920	5940	8920	5400	8110
	14	7060	10600	6520	9800	5860	8810	5330	8010
	15	6970	10500	6440	9680	5780	8690	5250	7890
	16	6880	10300	6350	9540	5690	8560	5170	7770
	17	6780	10200	6250	9400	5610	8430	5090	7650
	18	6680	10000	6160	9250	5510	8290	5000	7520
	19	6570	9870	6050	9100	5420	8140	4910	7380
	20	6460	9700	5950	8940	5320	7990	4820	7240
	22	6220	9350	5730	8610	5110	7670	4620	6950
	24	5980	8980	5490	8260	4890	7340	4420	6640
	26	5720	8600	5250	7890	4660	7000	4200	6320
	28	5460	8200	5000	7520	4420	6650	3990	5990
	30	5190	7790	4750	7130	4180	6290	3760	5660
	32	4910	7380	4490	6750	3940	5930	3540	5320
	34	4630	6970	4230	6360	3700	5560	3320	4990
	36	4360	6550	3970	5970	3460	5200	3100	4650
	38	4080	6140	3710	5580	3220	4850	2880	4330
	40	3810	5730	3460	5200	2990	4500	2670	4010
	42	3550	5340	3210	4830	2770	4160	2460	3690
	44	3290	4950	2970	4470	2550	3830	2260	3390
	46	3040	4570	2740	4120	2330	3510	2060	3100
	48	2800	4200	2520	3780	2140	3220	1900	2850
	50	2580	3870	2320	3480	1970	2970	1750	2630

6

Chapter 4 – Tables for Members

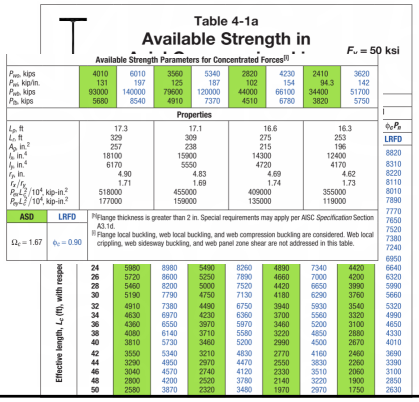

Table 4-1a
Available Strength in
$F_y = 50$ ksi

Available Strength Parameters for Concentrated Forces[f]

P_{wo}, kips	4010	6010	3560	5340	2820	4230	2410	3620
P_{wo}, kip/in.	131	197	125	187	102	154	94.3	142
P_{wb}, kips	93000	140000	79600	120000	44000	66100	34400	51700
P_{bb}, kips	5660	8540	4910	7370	4510	6780	3820	5750

Properties

L_p, ft	17.3	17.1	16.6	16.3
L_r, ft	329	309	275	253
A_g, in.^{2}	257	238	215	196
I_x, in.^{4}	18100	15900	14300	12400
I_y, in.^{4}	6170	5550	4720	4170
r_y, in.	4.90	4.83	4.69	4.62
r_z/r_y	1.71	1.69	1.74	1.73
$B_{pz}L_p^2/10^4$, kip-in.^{2}	518000	455000	409000	355000
$B_{pz}L_r^2/10^4$, kip-in.^{2}	177000	159000	135000	119000

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.90$

[f] If flange thickness is greater than 2 in. Special requirements may apply per AISC *Specification* Section A3.1d.
[g] Flange local buckling, web local buckling, and web compression buckling are considered. Web local crippling, web sidesway buckling, and web panel zone shear are not addressed in this table.

Effective length, L_c (ft), with respect	$\phi_c P_n$ LRFD							
24	5980	8980	5490	8260	4890	7340	4420	6640
26	5720	8600	5250	7890	4680	7000	4200	6320
28	5460	8200	5000	7520	4420	6650	3990	5990
30	5190	7790	4750	7130	4180	6290	3760	5660
32	4910	7380	4490	6750	3940	5930	3540	5320
34	4630	6970	4230	6360	3700	5560	3320	4990
36	4360	6550	3970	5970	3460	5200	3100	4650
38	4080	6140	3710	5580	3220	4850	2880	4330
40	3810	5730	3460	5200	2990	4500	2670	4010
42	3550	5340	3210	4830	2770	4160	2460	3690
44	3290	4950	2970	4470	2550	3830	2260	3390
46	3040	4570	2740	4120	2330	3510	2060	3100
48	2800	4200	2520	3780	2140	3220	1900	2850
50	2580	3870	2320	3480	1970	2970	1750	2630

7

Chapter 4 – Tables for Members

- **Example 4-5**: Compute the available strength of the compression member of **Example 4.2** with the aid of **Table 4-14** from Part 4 of the ***Manual***.
- A **W14 x 53** of **A992** steel (F_y=50 *ksi* and F_u=65 *ksi*) has a length of 15 *ft*, and the ends are pinned.

$$L_c = 1.0(15\,ft)(12\,in/ft) = 180\,in$$

$$\frac{L_c}{r} = \frac{180\,in}{1.92\,in} = 93.75$$

$$A_g = 15.6\,in^2$$

8

Chapter 4 – Tables for Members

- **Example 4-5**: Compute the available strength of the compression member of **Example 4.2** with the aid of **Table 4-14** from Part 4 of the ***Manual***.
- ***LRFD*** solution:

$$\frac{L_c}{r} = 93.75$$

$$F_y = 50\,ksi$$

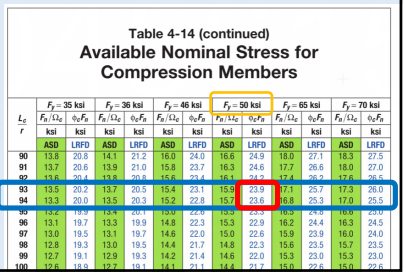

Table 4-14 (continued)
Available Nominal Stress for Compression Members

L_c/r	F_y = 35 ksi F_n/Ω_c ASD	F_y = 35 ksi $\phi_c F_n$ LRFD	F_y = 36 ksi F_n/Ω_c ASD	F_y = 36 ksi $\phi_c F_n$ LRFD	F_y = 46 ksi F_n/Ω_c ASD	F_y = 46 ksi $\phi_c F_n$ LRFD	F_y = 50 ksi F_n/Ω_c ASD	F_y = 50 ksi $\phi_c F_n$ LRFD	F_y = 65 ksi F_n/Ω_c ASD	F_y = 65 ksi $\phi_c F_n$ LRFD	F_y = 70 ksi F_n/Ω_c ASD	F_y = 70 ksi $\phi_c F_n$ LRFD
	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi
90	13.8	20.8	14.1	21.2	16.0	24.0	16.6	24.9	18.0	27.1	18.3	27.5
91	13.7	20.6	13.9	21.0	15.8	23.7	16.3	24.6	17.7	26.6	18.0	27.0
92	13.6	20.4	13.8	20.8	15.6	23.4	16.1	24.2	17.4	26.2	17.8	26.5
93	13.5	20.2	13.7	20.5	15.4	23.1	15.9	23.9	17.1	25.7	17.3	26.0
94	13.3	20.0	13.5	20.3	15.2	22.8	15.7	23.6	16.8	25.3	17.0	25.5
95	13.2	19.9	13.4	20.1	15.0	22.6	15.5	23.3	16.5	24.9	16.8	25.0
96	13.1	19.7	13.3	19.9	14.8	22.3	15.3	22.9	16.2	24.4	16.3	24.5
97	13.0	19.5	13.1	19.7	14.6	22.0	15.0	22.6	15.9	23.9	16.0	24.0
98	12.8	19.3	13.0	19.5	14.4	21.7	14.8	22.3	15.6	23.5	15.7	23.5
99	12.7	19.1	12.9	19.3	14.2	21.4	14.6	22.0	15.3	23.0	15.3	23.0
100	12.6	18.9	12.7	19.1	14.1	21.1	14.4	21.7	15.0	22.6	15.0	22.6

9

Chapter 4 – Tables for Members

- **Example 4-5**: For uniformity, we use interpolation in this course for all tables where it is valid unless otherwise indicated.

$$\frac{L_c}{r} = 93.75 \quad \therefore \; 23.9 + (23.6 - 23.9)0.75 = 23.68$$

$$\phi_c F_{cr} = 23.68\,ksi$$

$$\phi_c P_n = \phi_c F_{cr} A_g$$

$$= 23.68\,ksi\,(15.6\,in^2)$$

$$= 369.41k$$

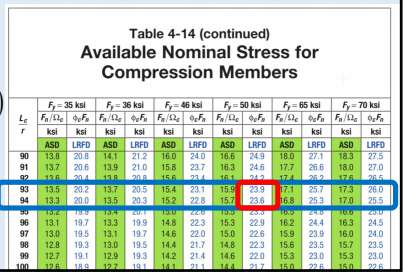

Table 4-14 (continued)
Available Nominal Stress for Compression Members

L_c/r	F_y = 35 ksi F_n/Ω_c ASD	F_y = 35 ksi $\phi_c F_n$ LRFD	F_y = 36 ksi F_n/Ω_c ASD	F_y = 36 ksi $\phi_c F_n$ LRFD	F_y = 46 ksi F_n/Ω_c ASD	F_y = 46 ksi $\phi_c F_n$ LRFD	F_y = 50 ksi F_n/Ω_c ASD	F_y = 50 ksi $\phi_c F_n$ LRFD	F_y = 65 ksi F_n/Ω_c ASD	F_y = 65 ksi $\phi_c F_n$ LRFD	F_y = 70 ksi F_n/Ω_c ASD	F_y = 70 ksi $\phi_c F_n$ LRFD
	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi
90	13.8	20.8	14.1	21.2	16.0	24.0	16.6	24.9	18.0	27.1	18.3	27.5
91	13.7	20.6	13.9	21.0	15.8	23.7	16.3	24.6	17.7	26.6	18.0	27.0
92	13.6	20.4	13.8	20.8	15.6	23.4	16.1	24.2	17.4	26.2	17.8	26.5
93	13.5	20.2	13.7	20.5	15.4	23.1	15.9	23.9	17.1	25.7	17.3	26.0
94	13.3	20.0	13.5	20.3	15.2	22.8	15.7	23.6	16.8	25.3	17.0	25.5
95	13.2	19.9	13.4	20.1	15.0	22.6	15.5	23.3	16.5	24.9	16.8	25.0
96	13.1	19.7	13.3	19.9	14.8	22.3	15.3	22.9	16.2	24.4	16.3	24.5
97	13.0	19.5	13.1	19.7	14.6	22.0	15.0	22.6	15.9	23.9	16.0	24.0
98	12.8	19.3	13.0	19.5	14.4	21.7	14.8	22.3	15.6	23.5	15.7	23.5
99	12.7	19.1	12.9	19.3	14.2	21.4	14.6	22.0	15.3	23.0	15.3	23.0
100	12.6	18.9	12.7	19.1	14.1	21.1	14.4	21.7	15.0	22.6	15.0	22.6

10

Chapter 4 – Tables for Members

- The column load tables in **Part 4 of the Manual** give the available strength for selected W-, HP-, single-angle, WT-, HSS, pipe, and double-angle shapes.
- The tabular values for the ***symmetrical shapes*** (W, HP, HSS, and pipe) were calculated by using the ***minimum radius of gyration*** for each shape.

11

Chapter 4 – Tables for Members

- Recall **Example 4-2**: A **W14 x 53** of **A992** steel (F_y=50 *ksi* and F_u=65 *ksi*) has a length of 15 *ft*, and the ends are pinned.
- In this example, K = 1.0, so $L_c = 1.0(15\,ft) = 15\,ft$

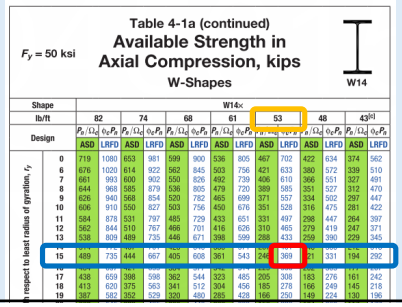

Table 4-1a (continued)
Available Strength in Axial Compression, kips
W-Shapes
F_y = 50 ksi
W14

Shape	W14×											
lb/ft	82		74		68		61		53		48	
Design	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	719	1080	653	981	599	900	536	805	467	702	422	634
6	676	1020	614	922	562	845	503	756	421	633	380	572
7	661	993	600	902	550	826	492	739	406	610	366	551
8	644	968	585	879	536	805	479	720	389	585	351	527
9	626	940	568	854	520	782	465	699	371	557	334	502
10	606	910	550	827	503	756	450	676	351	528	316	475
11	584	878	531	797	485	729	433	651	331	497	298	447
12	562	844	510	767	466	701	416	626	310	465	279	419
13	538	809	489	735	446	671	398	599	288	433	259	390
15	489	735	444	667	405	608	361	543	246	369	221	331
17	438	659	398	598	362	544	323	485	205	308	183	276
18	413	620	375	563	341	512	304	456	185	278	166	249
19	387	583	352	529	320	480	285	428	166	250	149	224

$\phi_c P_n = 369k$

12

Chapter 4 – Tables for Members

- The values from **Table 4-14** are based on flexural buckling and ***AISC Equations E3-2 and E3-3***.
- Thus, ***local stability is assumed***, and width-thickness ratio limits must not be exceeded.
- Although some shapes in the column load tables exceed those limits (and they are identified with a ***"c" footnote***), the tabulated strength has been computed according to the requirements of AISC Section E7, "Members with Slender Elements," and no further reduction is needed.
- From a practical standpoint, if a compression member can be ***found in the column load tables***, then these ***tables should be used***.

13

Chapter 4 – Tables for Members

Let's work on some problems

14

Chapter 4 – Tables for Members

Any questions?

15