

What are the different Design Tables

For Compression Members based

on CM # 14

CM # 15 ?

Solve Example 4-5 \rightarrow Table 4-22
For W section CM # 14.

\downarrow Solve Example 4-5 \rightarrow Table 4-1
CM # 14

CM # 14

AISC - 360 - 10

DESIGN TABLE DISCUSSION

Steel Compression—Member Selection Tables

Table 4-1-CM#14

Table 4-1. W-Shapes in Axial Compression

Available strengths in axial compression are given for W-shapes with $F_y = 50$ ksi (ASTM A992). The tabulated values are given for the effective length with respect to the y-axis $(KL)_y$. However, the effective length with respect to the x-axis $(KL)_x$ must also be investigated. To determine the available strength in axial compression, the table should be entered at the larger of $(KL)_y$ and $(KL)_y eq$, where

$$(KL)_{y eq} = \frac{(KL)_x}{\frac{r_x}{r_y}}$$

How do we drive ?

→ $\frac{(KL)_x}{r_x} \left(\frac{r_y}{r_x} \right)$

Multiply by $\frac{r_y}{r_x}$

(4-1)

⇒ $\frac{(KL)_x}{\left(\frac{r_x}{r_y} \right)} \cdot \frac{1}{r_y}$
→ $\frac{(KL)_y}{r_y}$

Compare with

$$(KL)_{y eq} = \frac{(KL)_x}{\frac{r_x}{r_y}}$$

Values of the ratio r_x/r_y and other properties useful in the design of W-shape compression members are listed at the bottom of Table 4-1.

Values of the ratio r_x/r_y and other properties useful in the design of W-shape compression members are listed at the bottom of Table 4-1.

Table 4-1. Available Strength in Axial Compression— W-Shapes

CM#15
AISC-360-16

Available strengths in axial compression are given for W-shapes in Tables 4-1a, 4-1b and 4-1c. The tables reflect $F_y = 50$ ksi (ASTM A992 and ASTM A913 where applicable), $F_y = 65$ ksi (ASTM A913) and $F_y = 70$ ksi (ASTM A913), respectively. These tables include W-shapes that are most commonly used in axial compression, and do not reflect the complete range of sections available in the relevant F_y . Available strengths in axial compression for all W-shapes, including those not shown in Table 4-1, are presented in Table 6-2 for $F_y = 50$ ksi.

The tabulated values are given for the effective length with respect to the y -axis, L_{cy} . However, the effective length with respect to the x -axis, L_{cx} , must also be investigated. To determine the available strength in axial compression, the table should be entered at the larger of L_{cy} and $L_{cy\ eq}$, where

$L_{cy} \Rightarrow$ instead of $(K L)_y$

Table 4-1-CM#15

Prepared by Eng. Maged Kamel.

CM # 14 - 2010

Table 4-22. Available Critical Stress for Compression Members

Table 4-22 provides the available critical stress for various ratios of Kl/r , for materials with a minimum specified yield strength of 35 ksi, 36 ksi, 42 ksi, 46 ksi and 50 ksi.

There is no Table 4-22 CM # 15 - 2016

In Table 4-22 Use (KL) For the bigger value of $(KL)_x$ } $(KL)_y$ } \Rightarrow get stress
 \downarrow
Multiply by Area
to get available strength

Table 4-14. Square HSS Filled with 4-ksi Normal Weight Concrete in Axial Compression

Table 4-14 is the same as Table 4-13, except that it provides available strengths in axial compression for square HSS filled with 4-ksi normal weight concrete.



New

I_p stiffness reduction Factor

Table 4-14. Available Critical Stress for Compression Members

Table 4-14 provides the available critical stress for various ratios of L_c/r , for materials with a specified minimum yield strength of 35 ksi, 36 ksi, 46 ksi, 50 ksi, 65 ksi and 70 ksi.

⇒ in lieu of Table 4-22

Table 4-14-Square HSS

EXAMPLE 4.5

Solved problem-4.5-w14x74

Compute the available strength of the compression member of Example 4.2 with the aid of (a) Table 4-22 from Part 4 of the *Manual* and (b) the column load tables.

LRFD SOLUTION

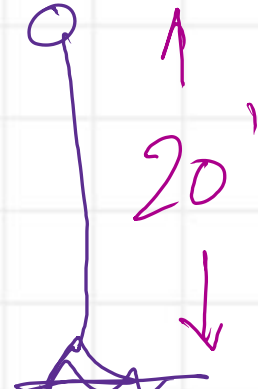
- a. From Example 4.2, $KL/r = 96.77$ and $F_y = 50$ ksi. Values of $\phi_c F_{cr}$ in Table 4-22 are given only for integer values of KL/r ; for decimal values, KL/r may be rounded *up* or linear interpolation may be used. For uniformity, we use interpolation in this book for all tables unless otherwise indicated. For $KL/r = 96.77$ and $F_y = 50$ ksi,

Reminders of Example 4.2

W14x74
 $h = 20'$

$r_x = 6.04''$, $r_y = 2.48''$, $K_x = 1$
 $K_y = 1$

$(\frac{KL}{r})_x = \frac{1(20)(12)}{6.04} = 39.74$, $(\frac{KL}{r})_y = \frac{240}{2.48} = 96.77$



EXAMPLE 4.5

Use Table 4-1 for r_x/r_y

Fifth Edition \Rightarrow 4-22

Compute the available strength of the compression member of Example 4.2 with the aid of (a) Table 4-22 from Part 4 of the *Manual* and (b) the column load tables.

LRFD SOLUTION

- a. From Example 4.2, $KL/r = 96.77$ and $F_y = 50$ ksi. Values of $\phi_c F_{cr}$ in Table 4-22 are given only for integer values of KL/r ; for decimal values, KL/r may be rounded up or linear interpolation may be used. For uniformity, we use interpolation in this book for all tables unless otherwise indicated. For $KL/r = 96.77$ and $F_y = 50$ ksi,

4.1 Table

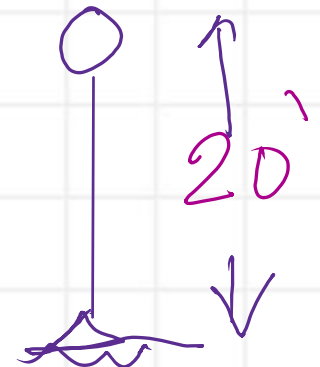
bigger $\frac{KL}{r} \rightarrow \left(\frac{KL}{r}\right)_x = 96.77 \Rightarrow$ Use Table 4-22
 CM # 14

$$\left(\frac{KL}{r}\right)_y = 39.74$$

For Table 4-1 Estimate

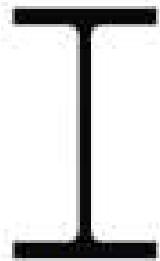
$$\left(\frac{KL}{r}\right)_y \text{ eq. } \rightarrow \left(\frac{KL}{r}\right)_x \left(\frac{r_x}{r_y}\right)$$

$$F_y = 50 \text{ ksi}$$



W14 x 74

$r_y = 2.48$



W14

Table 4-1 (continued)
Available Strength in Axial Compression, kips
W-Shapes

$F_y = 50$ ksi

Find r_x/r_y ratio

$(KL)_y = 20'$
 $(KL)_{y_{eq}} = \frac{(KL)_x}{\frac{r_x}{r_y}}$

$= \frac{20}{(2.44)}$

$(KL)_y_{eq} = 8.20'$

select

$\frac{r_x}{r_y} = 2.44$

bottom

Shape	W14x													
	82		74		68		61		53		48		43 ^a	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
P_{no} , kips	123	185	104	155	90.6	136	77.5	116	77.1	116	67.4	101	56.9	85.4
P_{nr} , kips/in.	17.0	25.5	15.0	22.5	13.8	20.8	12.5	18.9	12.3	18.5	11.3	17.0	10.2	15.3
P_{nt} , kips	201	302	138	207	108	163	80.1	120	76.7	115	59.5	89.5	43.0	64.7
P_{tt} , kips	137	206	115	173	97.0	146	77.8	117	81.5	123	66.2	99.6	52.6	79.0
L_p , ft	8.76		8.76		8.69		8.65		6.78		6.75		6.68	
L_r , ft	33.2		31.0		29.3		27.5		22.3		21.1		20.0	
A_g , in. ²	24.0		21.8		20.0		17.9		15.6		14.1		12.6	
I_x , in. ⁴	881		795		722		640		541		484		428	
I_y , in. ⁴	148		134		121		107		57.7		51.4		45.2	
r_y , in.	2.48		2.48		2.46		2.45		1.92		1.91		1.89	
r_x/r_y	2.44		2.44		2.44		2.44		3.07		3.06		3.08	
$P_{ex}(KL)^2/10^4$, k-in. ²	25200		22800		20700		18300		15500		13900		12300	
$P_{ey}(KL)^2/10^4$, k-in. ²	4240		3840		3460		3060		1650		1470		1290	
ASD	LRFD													
$\Omega_c = 1.67$	$\phi_c = 0.90$													

^a Shape is slender for compression with $F_y = 50$ ksi.
 Note: Heavy line indicates KL/r_y equal to or greater than 200.

a

Table 4-22 gives Factor $F_{cr} \left(\frac{KL}{r}\right)_y \Rightarrow 96.77$

Use table 4-22-LRFD stress

Available Critical Stress for Compression Members

$\left(\frac{KL}{r}\right)_y = \frac{20(12)}{2.48} = 96.77$

r_y between 96
97

$\phi_c F_{cr} = 22.90$
ksi

$\left(\frac{KL}{r}\right)_y = 96$

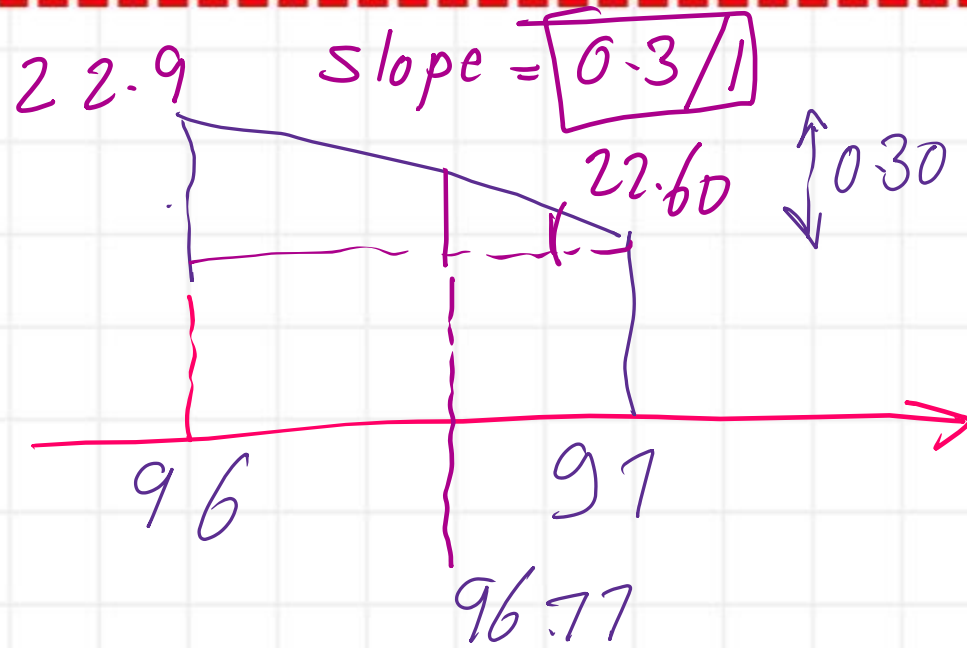
$\phi_c F_{cr} = 22.60$ ksi

$\left(\frac{KL}{r}\right)_y = 97$

$F_y = 35$ ksi			$F_y = 36$ ksi			$F_y = 42$ ksi			$F_y = 46$ ksi			$F_y = 50$ ksi		
$\frac{KL}{r}$	F_{cr}/Ω_c	$\phi_c F_{cr}$	$\frac{KL}{r}$	F_{cr}/Ω_c	$\phi_c F_{cr}$	$\frac{KL}{r}$	F_{cr}/Ω_c	$\phi_c F_{cr}$	$\frac{KL}{r}$	F_{cr}/Ω_c	$\phi_c F_{cr}$	$\frac{KL}{r}$	F_{cr}/Ω_c	$\phi_c F_{cr}$
	ksi	ksi		ksi	ksi		ksi	ksi		ksi	ksi		ksi	ksi
	ASD	LRFD		ASD	LRFD		ASD	LRFD		ASD	LRFD		ASD	LRFD
81	15.0	22.5	81	15.3	22.9	81	16.8	25.3	81	17.7	26.6	81	18.5	27.9
82	14.9	22.3	82	15.1	22.7	82	16.6	25.0	82	17.5	26.3	82	18.3	27.5
83	14.7	22.1	83	15.0	22.5	83	16.5	24.8	83	17.3	26.0	83	18.1	27.2
84	14.6	22.0	84	14.9	22.3	84	16.3	24.5	84	17.1	25.8	84	17.9	26.9
85	14.5	21.8	85	14.7	22.1	85	16.1	24.3	85	16.9	25.5	85	17.7	26.5
86	14.4	21.6	86	14.6	22.0	86	16.0	24.0	86	16.7	25.2	86	17.4	26.2
87	14.2	21.4	87	14.5	21.8	87	15.8	23.7	87	16.6	24.9	87	17.2	25.9
88	14.1	21.2	88	14.3	21.6	88	15.6	23.5	88	16.4	24.6	88	17.0	25.5
89	14.0	21.0	89	14.2	21.4	89	15.5	23.2	89	16.2	24.3	89	16.8	25.2
90	13.8	20.8	90	14.1	21.2	90	15.3	23.0	90	16.0	24.0	90	16.6	24.9
91	13.7	20.6	91	13.9	21.0	91	15.1	22.7	91	15.8	23.7	91	16.3	24.6
92	13.6	20.4	92	13.8	20.8	92	15.0	22.5	92	15.6	23.4	92	16.1	24.2
93	13.5	20.2	93	13.7	20.5	93	14.8	22.2	93	15.4	23.1	93	15.9	23.9
94	13.3	20.0	94	13.5	20.3	94	14.6	22.0	94	15.2	22.8	94	15.7	23.6
95	13.2	19.9	95	13.4	20.1	95	14.4	21.7	95	15.0	22.6	95	15.5	23.3
96	13.1	19.7	96	13.3	19.9	96	14.3	21.5	96	14.8	22.3	96	15.3	22.9
97	13.0	19.5	97	13.1	19.7	97	14.1	21.2	97	14.6	22.0	97	15.0	22.6
98	12.8	19.3	98	13.0	19.5	98	13.9	21.0	98	14.4	21.7	98	14.8	22.3
99	12.7	19.1	99	12.9	19.3	99	13.8	20.7	99	14.2	21.4	99	14.6	22.0
100	12.6	18.9	100	12.7	19.1	100	13.6	20.5	100	14.1	21.1	100	14.4	21.7



Prepared by Eng. Maged Kamel.



$\phi_c F_{cr} \Rightarrow$ Very Close to 22.60
 $\frac{(KL)_y}{r_y} = 96.77$

$\frac{(KL)_y}{r_y} \phi_c F_{cr} = 22.60 + (0.23)(0.30)$
 $\approx 22.67 \text{ ksi}$

We need $\phi_c F_{cr} (A_c)$ or $\phi_c P_n$

$\phi_c P_n = 22.67 (21.80) = 494.2$
 $\approx 494 \text{ kips}$

LRFD

CM # 14
AISC-360-16

Find LRFD design load

Prepared by Eng. Maged Kamel.

ASD

Stress

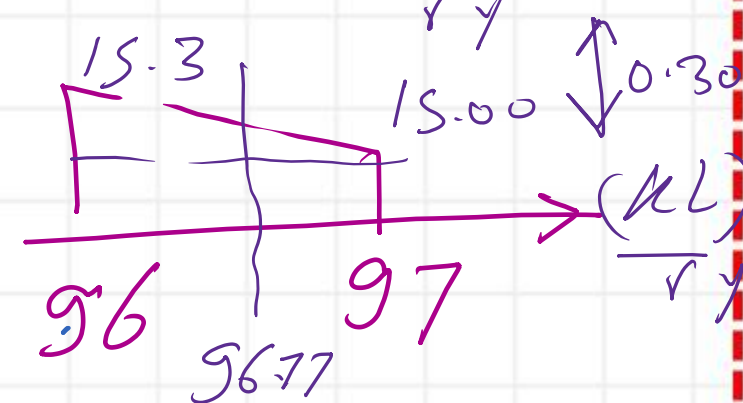
Area = $(\frac{KL}{r_y})^2 = 96.77 \rightarrow 96 \rightarrow 97$

Table 4-22 (continued) Available Critical Stress for Compression Members

Find stress value F_{cr}/Ω_c

$\frac{F_{cr}}{\Omega_c} = 15.3 \rightarrow (\frac{KL}{r_y})^2 = 96$

$\frac{F_{cr}}{\Omega_c} = 15.00 \rightarrow (\frac{KL}{r_y})^2 = 97$



$\frac{F_{cr}}{\Omega_c} = 15 + \frac{0.23}{1} (0.30)$
 $= 15.07 \text{ ksi}$

$\frac{F_{cr} A}{\Omega_c} = 15.07 (21.8)$
 $= 328.5 \text{ kips}$

F _y = 35 ksi			F _y = 36 ksi			F _y = 42 ksi			F _y = 46 ksi			F _y = 50 ksi		
KL/r	F _{cr} /Ω _c	φ _c F _{cr}	KL/r	F _{cr} /Ω _c	φ _c F _{cr}	KL/r	F _{cr} /Ω _c	φ _c F _{cr}	KL/r	F _{cr} /Ω _c	φ _c F _{cr}	KL/r	F _{cr} /Ω _c	φ _c F _{cr}
	ksi	ksi		ksi	ksi		ksi	ksi		ksi	ksi		ksi	ksi
	ASD	LRFD		ASD	LRFD		ASD	LRFD		ASD	LRFD		ASD	LRFD
81	15.0	22.5	81	15.3	22.9	81	16.8	25.3	81	17.7	26.6	81	18.5	27.9
82	14.9	22.3	82	15.1	22.7	82	16.6	25.0	82	17.5	26.3	82	18.3	27.5
83	14.7	22.1	83	15.0	22.5	83	16.5	24.8	83	17.3	26.0	83	18.1	27.2
84	14.6	22.0	84	14.9	22.3	84	16.3	24.5	84	17.1	25.8	84	17.9	26.9
85	14.5	21.8	85	14.7	22.1	85	16.1	24.3	85	16.9	25.5	85	17.7	26.5
86	14.4	21.6	86	14.6	22.0	86	16.0	24.0	86	16.7	25.2	86	17.4	26.2
87	14.2	21.4	87	14.5	21.8	87	15.8	23.7	87	16.6	24.9	87	17.2	25.9
88	14.1	21.2	88	14.3	21.6	88	15.6	23.5	88	16.4	24.6	88	17.0	25.5
89	14.0	21.0	89	14.2	21.4	89	15.5	23.2	89	16.2	24.3	89	16.8	25.2
90	13.8	20.8	90	14.1	21.2	90	15.3	23.0	90	16.0	24.0	90	16.6	24.9
91	13.7	20.6	91	13.9	21.0	91	15.1	22.7	91	15.8	23.7	91	16.3	24.6
92	13.6	20.4	92	13.8	20.8	92	15.0	22.5	92	15.6	23.4	92	16.1	24.2
93	13.5	20.2	93	13.7	20.5	93	14.8	22.2	93	15.4	23.1	93	15.9	23.9
94	13.3	20.0	94	13.5	20.3	94	14.6	22.0	94	15.2	22.8	94	15.7	23.6
95	13.2	19.9	95	13.4	20.1	95	14.4	21.7	95	15.0	22.6	95	15.5	23.3
96	13.1	19.7	96	13.3	19.9	96	14.3	21.5	96	14.8	22.3	96	15.3	22.9
97	13.0	19.5	97	13.1	19.7	97	14.1	21.2	97	14.6	22.0	97	15.0	22.6
98	12.8	19.3	98	13.0	19.5	98	13.9	21.0	98	14.4	21.7	98	14.8	22.3
99	12.7	19.1	99	12.9	19.3	99	13.8	20.7	99	14.2	21.4	99	14.6	22.0
100	12.6	18.9	100	12.7	19.1	100	13.6	20.5	100	14.1	21.1	100	14.4	21.7

6 Use Table 4-1 AISC-360-10
Table

We have W 14 x 74 \Rightarrow Page 4-16

Select bigger
value of $(Kl)_{y_{eq}}$
and $(Kl)_y$

$$\left. \begin{array}{l} (Kl)_x = 20' \\ r_x = 6.04'' \end{array} \right\} \begin{array}{l} (Kl)_y = 20' \\ r_y = 2.48'' \end{array}$$

Find $(Kl)_{y_{eq}} \Rightarrow$ for $(Kl)_x \Rightarrow \frac{(Kl)_x}{\frac{r_x}{r_y}} = \frac{20}{\frac{6.04}{2.48}} = 8.21'$

While $(Kl)_y \Rightarrow 20(1) = 20'$

Choose $(Kl)_y \Rightarrow 20'$ bigger

buckling about
minor direction
controls

$$(KL)_y = 20'$$

CM # 14

Table 4-1 (continued)
Available Strength in Axial Compression, kips
W-Shapes

$F_y = 50$ ksi

Find LRFD and ASD Design loads

Shape	W14x														
	82		74		68		61		53		48		43 ^c		
	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	
Design	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
with r	19	387	582	352	529	320	480	285	428	166	250	149	224	130	196
	20	362	545	329	495	299	449	266	399	150	226	134	202	117	177

(KL)
r/y

$$\phi_c P_n = 495 \text{ kips}$$

LRFD

$$\frac{P_o}{\Omega_c} = 329 \text{ kips}$$

ASD Design