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What are the different Design Tables

For Compression Members based

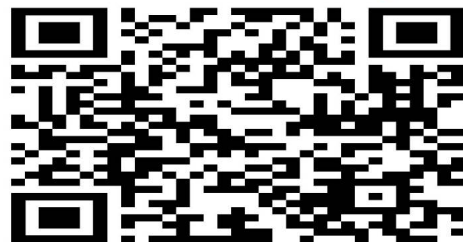
on CM # 14

CM # 15 ?

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

↓ Solve Example 4-5 → Table 4-1
CM # 14

Prepared by Eng. Maged Kamel.



Review the full data
for post 4

CM # 14

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DESIGN TABLE DISCUSSION

Steel Compression—Member Selection Tables

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?

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

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

(4-1)

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

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

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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 $(KL)_y$

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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 $(KL)_x$ } \Rightarrow get stress
 $(KL)_y$ } \searrow

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

EXAMPLE 4.5

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

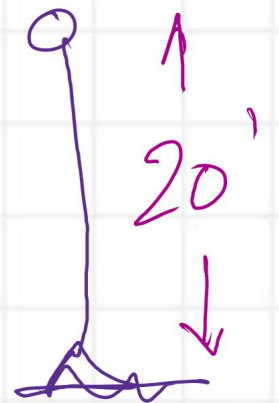
W14x74

$h = 20'$

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

$K_y = 1$

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



EXAMPLE 4.5

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

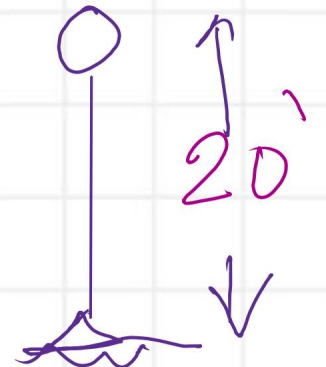
bigger $\frac{KL}{r} \rightarrow \left(\frac{KL}{r}\right)_x = 96.77 \Rightarrow$ Use Table 4-22
 CM # 14

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

For Table 4-1 Estimate

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

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



a

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

r_y between 96
97

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

$\phi_c F_{cr} = 22.90$
ksi

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

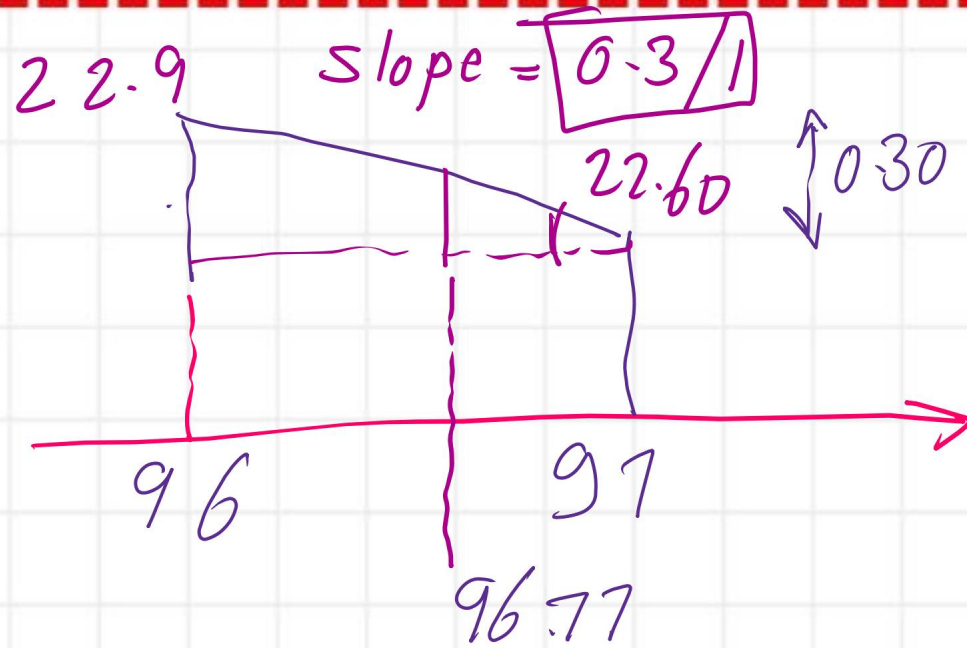
$\phi_c F_{cr} = 22.60$ ksi

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

F _y = 35 ksi			F _y = 36 ksi			F _y = 42 ksi			F _y = 46 ksi			F _y = 50 ksi		
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



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

ASD

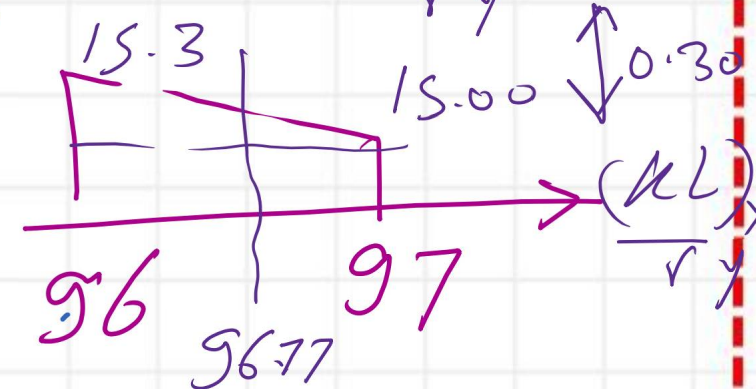
Stress

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

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

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

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



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

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

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

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

Find $(KL)_y$ eq \Rightarrow for $(KL)_x \Rightarrow \frac{(KL)_x}{\frac{r_x}{r_y}} = \frac{20(12)}{\frac{6.04}{2.48}} = 8.21'$

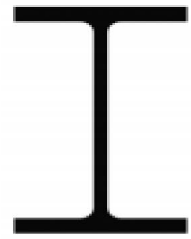
While $(KL)_y \Rightarrow 20(1) = 20'$

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

buckling about
minor direction
Controls

$$(KL)_y = 20'$$

CM # 14



W14

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

$F_y = 50$ ksi

Shape	W14×														
	82		74		68		61		53		48		43 ^c		
lb/ft															
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	
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

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

LRFD

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

ASD Design