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.

Summary of post 4-content

CM # 14

AISC - 360 - 10

## DESIGN TABLE DISCUSSION

Table 4-1-CM#14

## Steel Compression—Member Selection Tables

### Table 4-1. W-Shapes in Axial Compression

→ Compression with $(KL)_y$ eq

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

How do we drive ?

$$(KL)_{y\,eq} = \frac{(KL)_x}{\frac{r_x}{r_y}} \qquad (4\text{-}1)$$

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

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

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.

Compare with $\frac{(KL)_y}{r_y}$

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.

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

Prepared by Eng.Maged Kamel.

CM#15
AISC-360-16

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

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

$L_{cy}$ => instead of $(KL)_y$

Table 4-1-CM#15

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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 $(KL)_x$, $(KL)_y$ ⟹ get stress ⟹ Multiply by Area to get available strength

Prepared by Eng.Maged Kamel.

Table 4-22-CM#14

**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 $\tau_b$ 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.

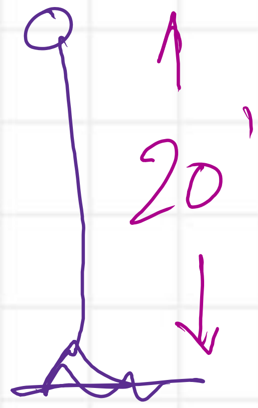
**LRFD SOLUTION**

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,

Reminder of Example 4.2

W14x74

$h = 20'$




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

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

Use Table 4-1 for rx/ry

# EXAMPLE 4.5

Fifth Edition ⇒ 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.

4.1 Table

**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,

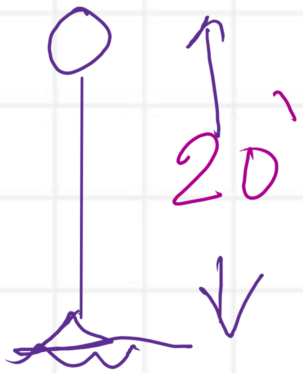
bigger $\frac{KL}{r}$ → $\left(\frac{K_x L}{r_x}\right)_x = 96.77$ ⇒ Use Table 4-22

CH # 14

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

For Table 4-1 Estimate $(KL)_y$ eq. → $\frac{(KL)_x}{\left(\frac{r_x}{r_y}\right)}$

$F_y = 50$ ksi




Prepared by Eng.Maged Kamel.

W14X74 $r_y = 2.48''$

$(KL)_y = 20'$

$KL_{y\,eq} = \dfrac{(KL)_x}{r_x/r_y}$

Find rx/ry ratio

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

$(KL_y)_{eq} = 8.20'$

select 20'

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

bottom

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

**W14**

$F_y = 50$ ksi

| Shape | W14× | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lb/ft | 82 | | 74 | | 68 | | 61 | | 53 | | 48 | | 43[c] | |
| Design | $P_n/\Omega_c$ ASD | $\phi_c P_n$ LRFD | $P_n/\Omega_c$ ASD | $\phi_c P_n$ LRFD | $P_n/\Omega_c$ ASD | $\phi_c P_n$ LRFD | $P_n/\Omega_c$ ASD | $\phi_c P_n$ LRFD | $P_n/\Omega_c$ ASD | $\phi_c P_n$ LRFD | $P_n/\Omega_c$ ASD | $\phi_c P_n$ LRFD | $P_n/\Omega_c$ ASD | $\phi_c P_n$ LRFD |
| **Properties** | | | | | | | | | | | | | | |
| $P_{wo}$, kips | 123 | 185 | 104 | 155 | 90.6 | 136 | 77.5 | 116 | 77.1 | 116 | 67.4 | 101 | 56.9 | 85.4 |
| $P_{wi}$, kips/in. | 17.0 | 25.5 | 15.0 | 22.5 | 13.8 | 20.8 | 12.5 | 18.8 | 12.3 | 18.5 | 11.3 | 17.0 | 10.2 | 15.3 |
| $P_{wb}$, kips | 201 | 302 | 138 | 207 | 108 | 163 | 80.1 | 120 | 76.7 | 115 | 59.5 | 89.5 | 43.0 | 64.7 |
| $P_{fb}$, 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 |
|---|---|
| $\Omega_c = 1.67$ | $\phi_c = 0.90$ |

[c] 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 Fcr $\left(\frac{KL}{r_y}\right) \Rightarrow 96.77$ between 96 and 97

Use table 4-22-LRFD stress

Table 4-22 (continued)

## Available Critical Stress for Compression Members

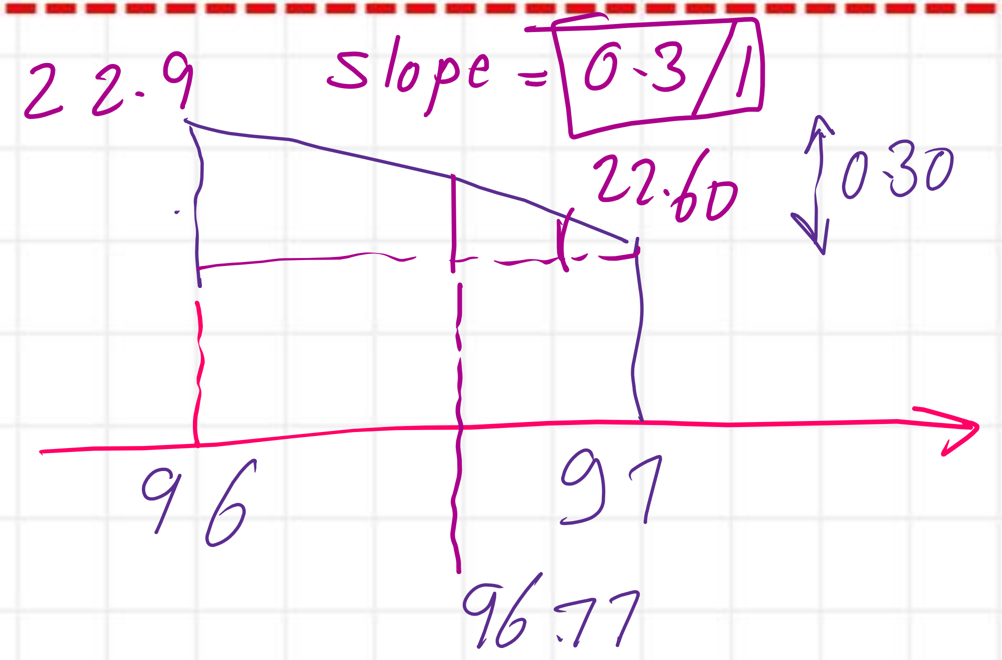
$\left(\frac{KL}{r}\right)_y = \frac{20(12)}{2.48} = 96.77$

| KL/r | $F_y$ = 35 ksi $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | KL/r | $F_y$ = 36 ksi $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | KL/r | $F_y$ = 42 ksi $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | KL/r | $F_y$ = 46 ksi $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | KL/r | $F_y$ = 50 ksi $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi 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 |

$\phi_c F_{cr} = 22.90$ ksi, $\left(\frac{KL}{r_y}\right) = 96$

$\phi_c F_{cr} = 22.60$ ksi, $\left(\frac{KL}{r_y}\right) = 97$

**Prepared by Eng.Maged Kamel.**




$\frac{(KL)_y}{r_y}$

$\phi_c F_{cr}$ ⇒ very close to 22.60

$\frac{(KL)_y}{r_y} = 96.77$

$\phi_c F_{cr} = 22.60 + (0.23)(0.30)$

$\simeq 22.67$ ksi

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

$\phi_c P_n = 22.67\,(21.80) = 494.2$ kips

$\simeq 494$ kips

LRFD

CM # 14
AISC-360-16

Find LRFD design load

Prepared by Eng.Maged Kamel.

ASD

Stress

Table 4-22 (continued)

# Available Critical Stress for Compression Members

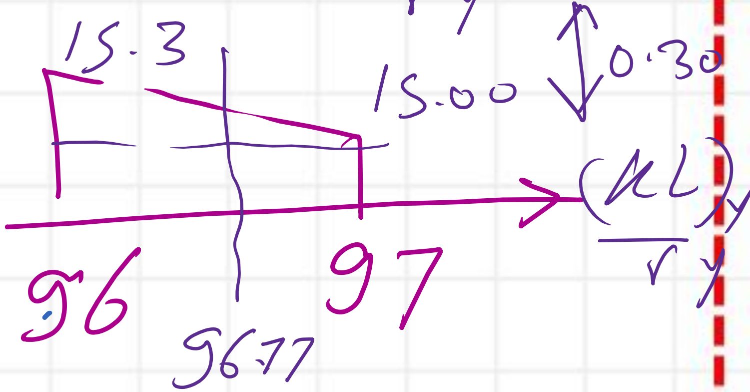
Find stress value Fcr/Ωc

| $Fy = 35$ ksi | | | $Fy = 36$ ksi | | | $Fy = 42$ ksi | | | $Fy = 46$ ksi | | | $Fy = 50$ ksi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $KL/r$ | $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | $KL/r$ | $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | $KL/r$ | $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | $KL/r$ | $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi LRFD | $KL/r$ | $F_{cr}/\Omega_c$ ksi ASD | $\phi_c F_{cr}$ ksi 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 |

Area = $(KL/r_y)_y = 96.77 \to 96$, $\to 97$

$F_{cr}/\Omega_c = 15.3 \to (KL/r_y)_y = 96$

$F_{cr}/\Omega_c = 15.00 \to (KL/r_y)_y = 97$




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

$= 15.07$ ksi

$F_{cr}A/\Omega_c = 15.07(21.8)$

$= 328.5$ kips

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

We have W14X74 ⇒ Page 4-16

Select bigger value of (Kl)yeq and (Kl)y

$(KL)_x = 20'$, $r_x = 6.04''$ ; $(KL)_y = 20'$, $r_y = 2.48''$

Find $(KL)_{y\,eq}$ ⇒ for $(KL)_x$ ⇒ $\dfrac{(KL)_x}{\frac{r_x}{r_y}} = \dfrac{20(12)}{\frac{6.04}{2.48}} = 8.21'$

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

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

buckling about minor direction controls

$(KL)_y = 20'$

CM # 14

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

W14

$F_y$ = 50 ksi

Find LRFD and ASD Design loads

| Shape | | W14× | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lb/ft | | 82 | | 74 | | 68 | | 61 | | 53 | | 48 | | 43[c] | |
| Design | | $P_n/\Omega_c$ | $\phi_c P_n$ | $P_n/\Omega_c$ | $\phi_c P_n$ | $P_n/\Omega_c$ | $\phi_c P_n$ | $P_n/\Omega_c$ | $\phi_c P_n$ | $P_n/\Omega_c$ | $\phi_c P_n$ | $P_n/\Omega_c$ | $\phi_c P_n$ | $P_n/\Omega_c$ | $\phi_c P_n$ |
| | | 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 |

$(KL)$ $r_y$

$\phi_c P_n = 495$ kips LRFD

$\frac{P_n}{\Omega_c} = 329$ kips ASD Design

Prepared by Eng.Maged Kamel.