Steel Column Bending Amplification Factor

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IN DESIGNING STEEL columns with axial compression and bending moment, the designer is required to use Formulas (7a) and (7b) of Sect. 1.6.1. of the AISC Specification, when $f_a/F_a > 0.15$. To save time in obtaining the bending amplification factor, $C_m/(f - f_a/F'_e)$, a chart (Fig. 1) has been prepared with the aid of a digital computer for given values of $K_b l_b/r_b$ and f_a for the case of $C_m = 0.85$, used for frames subject to joint translation. For other values of C_m, the amplification factors can be calculated by a single slide rule computation, multiplying the chart values by the ratio of the C_m values. As the amplification factor depends only on C_m, f_a and F'_e it is independent of the yield point of the steel.

Each curve is plotted with $K_b l_b/r_b$ as ordinate and the bending amplification factor as abscissa for a given value of f_a. Amplification factors greater than five are not plotted, since these are rarely encountered.

The following example illustrates the use of the chart:

EXAMPLE

Given: Using A36 steel, design 12WF column for:

$l_x = l_y = 18.0$ ft

$P = 350$ kips; $M_x = 65$ kip-ft; $C_{mx} = 0.85$

$K_x = 1.6$; $K_y = 1.0$

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Solution: Try 12 WF 106

$A = 31.19$ in.^{2}; $S_x = 144.5$ in.^{3}

$r_x = 5.46$ in.; $r_y = 3.11$ in.

$$\frac{K_x l_x}{r_x} = \frac{1.6 \times 18 \times 12}{5.46} = 63$$

$$\frac{K_y l_y}{r_y} = \frac{1.0 \times 18 \times 12}{3.11} = 69.5$$

$F_a = 16.48$ ksi

$$f_a = \frac{p}{A} = \frac{350}{31.19} = 11.2 \text{ ksi}$$

$f_a/F_a = 11.2/16.48 = 0.68 > 0.15$

Use Formulas (7a) and (7b):

Enter chart with $\frac{K_x l_x}{r_x} = 63$ and $f_a = 11.2$ ksi.

Find bending amplification factor $= 1.2$.

$$f_b = \frac{M_x}{S_x} = \frac{65 \times 12}{144.5} = 5.4 \text{ ksi}$$

$F_b = 22$ ksi (see AISC Spec. Sect. 1.5.1.4)

$f_b/F_b = 5.4/22 = 0.245$

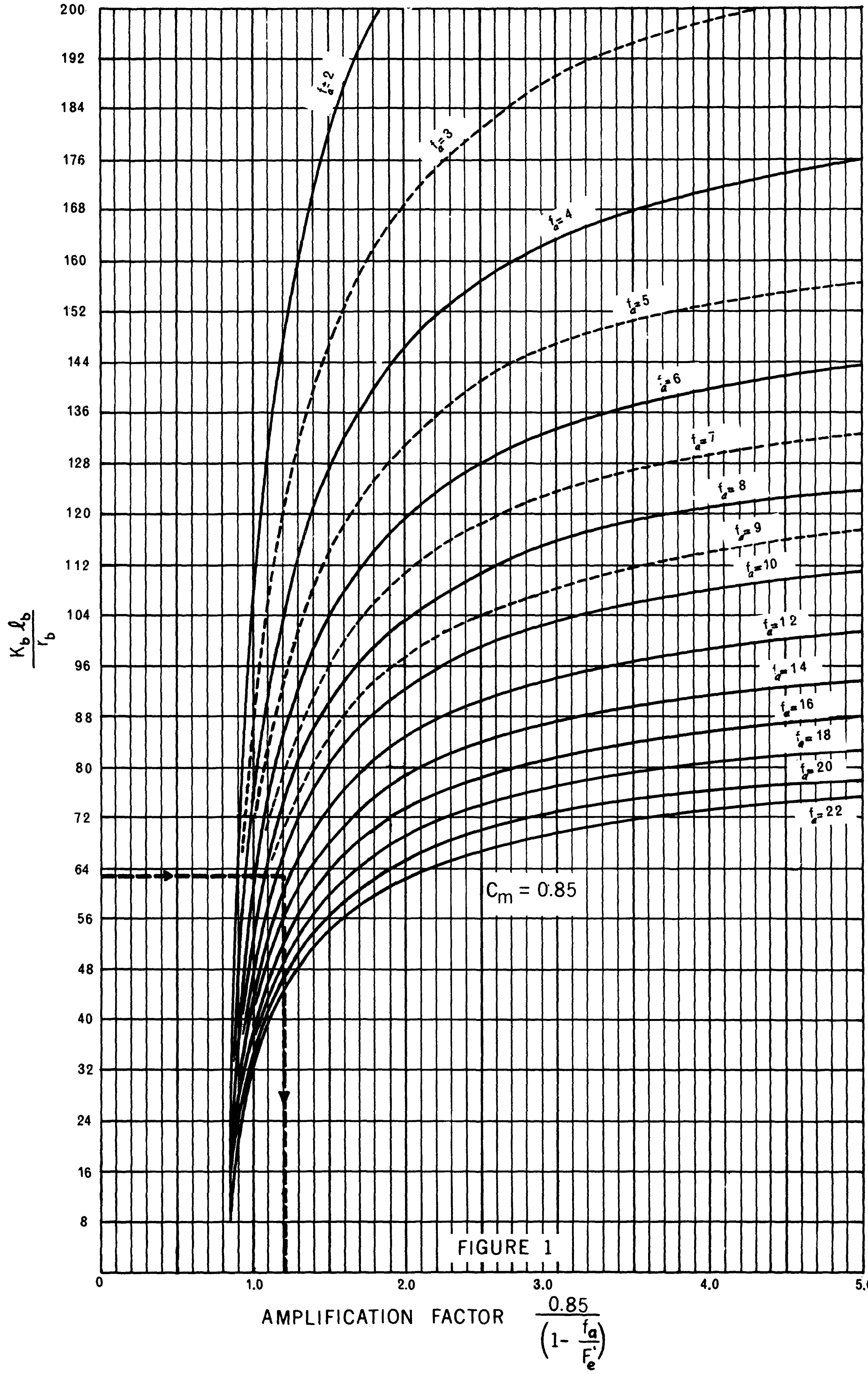
Formula (7a):

$$\frac{f_a}{F_a} + \frac{C_m}{\left(1 - \frac{f_a}{F_e'}\right)} \frac{f_b}{F_b} \leq 1.0$$

$0.68 + 1.2\ (0.245) = 0.975 < 1.0$ **o.k.**

By inspection, Formula (7b) does not govern.

Use: **12 WF 106**



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$\frac{K_b \ell_b}{r_b}$
$f_a=2$
$f_a=3$
$f_a=4$
$f_a=5$
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$f_a=8$
$f_a=9$
$f_a=10$
$f_a=12$
$f_a=14$
$f_a=16$
$f_a=18$
$f_a=20$
$f_a=22$
$C_m = 0.85$
FIGURE 1
AMPLIFICATION FACTOR $\frac{0.85}{\left(1-\frac{f_a}{F_e'}\right)}$