Allowable Stress Design For Building Beams

The maximum fiber stress in bending for laterally supported beams and girders is F_b = $0.66F_y$ if they are compact, except for hybrid girders and members with yield points exceeding 65 ksi (448.1 MPa). $F_b = 0.60F_y$ for non-compact sections. F_y is the minimum specified yield strength of the steel, ksi (MPa). Table lists values of F_b for two grades of steel.

Yield strength,ksi (MPa)	Compact$0.66F_y$(MPa)	Non-compact,0.60 F_y (MPa)
36 (248.2)	24 (165.5)	22 (151.7)
50 (344.7)	33 (227.5)	30 (206.8)

The allowable extreme-fiber stress of $0.60F_y$ applies to laterally supported, unsymmetrical members, except channels, and to non-compact box sections. Compression on outer surfaces of channels bent about their major axis should not exceed $0.60F_y$

The allowable stress of $0.66F_y$ for compact members should be reduced to $0.60F_y$ when the compression flange is unsupported for a length, in (mm), exceeding the smaller of

$l_{max}=76.0b_f/(F_y)^{½}$

$l_{max}=20{,}000/F_y d/A_f$

where b_f=width of compression flange, in (mm)

d=beam depth, in (mm)

A_f =area of compression flange, $in^2 (mm)^2$

The allowable stress should be reduced even more when l/r_T exceeds certain limits, where l is the unbraced length, in (mm), of the compression flange, and r_T is the radius of gyration, in (mm), of a portion of the beam consisting of the compression flange and one-third of the part of the web in compression.

For $\sqrt{102{,}000C_b/F_y} \leq l/r_T \leq \sqrt{510{,}00C_b/F_y}$, use

$$F_b = \left[\frac{2}{3} - \frac{F_y(l/r_T)^2}{1{,}530{,}000C_b}\right]F_y$$

For $l/r_T > \sqrt{510{,}000C_b/F_y}$, use

$$F_b = \frac{170{,}000C_b}{(l/r_T)^2}$$

Where C_b =modifier for moment gradient

When, however, the compression flange is solid and nearly rectangular in cross section, and its area is not less than that of the tension flange, the allowable stress may be taken as

F_b=12,000C_b/ld/A_f

When Eq. applies (except for channels), F_b should be taken as the larger of the values computed from Eqs above, but not more than 0.60F_y .

The moment-gradient factor C_b in Eqs. above may be computed from

C_b=1.75 + 1.05 M_1/M_2+ 0.3$(M_1/M_2)^2$ less than equal to 2.3

Where M_1 = smaller beam end moment, and M_2 = larger beam end moment.

The algebraic sign of M_1/M_2 is positive for double curvature bending and negative for single-curvature bending. When the bending moment at any point within an unbraced length is larger than that at both ends, the value of C_b should be taken as unity. For braced frames, C_b should be taken as unity for computation of F_{bx} and F_{by} .

Equations can be simplified by introducing a new term:

$Q=(l/r_T)^2F_y$

Now, for 0.2 less than equal to Q ess than equal to 1,

$F_b=(2 - Q)F_y/3$

For Q > 1:

$F_b=F_y/ 3Q$

Source: http://www.engineeringcivil.com/allowable-stress-design-for-building-beams.html