(2) At the beam end connections where the top flange is coped, and in similar situations where failure might occur by shear along a plane through the fasteners, or by a combination of shear along a plane through the fasteners plus tension along a perpendicular plane, on the effective area in resisting tearing failure shall be
\[ F_v = 0.30S_b \]  

The effective area is the minimum net failure surface, bounded by the bolt holes.

(c) Stress in Compression. The allowable stress in compression shall be as required by (1) through (3). The allowable compressive stress for columns, except those fabricated from austenitic stainless steel, shall be as required by (1). The allowable compressive stress for columns fabricated from austenitic stainless steel shall be as required by (2). The allowable compressive stress for member elements other than columns constructed of any material, including austenitic stainless steel, shall be as required by (3).

(1) Gross Sections of Columns, Except Those Fabricated of Austenitic Stainless Steel

(a) Where \( KI/r \) Is Less Than \( C_c \). On the gross section of axially loaded compression members whose cross sections meet the provisions of NF-3322.2(d), when \( KI/r \) (the largest effective slenderness ratio of any unbraced segment as defined in NF-3322.2) is less than \( C_c \), the allowable stress in compression shall be
\[ F_a = \frac{1 - \frac{(KI/r)^2}{2C_c^2}S_y}{5/3 + \frac{3(KI/r)/8C_c^2 - (KI/r)^3/8C_c^3}{}} \]  

where
\[ C_c = \sqrt{2 \pi^2 E / S_y} \]

(b) Where \( KI/r \) Is Greater Than \( C_c \). On the gross section of axially loaded compression members when \( KI/r \) exceeds \( C_c \), the allowable stress in compression shall be
\[ F_a = \frac{12 \pi^2 E}{23 (KI/r)^2} \]

(2) Gross Sections of Columns Fabricated From Austenitic Stainless Steel. On the gross section of axially loaded compression members whose cross sections meet the provisions of NF-3322.2(d) the allowable stress in compression shall be as required by (-a) and (-b).

(a) Where \( KI/r \) Is Less Than or Equal to 120.
\[ F_a = S_y \left( 0.47 - \frac{KI}{r} \right) \frac{1}{444} \]  

For Service Level D, the allowable compressive stress for columns fabricated from ferritic steel shall be as required by (4). For Service Level D, the allowable compressive stress for columns fabricated from austenitic or duplex stainless steel, except unequal leg angles, slendrer leg angles, and slender circular tubular members, shall be as required by (5).
(-b) Where $Kl/r$ Is Greater Than 120. The following compressive stress limit applies to bracing and secondary members, as well as main members:

$$F_a = \frac{S_y}{600} \left(0.40 - \frac{Kl/r}{600}\right)$$  \hspace{1cm} (6b)

(3) Member Elements Other Than Columns

(-a) Plate Girder Stiffeners. On the gross area of plate girder stiffeners, the allowable stress in compression shall be

$$F_a = 0.60S_y$$  \hspace{1cm} (7)

but not more than $0.50S_y$.

(-b) Webs of Rolled Shapes. On the web of rolled shapes at the toe of the fillet, the allowable stress in compression shall be

$$F_a = 0.75S_y$$  \hspace{1cm} (8)

but not more than $0.63S_y$.

For the use of stiffeners to avoid web crippling, see NF-3322.6(a).

(4) Level D. The maximum Level D allowable load for ferritic steel columns shall be determined in accordance with the following, provided that the initial out-of-straightness does not exceed $\frac{f_{\text{out}}}{1000}$ of the unsupported length. Effects of deformations due to existing loads shall also be considered.

(-a) Except as noted in (-b), the following rules shall be applied:

For $0 \leq \lambda \leq 1$

$$\frac{P}{P_y} = \frac{1}{1.11 + 0.50\lambda + 0.17\lambda^2 - 0.28\lambda^3}$$

For $1 \leq \lambda \leq \sqrt{2}$

$$\frac{P}{P_y} = \frac{2}{3} \left(1 - \frac{\lambda^2}{4}\right)$$

For $\lambda > \sqrt{2}$

$$\frac{P}{P_y} = \frac{2}{3\lambda^2}$$

where

$A_g$ = area of gross section

$E$ = modulus of elasticity

$K$ = effective length factor

$L$ = unbraced length

$P$ = maximum allowable load

$P_y = S_yA_g$

$r$ = radius of gyration

$$\lambda = \left(\frac{KL}{r}\right) \frac{1}{\pi} \sqrt{\frac{S_y}{E}}$$

(4) For Service Level D of Ferritic Steel Columns. The maximum Service Level D allowable load for ferritic steel columns
(b) For nonstress-relieved heavy structural shapes (web or flange thickness greater than 1 in. (25 mm)) or for nonstress-relieved built-up members using universal mill plate, the following rules shall be applied:

For \( 0 < \lambda < 1 \)

\[
\frac{P}{P_y} = \frac{1 - \lambda^2/4}{1.11 + 0.75\lambda + 0.83\lambda^2 - 0.81\lambda^4}
\]

For \( 1 < \lambda < \sqrt{2} \)

\[
\frac{P}{P_y} = \frac{1 - \lambda^2/4}{1.88}
\]

For \( \lambda > \sqrt{2} \)

\[
\frac{P}{P_y} = \frac{1}{1.88\lambda^2}
\]

(d) Stress in Bending. The allowable bending stress resulting from tension and compression in structural members shall be as required by (1) through (6).

(1) Compact Sections

(a) Tension and compression on extreme fibers of compact hot rolled or built-up members (except hybrid beams and members made from 65 ksi (450 MPa) or greater \( S_y \), material) symmetrical about and loaded in the plane of their minor axes and meeting the requirements of Subsection NF shall result in a maximum bending stress

\[
F_b = 0.66S_y
\]

but not more than 0.555\( S_u \).

In order to qualify, a member shall meet the requirements of (1) through (7).

(1) The flanges shall be continuously connected to the web or webs.

(2) The width-thickness ratio of unstiffened projecting elements of the compression flange [as defined in NF-3322.2(d)] shall not exceed 65 / \( \sqrt{S_y} \) (for SI units, use 170 / \( \sqrt{S_y} \)).

(3) The width-thickness ratio of stiffened elements of the compression flange [as defined in NF-3322.2(d)] shall not exceed 190 / \( \sqrt{S_y} \) (for SI units, use 500 / \( \sqrt{S_y} \)).

(4) The depth-thickness ratio of the web or webs shall not exceed the value given by eq. (10) or (11), as applicable

(U.S. Customary Units)

\[
d/t = \left[ \frac{640}{\sqrt{S_y}} \right] \left[ 1 - 3.74 \left( \frac{F_a}{S_y} \right) \right]
\]

(5) For Service Level D of Columns Fabricated From Austenitic or Duplex Stainless Steels, Except Unequal Leg Angles, Slender Leg Angles, and Slender Circular Tubular Members. On the gross section of axially loaded compression members whose cross-sections meet the provisions of NF-3322.2(d), the allowable stress in compression shall be as required by (a) and (b) provided that the initial out-of-straightness does not exceed 1/1000 of the unsupported length. Effects of deformations due to existing loads shall also be considered.

(a) Where

\[
Kl/r \leq 3.77\sqrt{E/S_y}
\]

\[
F_a = \frac{[0.50(S_y/F_e)]S_y}{1.50}
\]

(b) Where

\[
Kl/r > 3.77\sqrt{E/S_y}
\]

\[
F_a = \frac{0.531F_e}{1.50}
\]

(c) For (a) and (b),

\[
F_e = \frac{\pi^2E}{(Kl/r)^2}
\]
where
\[ M_1/M_2 = \text{the ratio of the smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending under consideration.} \]
\[ M_1/M_2 \text{ is positive when the member is bent in reverse curvature and negative when it is bent in single curvature.} \]


d) For compression members in frames braced against joint translation in the plane of loading and subjected to transverse loading between their supports, the value of \( C_m \) may be determined by rational analysis; however, in lieu of such analysis, the following values may be used:

- (1) for members whose ends are restrained against rotation in the plane of bending
\[ C_m = 0.85 \]

- (2) for members whose ends are unrestrained against rotation in the plane of bending
\[ C_m = 1.0 \]

- (d) For Level D, the allowable stresses in eqs. (20), (21), and (22) shall be defined as follows:

- (1) \( F_a = P/A_y \), where \( P \) shall be determined in accordance with (c)

- (2) The value of \( F'_e \) shall be taken as
\[ F'_e = \frac{\pi^2 E}{1.30(K_{lb}/r_b)^2} \]

- (3) \( F_b \) shall be determined using (2)(b) or (2)(c) as appropriate.

Axial Tension and Bending. Members subject to both axial tension and bending stresses shall be proportioned at all points along their length to satisfy the requirements of eq. (1)(21), where \( f_b \) is the computed bending tensile stress. However, the computed bending compressive stress, taken alone, shall not exceed the applicable value according to (d), “Stress in Bending.”

For Level D

- (a) the 0.60\( S_y \) in eq. (1)(21) may be replaced with the smaller of 1.2\( S_y \) or 0.75\( S_y \)

- (b) for members qualifying as compact sections under criteria of (d)(1), the maximum bending stress shall be given by
\[ F_b = f \times S_y \]

where
\[ f = \text{plastic shape factor for the cross section} \]

- (c) if members do not meet the compact section requirements, they shall be designed using one of the two methods below to determine \( F_b \) for use in the preceding equation.