as well as the redistribution of loads through jacket bracing to stiffer pile members by modeling the relative stiffness of foundation members interacting with the jacket stiffness.

3.2 ALLOWABLE STRESSES FOR CYLINDRICAL MEMBERS

3.2.1 Axial Tension

The allowable tensile stress, F_t, for cylindrical members subjected to axial tensile loads should be determined from:

$$F_t = 0.6\, F_y \qquad (3.2.1\text{-}1)$$

where

F_y = yield strength, ksi (MPa).

3.2.2 Axial Compression

3.2.2.a Column Buckling

The allowable axial compressive stress, F_a, should be determined from the following AISC formulas for members with a *D/t* ratio equal to or less than 60:

$$F_a = \frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2}\right]F_y}{5/3 + \frac{3(Kl/r)}{8C_c} - \frac{(Kl/r)^3}{8C_c^3}} \quad \text{for } Kl/r < C_c \qquad (3.2.2\text{-}1)$$

$$F_a = \frac{12\ \pi^2 E}{23(Kl/r)^2} \quad \text{for } Kl/r \geq C_c \qquad (3.2.2\text{-}1)$$

where

02 $C_c = \left(\frac{2\pi^2 E}{F_y}\right)^{\frac{1}{2}}$

E = Young's Modulus of elasticity, ksi (MPa),

K = effective length factor, Section 3.3.1d,

l = unbraced length, in. (m),

r = radius of gyration, in. (m).

For members with a *D/t* ratio greater than 60, substitute the critical local buckling stress (F_{xe} or F_{xc}, whichever is smaller) for F_y in determining C_c and F_a.

Equation 1.5-3 in the AISC Specification should not be used for design of primary bracing members in offshore structures. This equation may be used only for secondary members such as boat landings, stairways, etc.

3.2.2.b Local Buckling

Unstiffened cylindrical members fabricated from structural steels specified in Section 8.1 should be investigated for local buckling due to axial compression when the *D/t* ratio is greater than 60. When the *D/t* ratio is greater than 60 and less than 300, with wall thickness $t \geq 0.25$ in. (6 mm), both the elastic (F_{xe}) and inelastic local buckling stress (F_{xc}) due to axial compression should be determined from Eq. 3.2.2-3 and Eq. 3.2.2-4. Overall column buckling should be determined by substituting the critical local buckling stress (F_{xe} or F_{xc}, whichever is smaller) for F_y in Eq. 3.2.2-1 and in the equation for C_c.

1. Elastic Local Buckling Stress.

The elastic local buckling stress, F_{xe}, should be determined from:

$$F_{xe} = 2CE\, t/D \qquad (3.2.2\text{-}3)$$

where

C = critical elastic buckling coefficient,

D = outside diameter, in. (m),

t = wall thickness, in. (m).

The theoretical value of C is 0.6. However, a reduced value of $C = 0.3$ is recommended for use in Eq. 3.2.2-3 to account for the effect of initial geometric imperfections within API Spec 2B tolerance limits.

2. Inelastic Local Buckling Stress.

The inelastic local buckling stress, F_{xc}, should be determined from:

$$\left.\begin{aligned} F_{xc} &= F_y \times [1.64 - 0.23(D/t)^{1/4}] \leq F_{xe} \\ F_{xc} &= F_y \qquad \text{for } (D/t) \leq 60 \end{aligned}\right\} \qquad (3.2.2\text{-}4)$$

3.2.3 Bending

The allowable bending stress, F_b, should be determined from:

$$F_b = 0.75\, F_y \quad \text{for } \frac{D}{t} \leq \frac{1500}{F_y} \qquad (3.2.3\text{-}1a)$$

$$\left(\frac{D}{t} \leq \frac{10{,}340}{F_y}\text{, SI Units}\right)$$

$$F_b = \left[0.84 - 1.74\,\frac{F_y D}{Et}\right]F_y \quad \text{for } \frac{1500}{F_y} < \frac{D}{t} \leq \frac{3000}{F_y} \qquad (3.2.3\text{-}1b)$$

$$\left(\frac{10{,}340}{F_y} < \frac{D}{t} \leq \frac{20{,}680}{F_y}\text{, SI Units}\right)$$

$$F_b = \left[0.72 - 0.58\frac{F_y D}{Et}\right]F_y \text{ for } \frac{3000}{F_y} < \frac{D}{t} \le 300 \qquad (3.2.3\text{-}1c)$$

$$\left(\frac{20{,}680}{F_y} < \frac{D}{t} \le 300 \text{ , SI Units}\right)$$

For D/t ratios greater than 300, refer to API Bulletin 2U.

3.2.4 Shear†

3.2.4.a Beam Shear

The maximum beam shear stress, f_v, for cylindrical members is:

$$f_v = \frac{V}{0.5A} \qquad (3.2.4\text{-}1)$$

where

f_v = the maximum shear stress, ksi (MPa),

V = the transverse shear force, kips (MN),

A = the cross sectional area, in.^{2} (m^2).

The allowable beam shear stress, F_v, should be determined from:

$$F_v = 0.4\,F_y \qquad (3.2.4\text{-}2)$$

3.2.4.b Torsional Shear

The maximum torsional shear stress, F_v, for cylindrical members caused by torsion is:

$$f_{vt} = \frac{M_t(D/2)}{I_p} \qquad (3.2.4\text{-}3)$$

where

f_{vt} = maximum torsional shear stress, ksi (MPa),

M_t = torsional moment, kips-in. (MN-m),

I_p = polar moment of inertia, in.^{4} (m^4),

and the allowable torsional shear stress, F_{vt}, should be determined from:

$$F_{vt} = 0.4\,F_y \qquad (3.2.4\text{-}4)$$

3.2.5 Hydrostatic Pressure* (Stiffened and Unstiffened Cylinders)

For tubular platform members satisfying API Spec 2B out-of-roundness tolerances, the acting membrane stress, f_h, in ksi (MPa), should not exceed the critical hoop buckling stress, F_{hc}, divided by the appropriate safety factor:

$$f_h \le F_{hc}/SF_h \qquad (3.2.5\text{-}1)$$

$$f_h = pD/2t \qquad (3.2.5\text{-}2)$$

where

f_h = hoop stress due to hydrostatic pressure, ksi (MPa),

p = hydrostatic pressure, ksi (MPa),

SF_h = safety factor against hydrostatic collapse (see Section 3.3.5).

3.2.5.a Design Hydrostatic Head

The hydrostatic pressure ($p = \gamma H_z$) to be used should be determined from the design head, H_z, defined as follows:

$$H_z = z + \frac{H_w}{2}\left(\frac{\cosh[k(d-z)]}{\cosh kd}\right) \qquad (3.2.5\text{-}3)$$

where

z = depth below still water surface including tide, ft (m). z is positive measured downward from the still water surface. For installation, z should be the maximum submergence during the launch or differential head during the upending sequence, plus a reasonable increase in head to account for structural weight tolerances and for deviations from the planned installation sequence.

H_w = wave height, ft(m),

$k = \frac{2\pi}{L}$ with L equal to wave length, ft^{-1} (m^{-1}),

d = still water depth, ft. (m),

γ = seawater density, 64 lbs/ft^3 (0.01005 MN/m^3).

†While the shear yield stress of structural steel has been variously estimated as between $^1/_2$ and $^5/_8$ of the tension and compression yield stress and is frequently taken as $F_y/\sqrt{3}$, its permissible working stress value is given by AISC as $^2/_3$ the recommended basic allowable tensile stress. For cylindrical members when local shear deformations may be substantial due to cylinder geometry, a reduced yield stress may be need to be substituted for F_y in Eq. 3.2.4-4. Further treatment of this subject appears in Reference 1, Section C3.2.

*For large diameter cylinders of finite length, a more rigorous analysis may be used to justify fewer or smaller ring stiffeners provided the effects of geometrical imperfections and plasticity are properly considered. API Bulletin 2U and the fourth edition of the *Guide to Stability Design Criteria for Metal Structures* by the Structural Stability Research Council provides detailed analysis methods.