5411.4 Grooves (Type I Cranes). Drum grooves shall be machined to a minimum depth equal to three-eighths of the diameter of the hoist rope, and a pitch equal to 1.14 × rope diameter or rope diameter + \frac{1}{6} in., whichever is smaller. The groove radius shall be \frac{1}{32} in. larger than the radius of the rope.

Rope shall be secured to the drum as follows: No less than two wraps of the rope shall remain on the drum at each anchorage to the hoisting drum when the hook is in its extreme low position. Rope end shall be anchored by a minimum of two clamps attached to the drum, or by a socket arrangement specified by the crane or rope manufacturer. The rope clamp bolts shall be tightened evenly to the manufacturer's recommended torque.

5411.5 Drum Shell Design (Type I Cranes). The drum shell shall be of rolled or centrifugal cast steel, and shall be designed for both crushing and bending loads imposed by the hoist rope and drum brake loading, when used. The hoist rope loading on the drum shall include the effect of the rope reeving system efficiency. The drum shell thickness (effective material) shall account for machining tolerances, non-effective material on the inside of centrifugally cast tubes, inside diameter tolerances, inside diameter out-of-roundness tolerances, and inside diameter straightness tolerances due to sample and sweep.

(a) Drum shell stresses shall be calculated and combined in the following manner, and when a drum brake is used, the resulting stress shall be included:

1. Crushing Stress (Due to Rope Load)

   \[ \sigma_c = \frac{R_c}{P \times t_3} \]  

2. Bending Stress

   \[ \sigma_b = \frac{M_b}{Z_b} \]  

3. Maximum Shear Stress

   \[ \tau_{\text{max}} = \left[ |\sigma_c| + |\sigma_b| \right] / 2 \]  

4. Combined Stresses/Stress Intensity

   \[ \sigma_{\text{comb}} = \left[ (\sigma_c)^2 + (\sigma_b)^2 + |\sigma_c \times \sigma_b| \right]^{1/2} \]  

NOTES:

(1) Additional rope loadings resulting from seismic forces, a load hang-up, or a hoist two-block event need not be included in calculating the drum crushing stress [eq. (1)].

(2) Since torsional and transverse shear stresses are relatively low in a hoist drum shell and have a negligible effect on its structural integrity, they need not be included when calculating the maximum shear stress and combined stresses [eqs. (3) and (4)].

(3) The absolute values of the crushing and bending stresses are required when calculating the maximum shear stress and combined stresses [eqs. (3) and (4)].

(b) Allowable stresses shall be determined in the following manner, which is based on both material properties and buckling stability. When the drum grooves are hardened, the core material properties shall be used (material properties at the mid-thickness).

1. Critical Buckling Stress. The critical buckling stress is considered either elastic or inelastic, whereas it depends on the value of the elastic critical buckling stress relative to the minimum yield stress of the material.

   \[ \sigma_{\text{cr}} = \frac{E}{(1 - \nu^2)} \times \left( \frac{I_z}{d_3^4} \right)^2 \] \[ = 31.9 \times 10^6 \times \left( \frac{I_z}{d_3^4} \right)^2 \, \text{psi} \]  

If the elastic critical buckling stress is less than 50% of the minimum yield stress of the material, the critical buckling is considered elastic and is equal to the elastic critical buckling stress, whereas

\[ \sigma_{\text{cr}} = \sigma_{\gamma} \left( 1 - 0.25(\sigma_{\gamma}/\sigma_{\text{y}}) \right) \]  

If the elastic critical buckling stress exceeds 50% of the minimum yield stress of the material, the critical buckling stress is considered inelastic and is determined in the following manner:

(2) Allowable Stresses. For normal operational loads and construction loads, the following are the allowable stresses, where DFB equals 2.0 for normal operational loads and DFB equals 1.67 for construction loads:

\[ \tau_{\text{all}} = \sigma_{\text{all}} / (5.3) \]  

\[ \sigma_{\text{all}} = \sigma_{\gamma} / \text{DFB} \]

For extreme environmental and abnormal event conditions, the following is the allowable stress, where DFB equals 1.33:

\[ \sigma_{\text{all}} = \sigma_{\gamma} / \text{DFB} \]

where

DFB = design factor for buckling/yield
\[ d_r = \text{drum root diameter at rope grooves, in.} \]
\[ E = \text{modulus of elasticity of the material, psi (29,000,000 psi for steel)} \]
\[ M_b = \text{maximum bending moment of drum shell, in.-lb} \]
\[ P = \text{pitch of drum rope grooves as shown in Fig. 5411.5-1, in.} \]