10.3 SYMBOLS

A_s = surface area of one side of a flat plate or the projected area of complex shapes
A_i = cross-sectional area of ice
D = diameter of a circular structure or member as defined in Chapter 29, in ft (m)
D_c = diameter of the cylinder circumscribing an object
f_z = factor to account for the increase in ice thickness with height
I_i = importance factor for ice thickness from Table 1.5-2 based on the Risk Category from Table 1.5-1
I_w = importance factor for concurrent wind pressure from Table 1.5-2 based on the Risk Category from Table 1.5-1
K_{zt} = topographic factor as defined in Chapter 26
q_z = velocity pressure evaluated at height z above ground, in lb/ft^2 (N/m^2) as defined in Chapter 29
r = radius of the maximum cross-section of a dome or radius of a sphere
t = nominal ice thickness due to freezing rain at a height of 33 ft (10 m) from Figs. 10-2 through 10-6 in inches (mm)
t_d = design ice thickness in in. (mm) from Eq. 10.4-5
V_c = concurrent wind speed mph (m/s) from Figs. 10-2 through 10-6
V_i = volume of ice
z = height above ground in ft (m)
$\in$ = solidity ratio as defined in Chapter 29

10.4 ICE LOADS DUE TO FREEZING RAIN

10.4.1 Ice Weight

The ice load shall be determined using the weight of glaze ice formed on all exposed surfaces of structural members, guys, components, appurtenances, and cable systems. On structural shapes, prismatic members, and other similar shapes, the cross-sectional area of ice shall be determined by

$$A_i = \pi t_d(D_c + t_d) \qquad (10.4\text{-}1)$$

D_c is shown for a variety of cross-sectional shapes in Fig. 10-1.

On flat plates and large three-dimensional objects such as domes and spheres, the volume of ice shall be determined by

$$V_i = \pi t_d A_s \qquad (10.4\text{-}2)$$

For a flat plate A_s shall be the area of one side of the plate, for domes and spheres A_s shall be determined by

$$A_s = \pi r^2 \qquad (10.4\text{-}3)$$

It is acceptable to multiply V_i by 0.8 for vertical plates and 0.6 for horizontal plates.

The ice density shall be not less than 56 pcf (900 kg/m^3).

10.4.2 Nominal Ice Thickness

Figs. 10-2 through 10-6 show the equivalent uniform radial thicknesses t of ice due to freezing rain at a height of 33 ft (10 m) over the contiguous 48 states and Alaska for a 50-year mean recurrence interval. Also shown are concurrent 3-s gust wind speeds. Thicknesses for Hawaii, and for ice accretions due to other sources in all regions, shall be obtained from local meteorological studies.

10.4.3 Height Factor

The height factor f_z used to increase the radial thickness of ice for height above ground z shall be determined by

$$f_z = \left(\frac{z}{33}\right)^{0.10} \quad \text{for } 0\text{ ft} < z \le 900\text{ ft}$$
$$f_z = 1.4 \quad \text{for } z > 900\text{ ft} \qquad (10.4\text{-}4)$$

In SI:

$$f_z = \left(\frac{z}{10}\right)^{0.10} \quad \text{for } 0\text{ m} < z \le 275\text{ m}$$
$$f_z = 1.4 \quad \text{for } z > 275\text{ m}$$

10.4.4 Importance Factors

Importance factors to be applied to the radial ice thickness and wind pressure shall be determined from Table 1.5-2 based on the Risk Category from Table 1.5-1. The importance factor I_i shall be applied to the ice thickness, not the ice weight, because the ice weight is not a linear function of thickness.

10.4.5 Topographic Factor

Both the ice thickness and concurrent wind speed for structures on hills, ridges, and escarpments are higher than those on level terrain because of wind speed-up effects. The topographic factor for the concurrent wind pressure is K_{zt} and the topographic factor for ice thickness is $(K_{zt})^{0.35}$, where K_{zt} is obtained from Eq. 26.8-1.

10.4.6 Design Ice Thickness for Freezing Rain

The design ice thickness t_d shall be calculated from Eq. 10.4-5.

$$t_d = 2.0 t I_i f_z (K_{zt})^{0.35} \qquad (10.4\text{-}5)$$