Fig. 26.8-1 are intended for use with velocity pressure exposure coefficients, K_h and K_z, which are based on gust speeds.

It is not the intent of Section 26.8 to address the general case of wind flow over hilly or complex terrain for which engineering judgment, expert advice, or the Wind Tunnel Procedure as described in Chapter 31 may be required. Background material on topographic speed-up effects may be found in the literature (Jackson and Hunt 1975, Lemelin et al. 1988, and Walmsley et al. 1986).

The designer is cautioned that, at present, the standard contains no provision for vertical wind speed-up because of a topographic effect, even though this phenomenon is known to exist and can cause additional uplift on roofs. Additional research is required to quantify this effect before it can be incorporated into the standard.

C26.9 GUST EFFECT FACTOR

ASCE 7 contains a single gust effect factor of 0.85 for rigid buildings. As an option, the designer can incorporate specific features of the wind environment and building size to more accurately calculate a gust effect factor. One such procedure is located in the body of the standard (Solari 1993a and 1993b). A procedure is also included for calculating the gust effect factor for flexible structures. The rigid structure gust factor is 0 percent to 10 percent lower than the simple, but conservative, value of 0.85 permitted in the standard without calculation. The procedures for both rigid and flexible structures (1) provide a superior model for flexible structures that displays the peak factors g_Q and g_R and (2) cause the flexible structure value to match the rigid structure as resonance is removed. A designer is free to use any other rational procedure in the approved literature, as stated in Section 26.9.5.

The gust effect factor accounts for the loading effects in the along-wind direction due to wind turbulence–structure interaction. It also accounts for along-wind loading effects due to dynamic amplification for flexible buildings and structures. It does not include allowances for across-wind loading effects, vortex shedding, instability due to galloping or flutter, or dynamic torsional effects. For structures susceptible to loading effects that are not accounted for in the gust effect factor, information should be obtained from recognized literature (Kareem 1992 and 1985, Gurley and Kareem 1993, Solari 1993a and 1993b, and Kareem and Smith 1994) or from wind tunnel tests.

Along-Wind Response. Based on the preceding definition of the gust effect factor, predictions of along-wind response, for example, maximum displacement, root-mean-square (rms), and peak acceleration, can be made. These response components are needed for survivability and serviceability limit states. In the following, expressions for evaluating these along-wind response components are given.

Maximum Along-Wind Displacement. The maximum along-wind displacement $X_{\max}(z)$ as a function of height above the ground surface is given by

$$X_{\max}(z) = \frac{\phi(z)\rho BhC_{fx}\hat{V}_{\bar{z}}^2}{2m_1(2\pi n_1)^2}KG \quad \text{(C26.9-1)}$$

where $\phi(z)$ = the fundamental model shape $\phi(z) = (z/h)^{\xi}$; ξ = the mode exponent; ρ = air density; C_{fx} = mean along-wind force coefficient; m_1 = modal mass = $\int_0^h \mu(z)\phi^2(z)\,dz$; $\mu(z)$ = mass per unit height: $K = (1.65)^{\hat{\alpha}}/(\hat{\alpha}+\xi+1)$; and $\hat{V}_{\bar{z}}$ is the 3-s gust speed at height $\bar{z}$. This can be evaluated by $\hat{V}_{\bar{z}} = \hat{b}(z/33)^{\hat{\alpha}}\,V$, where V is the 3-s gust speed in Exposure C at the reference height (obtained from Fig. 26.5-1); $\hat{b}$ and $\hat{\alpha}$ are given in Table 26.9-1.

RMS Along-Wind Acceleration. The rms along-wind acceleration $\sigma_{\ddot{x}}(z)$ as a function of height above the ground surface is given by

$$\sigma_{\ddot{x}}(z) = \frac{0.85\phi(z)\rho BhC_{fx}\bar{V}_{\bar{z}}^2}{m_1}I_{\bar{z}}KR \quad \text{(C26.9-2)}$$

where $\bar{V}_{\bar{z}}$ is the mean hourly wind speed at height $\bar{z}$, ft/s

$$\bar{V}_{\bar{z}} = \bar{b}\left(\frac{\bar{z}}{33}\right)^{\bar{\alpha}} V \quad \text{(C26.9-3)}$$

where $\bar{b}$ and $\bar{\alpha}$ are defined in Table 26.9-1.

Maximum Along-Wind Acceleration. The maximum along-wind acceleration as a function of height above the ground surface is given by

$$\ddot{X}_{\max}(z) = g_{\ddot{x}}\sigma_{\ddot{x}}(z) \quad \text{(C26.9-4)}$$

$$g_{\ddot{x}} = \sqrt{2\ln(n_1T)} + \frac{0.5772}{\sqrt{2\ln(n_1T)}} \quad \text{(C26.9-5)}$$

where T = the length of time over which the minimum acceleration is computed, usually taken to be 3,600 s to represent 1 h.

Approximate Fundamental Frequency. To estimate the dynamic response of structures, knowledge of the fundamental frequency (lowest natural frequency) of the structure is essential. This value would also assist in determining if the dynamic