damping values associated with these states may differ. Further, due to the number of mechanisms responsible for damping, the limited full-scale data manifest a dependence on factors such as material, height, and type of structural system and foundation. The Committee on Damping of the Architectural Institute of Japan suggests different damping values for these states based on a large damping database described in Sataka et al. (2003).

In addition to structural damping, aerodynamic damping may be experienced by a structure oscillating in air. In general, the aerodynamic damping contribution is quite small compared to the structural damping, and it is positive in low to moderate wind speeds. Depending on the structural shape, at some wind velocities, the aerodynamic damping may become negative, which can lead to unstable oscillations. In these cases, reference should be made to recognized literature or a wind tunnel study.

Alternate Procedure to Calculate Wind Loads. The concept of the gust effect factor implies that the effect of gusts can be adequately accounted for by multiplying the mean wind load distribution with height by a single factor. This is an approximation. If a more accurate representation of gust effects is required, the alternative procedure in this section can be used. It takes account of the fact that the inertial forces created by the building's mass, as it moves under wind action, have a different distribution with height than the mean wind loads or the loads due to the direct actions of gusts (ISO 1997 and Sataka et al. 2003). The alternate formulation of the equivalent static load distribution utilizes the peak base bending moment and expresses it in terms of inertial forces at different building levels. A base bending moment, instead of the base shear as in earthquake engineering, is used for the wind loads, as it is less sensitive to deviations from a linear mode shape while still providing a gust effect factor generally equal to the gust factor calculated by the ASCE 7-05 standard. This equivalence occurs only for structures with linear mode shape and uniform mass distribution, assumptions tacitly implied in the previous formulation of the gust effect factor, and thereby permits a smooth transition from the existing procedure to the formulation suggested here. For a more detailed discussion on this wind loading procedure, see ISO (1997) and Sataka et al. (2003).

Along-Wind Equivalent Static Wind Loading. The equivalent static wind loading for the mean, background, and resonant components is obtained using the procedure outlined in the following text.

Mean wind load component $\bar{P}_j$ at the j^{th} floor level is given by

$$\bar{P}_j = q_j \times C_p \times A_j \times \bar{G} \qquad \text{(C26.9-16)}$$

where

j = floor level
z_j = height of the j^{th} floor above the ground level
q_j = velocity pressure at height z_j
C_p = external pressure coefficient
$\bar{G} = 0.925 \cdot (1 + 1.7 g_v I_{\bar{z}})^{-1}$ is the gust velocity factor

Peak background wind load component $\hat{P}_{Bj}$ at the j^{th} floor level is given similarly by

$$\hat{P}_{Bj} = \bar{P}_j \cdot G_B / \bar{G} \qquad \text{(C26.9-17)}$$

where $G_B = 0.925 \cdot \left(\dfrac{1.7 I_{\bar{z}} \cdot g_Q Q}{1 + 1.7 g_v I_{\bar{z}}} \right)$ is the background component of the gust effect factor.

Peak resonant wind load component $\hat{P}_{Rj}$ at the j^{th} floor level is obtained by distributing the resonant base bending moment response to each level

$$\hat{P}_{Rj} = C_{Mj} \hat{M}_R \qquad \text{(C26.9-18)}$$

$$C_{Mj} = \frac{w_j \phi_j}{\sum w_j \phi_j z_j} \qquad \text{(C26.9-19)}$$

$$\hat{M}_R = \bar{M} \cdot G_R / \bar{G} \qquad \text{(C26.9-20)}$$

$$\bar{M} = \sum_{j=1,n} \bar{P}_j \cdot z_j \qquad \text{(C26.9-21)}$$

where

C_{Mj} = vertical load distribution factor
$\hat{M}_R$ = peak resonant component of the base bending moment response
w_j = portion of the total gravity load of the building located or assigned to level j
n = total stories of the building
ϕ_j = first structural mode shape value at level j
$\bar{M}$ = mean base bending produced by mean wind load
$G_R = 0.925 \cdot \left(\dfrac{1.7 I_{\bar{z}} \cdot g_R R}{1 + 1.7 g_v I_{\bar{z}}} \right)$ is the resonant component of the gust effect factor

Along-Wind Response. Through a simple static analysis the peak-building response along-wind direction can be obtained by

$$\hat{r} = \bar{r} + \sqrt{\hat{r}_B^2 + \hat{r}_R^2} \qquad \text{(C26.9-22)}$$

where $\bar{r}$, $\hat{r}_B$, and $\hat{r}_R$ = mean, peak background, and resonant response components of interest, for example, shear forces, moment, or displacement. Once the equivalent static wind load distribution is obtained, any response component including