damping system. The stiffness and damping properties of the damping devices used in the models shall be based on or verified by testing of the damping devices as specified in Section 18.9.

The elastic stiffness of elements of the damping system other than damping devices shall be explicitly modeled. Stiffness of damping devices shall be modeled depending on damping device type as follows:

1. Displacement-dependent damping devices: Displacement-dependent damping devices shall be modeled with an effective stiffness that represents damping device force at the response displacement of interest (e.g., design story drift). Alternatively, the stiffness of hysteretic and friction damping devices is permitted to be excluded from response spectrum analysis provided design forces in displacement-dependent damping devices, $Q_{DSD}$, are applied to the model as external loads (Section 18.7.2.5).
2. Velocity-dependent damping devices: Velocity-dependent damping devices that have a stiffness component (e.g., viscoelastic damping devices) shall be modeled with an effective stiffness corresponding to the amplitude and frequency of interest.

### 18.4.2 Seismic Force-Resisting System

#### *18.4.2.1 Seismic Base Shear*

The seismic base shear, $V$, of the structure in a given direction shall be determined as the combination of modal components, $V_m$, subject to the limits of Eq. 18.4-1:

$$V \geq V_{\min} \tag{18.4-1}$$

The seismic base shear, $V$, of the structure shall be determined by the sum of the square root method (SRSS) or complete quadratic combination of modal base shear components, $V_m$.

#### *18.4.2.2 Modal Base Shear*

Modal base shear of the $m^{\text{th}}$ mode of vibration, $V_m$, of the structure in the direction of interest shall be determined in accordance with Eqs. 18.4-2:

$$V_m = C_{sm}\bar{W} \tag{18.4-2a}$$

$$\bar{W}_m = \frac{\left(\sum_{i=1}^{n} w_i \phi_{im}\right)^2}{\sum_{i=1}^{n} w_i \phi_{im}^2} \tag{18.4-2b}$$

where

$C_{sm}$ = seismic response coefficient of the $m^{\text{th}}$ mode of vibration of the structure in the direction of interest as determined from Section 18.4.2.4 ($m$ = 1) or Section 18.4.2.6 ($m$ > 1)

$\bar{W}_m$ = effective seismic weight of the $m^{\text{th}}$ mode of vibration of the structure

#### *18.4.2.3 Modal Participation Factor*

The modal participation factor of the $m^{\text{th}}$ mode of vibration, $\Gamma_m$, of the structure in the direction of interest shall be determined in accordance with Eq. 18.4-3:

$$\Gamma_m = \frac{\bar{W}_m}{\sum_{i=1}^{n} w_i \phi_{im}} \tag{18.4-3}$$

where

$\phi_{im}$ = displacement amplitude at the $i^{\text{th}}$ level of the structure in the $m^{\text{th}}$ mode of vibration in the direction of interest, normalized to unity at the roof level.

#### *18.4.2.4 Fundamental Mode Seismic Response Coefficient*

The fundamental mode ($m$ = 1) seismic response coefficient, $C_{S1}$, in the direction of interest shall be determined in accordance with Eqs. 18.4-4 and 18.4-5:

For $T_{1D} < T_S$,

$$C_{S1} = \left(\frac{R}{C_d}\right)\frac{S_{DS}}{\Omega_0 B_{1D}} \tag{18.4-4}$$

For $T_{1D} \geq T_S$,

$$C_{S1} = \left(\frac{R}{C_d}\right)\frac{S_{D1}}{T_{1D}\,(\Omega_0 B_{1D})} \tag{18.4-5}$$

#### *18.4.2.5 Effective Fundamental Mode Period Determination*

The effective fundamental mode ($m$ = 1) period at the design earthquake ground motion, $T_{1D}$, and at the $\text{MCE}_\text{R}$ ground motion, $T_{1M}$, shall be based on either explicit consideration of the post-yield force deflection characteristics of the structure or determined in accordance with Eqs. 18.4-6 and 18.4-7:

$$T_{1D} = T_1\sqrt{\mu_D} \tag{18.4-6}$$

$$T_{1M} = T_1\sqrt{\mu_M} \tag{18.4-7}$$