18.4.2.6 Higher Mode Seismic Response Coefficient

Higher mode ($m > 1$) seismic response coefficient, C_{Sm}, of the m^{th} mode of vibration ($m > 1$) of the structure in the direction of interest shall be determined in accordance with Eqs. 18.4-8 and 18.4-9:

For $T_m < T_S$,

$$C_{Sm} = \left(\frac{R}{C_d}\right)\frac{S_{D1}}{\Omega_0 B_{mD}} \quad (18.4\text{-}8)$$

For $T_m \geq T_S$,

$$C_{Sm} = \left(\frac{R}{C_d}\right)\frac{S_{D1}}{T_m\,(\Omega_0 B_{mD})} \quad (18.4\text{-}9)$$

where

T_m = period, in seconds, of the m^{th} mode of vibration of the structure in the direction under consideration

B_{mD} = numerical coefficient as set forth in Table 18.6-1 for effective damping equal to β_{mD} and period of the structure equal to T_m

18.4.2.7 Design Lateral Force

Design lateral force at Level i due to the m^{th} mode of vibration, F_{im}, of the structure in the direction of interest shall be determined in accordance with Eq. 18.4-10:

$$F_{im} = w_i \phi_{im} \frac{\Gamma_m}{\bar{W}_m} V_m \quad (18.4\text{-}10)$$

Design forces in elements of the seismic force-resisting system shall be determined by the SRSS or complete quadratic combination of modal design forces.

18.4.3 Damping System

Design forces in damping devices and other elements of the damping system shall be determined on the basis of the floor deflection, story drift, and story velocity response parameters described in the following sections.

Displacements and velocities used to determine maximum forces in damping devices at each story shall account for the angle of orientation of each device from the horizontal and consider the effects of increased response due to torsion required for design of the seismic force-resisting system.

Floor deflections at Level i, δ_{iD} and δ_{iM}, story drifts, Δ_D and Δ_M, and story velocities, ∇_D and ∇_M, shall be calculated for both the design earthquake ground motions and the maximum considered earthquake ground motions, respectively, in accordance with this section.

18.4.3.1 Design Earthquake Floor Deflection

The deflection of structure due to the design earthquake ground motions at Level i in the m^{th} mode of vibration, δ_{imD}, of the structure in the direction of interest shall be determined in accordance with Eq. 18.4-11:

$$\delta_{imD} = D_{mD}\phi_{im} \quad (18.4\text{-}11)$$

The total design deflection at each floor of the structure shall be calculated by the SRSS or complete quadratic combination of modal design earthquake deflections.

18.4.3.2 Design Earthquake Roof Displacement

Fundamental ($m = 1$) and higher mode ($m > 1$) roof displacements due to the design earthquake ground motions, D_{1D} and D_{mD}, of the structure in the direction of interest shall be determined in accordance with Eqs. 18.4-12 and to 18.4-13:

For $m = 1$,

$$D_{1D} = \left(\frac{g}{4\pi^2}\right)\Gamma_1 \frac{S_{DS}T_{1D}^2}{B_{1D}} \geq \left(\frac{g}{4\pi^2}\right)\Gamma_1 \frac{S_{DS}T_1^2}{B_{1E}},\ T_{1D} < T_S \quad (18.4\text{-}12a)$$

$$D_{1D} = \left(\frac{g}{4\pi^2}\right)\Gamma_1 \frac{S_{D1}T_{1D}}{B_{1D}} \geq \left(\frac{g}{4\pi^2}\right)\Gamma_1 \frac{S_{D1}T_1}{B_{1E}},\ T_{1D} \geq T_S \quad (18.4\text{-}12b)$$

For $m > 1$,

$$D_{mD} = \left(\frac{g}{4\pi^2}\right)\Gamma_m \frac{S_{D1}T_m}{B_{mD}} \leq \left(\frac{g}{4\pi^2}\right)\Gamma_m \frac{S_{DS}T_m^2}{B_{mD}} \quad (18.4\text{-}13)$$

18.4.3.3 Design Earthquake Story Drift

Design story drift in the fundamental mode, Δ_{1D}, and higher modes, Δ_{mD} ($m > 1$), of the structure in the direction of interest shall be calculated in accordance with Section 12.8.6 using modal roof displacements of Section 18.4.3.2.

Total design story drift, Δ_D, shall be determined by the SRSS or complete quadratic combination of modal design earthquake drifts.

18.4.3.4 Design Earthquake Story Velocity

Design story velocity in the fundamental mode, ∇_{1D}, and higher modes, ∇_{mD} ($m > 1$), of the structure in the direction of interest shall be calculated in accordance with Eqs. 18.4-14 and 18.4-15:

$$\text{For } m = 1,\ \nabla_{1D} = 2\pi\frac{\Delta_{1D}}{T_{1D}} \quad (18.4\text{-}14)$$

$$\text{For } m > 1,\ \nabla_{mD} = 2\pi\frac{\Delta_{mD}}{T_m} \quad (18.4\text{-}15)$$