

18.7.1.2 Damping Systems

The damping devices and their connections shall be sized to resist the forces, displacements, and velocities from the maximum considered earthquake ground motions.

18.7.1.3 Combination of Load Effects

The effects on the damping system due to gravity loads and seismic forces shall be combined in accordance with Section 12.4 using the effect of horizontal seismic forces, Q_E , determined in accordance with the analysis. The redundancy factor, ρ , shall be taken equal to 1.0 in all cases, and the seismic load effect with overstrength factor of Section 12.4.3 need not apply to the design of the damping system.

18.7.1.4 Acceptance Criteria for the Response Parameters of Interest

The damping system components shall be evaluated using the strength design criteria of this standard using the seismic forces and seismic loading conditions determined from the nonlinear procedures and $\phi = 1.0$. The members of the seismic force-resisting system need not be evaluated where using the nonlinear procedure forces.

18.7.2 Response-Spectrum and Equivalent Lateral Force Procedures

Where response-spectrum or equivalent lateral force procedures are used in analysis, the seismic force-resisting system, damping system, seismic loading conditions, and acceptance criteria shall conform to the following subsections.

18.7.2.1 Seismic Force-Resisting System

The seismic force-resisting system shall satisfy the requirements of Section 12.2.1 using seismic base shear and design forces determined in accordance with Section 18.4.2 or 18.5.2.

The design story drift, Δ_D , as determined in either Section 18.4.3.3 or 18.5.3.3 shall not exceed (R/C_d) times the allowable story drift, as obtained from Table 12.12-1, considering the effects of torsion as required in Section 12.12.1.

18.7.2.2 Damping System

The damping system shall satisfy the requirements of Section 12.2.1 for seismic design forces and seismic loading conditions determined in accordance with this section.

18.7.2.3 Combination of Load Effects

The effects on the damping system and its components due to gravity loads and seismic forces

shall be combined in accordance with Section 12.4 using the effect of horizontal seismic forces, Q_E , determined in accordance with Section 18.7.2.5. The redundancy factor, ρ , shall be taken equal to 1.0 in all cases, and the seismic load effect with overstrength factor of Section 12.4.3 need not apply to the design of the damping system.

18.7.2.4 Modal Damping System Design Forces

Modal damping system design forces shall be calculated on the basis of the type of damping devices and the modal design story displacements and velocities determined in accordance with either Section 18.4.3 or 18.5.3.

Modal design story displacements and velocities shall be increased as required to envelop the total design story displacements and velocities determined in accordance with Section 18.3 where peak response is required to be confirmed by response-history analysis.

1. Displacement-dependent damping devices: Design seismic force in displacement-dependent damping devices shall be based on the maximum force in the device at displacements up to and including the design story drift, Δ_D .
2. Velocity-dependent damping devices: Design seismic force in each mode of vibration in velocity-dependent damping devices shall be based on the maximum force in the device at velocities up to and including the design story velocity for the mode of interest.

Displacements and velocities used to determine design forces in damping devices at each story shall account for the angle of orientation of the damping device from the horizontal and consider the effects of increased floor response due to torsional motions.

18.7.2.5 Seismic Load Conditions and Combination of Modal Responses

Seismic design force, Q_E , in each element of the damping system shall be taken as the maximum force of the following three loading conditions:

1. Stage of maximum displacement: Seismic design force at the stage of maximum displacement shall be calculated in accordance with Eq. 18.7-1:

$$Q_E = \Omega_0 \sqrt{\sum_m (Q_{mSFERS})^2} \pm Q_{DSD} \quad (18.7-1)$$