Seismic Demands of Non-Structural Components

NZS/TS 1170.5 vs ASCE 7-22

TS 1170.5 (Section 8)

TS 1170.5 – Seismic Coefficient, $C_p(T_p)$

8.2 Design response coefficient for parts and components

The design response coefficient for parts and components, $C_p(T_p)$, is the horizontal acceleration coefficient derived for the level of structure that provides support for the part. It shall be calculated using Equation 8.1.

$$C_p(T_p) = PGA \left[\frac{C_{Hi}}{C_{str}}\right]\left[\frac{C_i(T_p)}{C_{ph}}\right] \quad \text{(Eq. 8.1)}$$

where

PGA = the peak ground acceleration, determined from 3.3.1.

C_{Hi} = the floor-height coefficient for level i, determined from 8.3

C_{str} = the structural-nonlinearity-reduction factor, determined from 8.4

T_p = the period of the part

$C_i(T_p)$ = the part or component spectral-shape coefficient, determined from 8.5

C_{ph} = the part or component horizontal-response factor, determined from 8.6

TS 1170.5 - Long-period Parts Seismic Coefficient

For long-period parts and components possessing a period, T_p, greater than $T_{p.long}$, determined using Equation 8.2, the design response coefficient, $C_{p,long}(T_p)$ can be used in place of $C_p(T_p)$ and calculated using Equation 8.3.

$$T_{p,long} = T_1(1 + \sqrt{\mu}) \text{ ---------- (Eq. 8.2)}$$

where

T_1 = the largest translational period of vibration of the primary structure, in the direction being considered

μ = the structural-ductility factor, determined from 4.3

$$C_{p,long}(T_p) = \frac{S_a(T_p)}{C_{ph}}\left[1 + \frac{1}{\left(\frac{T_p}{T_1} - 1\right)^2}\right] \text{ ---------- (Eq. 8.3)}$$

where

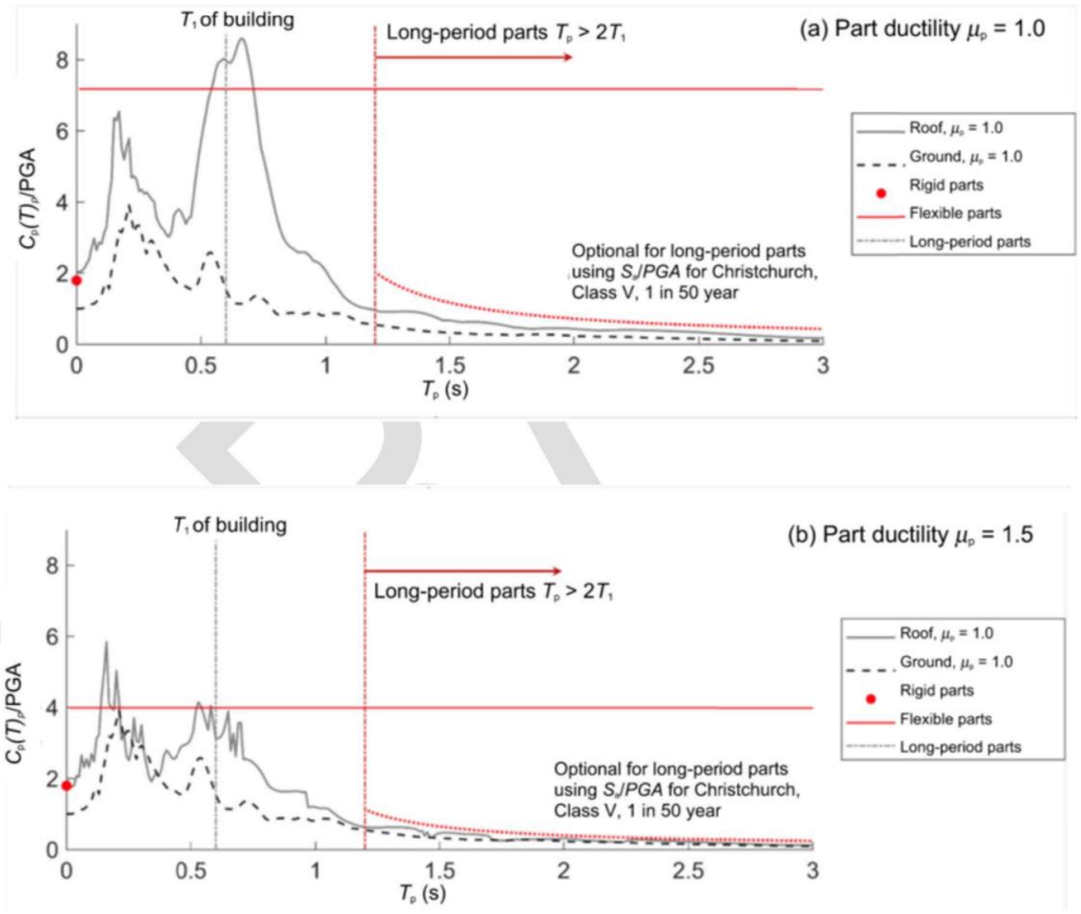
$S_a(T_p)$ = the spectral-acceleration of the part, , determined from $S_a(T)$ (see 3.1.2) at period T_p

TS 1170.5 - Rigid Parts

Given the practical challenge of estimating the part period, and uncertainties in estimates of the part and building period, the approach adopted in Table 8.2 assumes a dynamic amplification factor of 4.0 for any flexible part, noting that parts with long periods can instead, if desired, be designed for lower demands (see

C8.2). A rigid part has an amplification factor of 1.0 and is expected to be subject to PFA. Table C8.3 classifies different types of parts and components as flexible or rigid. These classifications can be adopted without explicit evaluation of the part period. A flexible part is any part with a period of vibration greater than 0.06 s (this is evaluated by considering the expected mass and stiffness, and allowing for flexibility of connections). The general classification of parts, and their corresponding ductility values, in Table C8.2 should be used only when the type of part or component does not match one listed in Table C8.3. Table C8.3 also provides part and component design ductility values that are discussed in C8.6.

TS 1170.5 – Floor Spectral Shape



Application of provisions for rigid, flexible, and long period parts (TS 1170.5)

TS 1170.5 – Floor-height coefficient, C_H

8.3 Floor-height coefficient

The floor-height coefficient at level *i*, C_{Hi}, shall be calculated using Equation 8.4.

$$C_{Hi} = 1 + \frac{1}{T_1}\left(\frac{h_i}{h_n}\right) + \left[1 - \left(\frac{0.4}{T_1}\right)^2\right]\left(\frac{h_i}{h_n}\right)^{10} \quad \text{(Eq. 8.4)}$$

Alternatively, it is permitted to determine C_{Hi} from Equation 8.5.

$$C_{Hi} = 1 + 2.5\left(\frac{h_i}{h_n}\right) \quad \text{(Eq. 8.5)}$$

where

T_1 = the largest translational period of vibration of the primary structure in the direction being considered, but not less than 0.4 seconds

h_i = the height of the attachment of the part or component from the base of the structure

h_n = the height from the base of the structure to the uppermost seismic weight or mass in the structure

TS 1170.5 – Structural-nonlinearity-reduction factor, C_{str}

8.4 Structural-nonlinearity-reduction factor

The structural-nonlinearity-reduction factor, C_{str}, shall be taken as 1.0 for components at ground level and shall be calculated using Equation 8.6 for parts and components at other levels.

$$C_{str} = (C_{\mathrm{str,max}})^{\wedge e_{\mathrm{str}}} \quad \text{(Eq. 8.6)}$$

where

$C_{str,max}$ = the maximum structural-nonlinearity-reduction factor, determined using Equation 8.7

e_{str} = the floor-height distribution exponent for structural nonlinearity reduction, determined using Equation 8.8

$$C_{str,max} = \sqrt{\mu} \geq 1.3 \quad \text{(Eq. 8.7)}$$

where

μ = the structural-ductility factor, determined from 4.3

$$e_{str} = \left(\frac{h_{\mathrm{i}}}{h_{\mathrm{n}}}\right)^{1.5} \quad \text{(Eq. 8.8)}$$

where

h_i = the height of the attachment of the part or component from the base of the structure

h_n = the height from the base of the structure to the uppermost seismic weight or mass in the structure

TS 1170.5 – Spectral-shape coefficient, $C(T_p)$

8.5 Part or component spectral-shape coefficient

The part or component spectral-shape coefficient, $C_i(T_p)$, shall be determined from Table 8.2. .

Table 8.2 – Part or component spectral-shape coefficient, $C_i(T_p)$

Rigid components	Flexible components	
All levels	At ground level or below ground level	Above ground level
1.0	$\frac{S_{as}}{PGA}$	4.0

where

$S_{a,s}$ = the short-period spectral acceleration, determined from 3.1.2

PGA = the peak ground acceleration, determined from 3.3.1

NOTE –

(1) Refer to C8.5 for guidance on classifying parts or components as rigid or flexible.

(2) The part or component spectral-shape coefficient for flexible and long-period components assumes that parts are characterised with 5% damping. Alternative spectral-shape coefficients can be adopted if they are supported by the results of a special study.

TS 1170.5 – Response-factor, C_{ph} & C_{pv}

8.6 Part-response factor or component-response factor

The part-horizontal-response factor or component-horizontal-response factor, C_{ph}, shall be taken from Table C8.3 with the ductility of the part μ_p = 1.0 for SLS1 design and μ_p =1.25 for SLS2 design. The recommendations of Table C8.3 can be used, directly or by interpolation, without further verification. Alternatively, part ductility values for ULS design may be determined based on analysis or testing.

The part-vertical-response factor or component-vertical-response factor, C_{pv}, shall be taken from Table 8.3 with μ_p = 1.0.

Table 8.3 – Part-response or component-response factor, C_{ph} and C_{pv}

Ductility of the part μ_p	Rigid components	Flexible components		Long-period components[a]
	All levels	At ground level or below	Above ground level	All levels
1.0	1.0	1.0	1.0	1.0
1.25	1.0	1.25	1.4	1.25
1.5	1.0	1.5	1.85	1.5
2.0	1.0	2.0	2.8	2.0
≥2.5	1.0	2.5	4.0	2.5

NOTE –

a. A long-period component is taken as a component that has a fundamental period, T_p, greater than $T_{p,long}$, where $T_{p,long}$ is defined in 8.2.

TS 1170.5 – Ductility of the part, μ_p

Table C8.2 – General classification of parts or components and design ductility values

Description of part or component	Class	Part design ductility		
		SLS1	SLS2	ULS
Rigid parts or components	Rigid	N/A	N/A	N/A
Flexible parts or components				
Parts with good post-yield deformation capacity	Flexible	1.0	1.0	2.5
Parts with unknown post-yield behaviour, but some expected inelastic displacement capacity or ability to slip or rock	Flexible	1.0	1.0	1.5
Parts with unknown post-yield behaviour that may be brittle	Flexible	1.0	1.0	1.25

TS 1170.5 – Ductility and Classification of the part

Table C8.3 – Classification of common parts or components and design ductility values

Description of part or component	Class	Part design ductility[a]		
		SLS1	SLS2[b]	ULS[c]
Ceilings				
Direct-fixed to underside of structural floors	Rigid	N/A	N/A	N/A
Framed and end-fixed to walls	Flexible	1.0	1.0	1.5
Suspended – braced	Flexible	1.0	1.0	1.5
Suspended – un-braced[d]	Flexible	N/A	N/A	N/A
Suspended or framed and with clips restraining vertical movement of ceiling tiles	Flexible	1.0	1.0	2.0

TS 1170.5 – Ductility and Classification of the part

Description of part or component	Class	Part design ductility[a]		
		SLS1	SLS2[b]	ULS[c]
Precast reinforced-concrete cladding panels (out-of-plane loading)[e]	Flexible	1.0	1.0	2.0
Glass facades, balustrades, and walls (out-of-plane loading)				
Systems using laminated glass and multiple support points	Flexible	1.0	1.0	1.5
Other systems	Flexible	1.0	1.0	1.0
Timber-framed partitions, facades, balustrades, and walls (out-of-plane loading)	Flexible	1.0	1.0	2.5
Masonry facades, parapets, and walls (out-of-plane loading)	Flexible	1.0	1.0	1.25
Steel-framed partitions, facades, and parapet walls (out-of-plane loading)	Flexible	1.0	1.0	2.5
Stairs (fixed to one level and free to slide at the other)				
Reinforced-concrete, steel or timber stairs	Flexible	1.0	1.0	2.5

TS 1170.5 – Ductility and Classification of the part

Storage racks[f]				
Floor-supported	Flexible	1.0	1.0	1.5
Braced laterally, top and bottom	Flexible	1.0	1.0	2.0
Lifts and guide rails[g]	Flexible	1.0	1.0	2.0
Mechanical parts or components				
Heavy equipment, direct-fixed to slabs, or with saddle supports	Rigid	N/A	N/A	N/A
Vibration-isolated heavy equipment	Flexible	1.0	1.0	1.5
Heavy equipment with other supports	Flexible	1.0	1.0	2.00
Storage vessels (without hazardous materials)	Flexible	1.0	1.0	1.5
Vibration-isolated HVAC equipment	Flexible	1.0	1.0	1.5
HVAC equipment with stiff restraints	Flexible	1.0	1.0	2.0
Distribution systems, including pipes, ducts, conduits, and cable trays[(7)]	Flexible	1.0	1.0	1.5

TS 1170.5 – Ductility and Classification of the part

Description of part or component	Class	Part design ductility[a]		
		SLS1	SLS2[b]	ULS[c]
Electrical parts or components				
Lighting – surface mounted to underside of structural floors	Rigid	N/A	N/A	N/A
Lighting – integrated within ceiling	Flexible	1.0	1.0	1.5
Lighting – Stiff or braced pendant lighting	Flexible	1.0	1.0	1.5
Lighting – Flexible pendant lighting	Flexible	See note (h)		
Electrical cabinets or equipment – fixed to structural floor	Flexible	1.0	1.0	2.0

TS 1170.5 – Ductility and Classification of the part

Cantilever structures				
Capacity designed	Flexible	1.0	1.0	2.5
Non-capacity designed	Flexible	1.0	1.0	1.25
Penthouse structures				
Capacity designed	Flexible	1.0	1.0	2.5
Non-capacity designed	Flexible	1.0	1.0	1.25
Raised floors	Flexible	1.0	1.0	1.5
Parts supporting, or containing, hazardous materials	Flexible	1.0	1.0	1.0

NOTE –

TS 1170.5 – Ductility and Classification of the part

NOTE –

a. The part design ductility refers to the ratio of the displacement capacity to the displacement at yield. The displacement capacity for ULS may be higher than the inelastic deformation alone, due to contributions from connection slip and the level of redundancy in the part or component system.

b. The ductility values indicated for SLS2 refer to the design ductility of the part or component for what regards its restraint only. The designer should also verify that, post-earthquake, P.5 parts (such as mechanical and electrical equipment) can remain operational, or be easily repaired, when they are subject to the associated design accelerations.

c. The ductility values indicated for ULS refer to the design ductility only for the restraint of the part or component against falling. The designer should also verify that, post-earthquake, P.4 parts within the structure can continue to function, for evacuation and human-life-support purposes.

d. If a ceiling system is suspended and has no lateral bracing system, the concern is not the lateral forces, but the lateral displacement demands, clearance requirements, and interactions with other components. These should be evaluated through engineering calculations or analysis.

e. The ductility and design seismic actions for connections of pre-cast panels should be verified in line with the TS (see 8.8). The in-plane drift demand on a panel may have an impact on the out-of-plane capacity (Belleri et al, 2017), and this should be allowed for when verifying the out-of-plane capacity.

f. The contents of storage racks should be restrained against falling. If racks support hazardous materials, they should be designed using the classification for parts that contain or support hazardous materials.

g. For elements that are continuous between two or more floors (e.g., lift guide rails), the designer should consider additional forces induced by relative inter-storey displacement demands.

h. For unrestrained flexible pendant lighting, the engineer shall check displacement clearances.

The notes below Table 8.2 indicate that alternative spectral-shape coefficients may be adopted if this is supported by the results of a special study. The spectral-shape coefficient is affected by the inherent damping of the part or component. Therefore, if test data is available to demonstrate that the damping of the component differs from 5%, the spectral-shape-coefficient for above ground can be quantified according to Equation C8.1 with 5% damping specified for the building damping. The expression that led to Equation C8.1 (Welch, 2016) considered data for supporting structures with low levels of damping (between 1% and 5%). Its applicability to structures with added dampers has not been tested.

TS 1170.5 – Horizontal Design actions, F_{ph}

8.7 Design actions on parts and components

8.7.1 Horizontal design actions

The horizontal design earthquake actions on a part, F_{ph}, shall be determined from Equation 8.9.

$$F_{ph} = \frac{C_p(T_p)}{\Omega_p} R_p W_p \leq \frac{7.5\ PGA\ W_p}{\Omega_p} \quad \text{(Eq. 8.9)}$$

where

$C_p(T_p)$ = the horizontal design coefficient of the part or component, determined from 8.2

Ω_p = the part or component reserve-capacity factor, taken as 1.5 for ULS and 1.0 for SLS1 and SLS2, unless demonstrated to be greater

R_p = the part or component risk factor, given by Table 8.1

PGA = the peak ground acceleration, determined from 3.3.1.

W_p = the weight of the part or component

TS 1170.5 – Vertical Design Actions, F_{pv}

8.7.2 Vertical design actions

Parts or components that are sensitive to vertical acceleration amplification shall be designed for vertical earthquake actions. The vertical earthquake actions on a part or component, F_{pv}, shall be calculated using Equation 8.10.

$$F_{pv} = \frac{C_{vd}}{C_{pv}} R_p W_p \leq 2.5W_p \quad \text{(Eq. 8.10)}$$

where

C_{pv} = the part or component vertical-response factor, determined from 8.6

C_{vd} = the vertical design action coefficient, determined from 5.5 for the period of the system supporting the part

R_p = the part risk factor, given by Table 8.1

W_p = the weight of the part

8.7.3 Deflection-induced actions

When the part is connected to the primary structure on more than one level, the part shall be designed to sustain the actions resulting from the relative deflections that occur for the limit state being considered.

Parts and components that are supported at more than one level, or between different structures, and where at least one support is on a sliding ledge, shall also comply with 8.9.

TS 1170.5 – Parts Connections

8.8 Connections

8.8.1 Non-ductile connections

Non-ductile connections for parts shall be designed for seismic actions that correspond to a ductility factor of the part of μ_p= 1.0, or derived using capacity design considering the maximum resistance of the part. Non-ductile connections include, but are not limited to, expansion anchors, shallow chemical anchors, or shallow (non-ductile) cast-in-place anchors in tension and not engaged with the main reinforcement.

8.8.2 Other connections

Other connections can be designed for a greater value of μ_p, where the specific detailing can be verified to sustain not less than 90% of its design action effects at a displacement greater than twice its yield displacement under reversed cyclic loading.

ASCE 7-22 (Section 13)

ASCE 7-22 – Horizontal Seismic Force

The horizontal seismic design force shall be calculated as

$$F_p = 0.4 S_{DS} I_p W_p \left[\frac{H_f}{R_\mu}\right]\left[\frac{C_{AR}}{R_{po}}\right] \qquad (13.3\text{-}1)$$

F_p is not required to be taken as greater than

$$F_p = 1.6 S_{DS} I_p W_p \qquad (13.3\text{-}2)$$

and shall not be taken as less than

$$F_p = 0.3 S_{DS} I_p W_p \qquad (13.3\text{-}3)$$

where

F_p = Seismic design force;
S_{DS} = Spectral acceleration, short period, as determined in accordance with Section 11.4.5;
I_p = Component Importance Factor as determined in accordance with Section 13.1.3;
W_p = Component operating weight;
H_f = Factor for force amplification as a function of height in the structure as determined in Section 13.3.1.1;
R_μ = Structure ductility reduction factor as determined in Section 13.3.1.2;
C_{AR} = Component resonance ductility factor that converts the peak floor or ground acceleration into the peak component acceleration, as determined in Section 13.3.1.3; and
R_{po} = Component strength factor as determined in Section 13.3.1.4.

ASCE 7-22 – Heigh Amplification, H_f

13.3.1.1 Amplification with Height, H_f For nonstructural components supported at or below grade plane, the factor for force amplification with height H_f, is 1.0. For components supported above grade plane by a building or nonbuilding structure, H_f is permitted to be determined by Equation (13.3-4) or Equation (13.3-5). Where the approximate fundamental period of the supporting building or nonbuilding structure is unknown, H_f is permitted to be determined by Equation (13.3-5).

$$H_f = 1 + a_1\left(\frac{z}{h}\right) + a_2\left(\frac{z}{h}\right)^{10} \tag{13.3-4}$$

$$H_f = 1 + 2.5\left(\frac{z}{h}\right) \tag{13.3-5}$$

where

$a_1 = 1/T_a \le 2.5$;

$a_2 = [1 - (0.4/T_a)^2] \ge 0$;

z = Height above the base of the structure to the point of attachment of the component. For items at or below the base, z shall be taken as 0. The value of $\frac{z}{h}$ need not exceed 1.0;

h = Average roof height of structure with respect to the base; and

T_a = Lowest approximate fundamental period of the supporting building or nonbuilding structure in either orthogonal direction. For structures with combinations of seismic force-resisting systems (SFRSs), the SFRS that produces the lowest value of T_a shall be used.

ASCE 7-22 – Structure ductility reduction factor, R_μ

13.3.1.2 Structure Ductility Reduction Factor, R_μ For components supported by a building or nonbuilding structure, the reduction factor for ductility of the supporting structure, R_μ, is calculated as

$$R_\mu = [1.1R/(I_e\Omega_0)]^{1/2} \geq 1.3 \qquad (13.3\text{-}6)$$

where

I_e = Importance Factor as prescribed in Section 11.5.1 for the building or nonbuilding structure supporting the component;

R = Response modification factor for the building or nonbuilding structure supporting the component, from Table 12.2-1, 15.4-1, or 15.4-2; and

Ω_0 = Overstrength factor for the building or nonbuilding structure supporting the component, from Table 12.2-1, 15.4-1, or 15.4-2.

ASCE 7-22 – Architectural parts coefficients

Table 13.5-1. Coefficients for Architectural Components.

Architectural Component	C_{AR}: Supported at or below grade plane	C_{AR}: Supported above grade plane by a structure	R_{po}	Ω_{op}[a]
Interior nonstructural walls and partitions[b]				
Light frame ≤ 9 ft (2.74 m) in height	1	1	1.5	2
Light frame > 9 ft (2.74 m) in height	1.4	1.4	1.5	2
Reinforced masonry	1	1	1.5	2
All other walls and partitions	2.2	2.8	1.5	1.5
Cantilever elements (unbraced or braced to structural frame below its center of mass)				
Parapets and cantilever interior nonstructural walls	1.8	2.2	1.5	1.75
Chimneys where laterally braced or supported by the structural frame	1.8	2.2	1.5	1.75
Cantilever elements (braced to structural frame above its center of mass)				
Parapets	1	1	1.5	2
Chimneys	1	1	1.5	2
Exterior nonstructural walls[b]	1	1	1.5	2
Exterior nonstructural wall elements and connections[b]				
Wall element	1	1	1.5	2
Body of wall panel connections	1	1	1.5	2
Fasteners of the connecting system	2.2	2.8	1.5	1
Veneer				
Limited-deformability elements and attachments	1	1	1.5	2
Low-deformability elements and attachments	1	1	1.5	2
Penthouses (except where framed by an extension of the building frame)				
Seismic force-resisting systems with $R \geq 6$	N/A	1.4	2	2
Seismic force-resisting systems with $4 \leq R < 6$	N/A	2.2	2	1.75
Seismic force-resisting systems with $R < 4$	N/A	2.8	2	1.5
Other systems	N/A	2.8	1.5	1.5

ASCE 7-22 – Architectural parts coefficients

Ceilings				
All	1	1	1.5	2
Cabinets				
Permanent floor-supported storage cabinets more than 6 ft (1.8 m) tall, including contents	1	1	1.5	2
Permanent floor-supported library shelving, book stacks, and bookshelves more than 6 ft (1.8 m) tall, including contents	1	1	1.5	2
Laboratory equipment	1	1	1.5	2
Access floors				
Special access floors (designed in accordance with Section 13.5.7.2)	1	1	2	2
All other	2.2	2.8	1.5	1.5
Appendages and ornamentations	1.8	2.2	1.5	1.75
Signs and billboards	1.8	2.2	1.5	1.75
Other rigid components	1	1	1.5	2
Other flexible components				
High-deformability elements and attachments	1.4	1.4	1.5	2
Limited-deformability elements and attachments	1.8	2.2	1.5	1.75
Low-deformability materials and attachments	2.2	2.8	1.5	1.5
Egress stairways not part of the building seismic force-resisting system	1	1	1.5	2
Egress stairs and ramp fasteners and attachments	1.8	2.2	1.5	1.75

[a] Overstrength factor, where required for nonductile anchorage to concrete and masonry (see Section 13.4.2).

[b] Where flexible diaphragms provide lateral support for concrete or masonry walls and partitions, *the design forces for anchorage to the diaphragm shall be as specified in Section 12.11.2.*

Note: N/A = not applicable.

ASCE 7-22 – Mechanical & Electrical parts coefficients

Table 13.6-1. Seismic Coefficients for Mechanical and Electrical Components.

MECHANICAL AND ELECTRICAL COMPONENTS	C_{AR} Supported at or below grade plane	C_{AR} Supported above grade plane by a structure	R_{po}	$\Omega_{op}{}^{b}$
Air-side HVACR, fans, air handlers, air conditioning units, cabinet heaters, air distribution boxes, and other mechanical components constructed of sheet metal framing	1.4	1.4	2	2
Wet-side HVACR, boilers, furnaces, atmospheric tanks and bins, chillers, water heaters, heat exchangers, evaporators, air separators, manufacturing or process equipment, and other mechanical components constructed of high-deformability materials	1	1	1.5	2
Air coolers (fin fans), air-cooled heat exchangers, condensing units, dry coolers, remote radiators, and other mechanical components elevated on integral structural steel or sheet metal supports	1.8	2.2	1.5	1.75
Engines, turbines, pumps, compressors, and pressure vessels not supported on skirts and not within the scope of Chapter 15	1	1	1.5	2
Skirt-supported pressure vessels not within the scope of Chapter 15	1.8	2.2	1.5	1.75
Elevator and escalator components	1	1	1.5	2
Generators, batteries, inverters, motors, transformers, and other electrical components constructed of high-deformability materials	1	1	1.5	2
Motor control centers, panel boards, switch gear, instrumentation cabinets, and other components constructed of sheet metal framing	1.4	1.4	2	2
Communication equipment, computers, instrumentation, and controls	1	1	1.5	2
Roof-mounted stacks, cooling and electrical towers laterally braced below their center of mass	1.8	2.2	1.5	1.75
Roof-mounted stacks, cooling and electrical towers laterally braced above their center of mass	1	1	1.5	2
Lighting fixtures	1	1	1.5	2
Other mechanical or electrical components	1	1	1.5	2
Manufacturing or process conveyors (nonpersonnel)	1.8	2.2	1.5	1.75

ASCE 7-22 – Mechanical & Electrical parts coefficients

VIBRATION-ISOLATED COMPONENTS AND SYSTEMS[a]				
Components and systems isolated using neoprene elements and neoprene isolated floors with built-in or separate elastomeric snubbing devices or resilient perimeter stops	1.8	2.2	1.3	1.75
Spring-isolated components and systems and vibration-isolated floors closely restrained using built-in or separate elastomeric snubbing devices or resilient perimeter stops	1.8	2.2	1.3	1.75
Internally isolated components and systems	1.8	2.2	1.3	1.75
Suspended vibration-isolated equipment, including in-line duct devices and suspended internally isolated components	1.8	2.2	1.3	1.75
EQUIPMENT SUPPORT STRUCTURES AND PLATFORMS				
Support structures and platforms where $T_p/T_a < 0.2$, or $T_p \leq 0.06$ s, per Section 13.6.4.6	NA	1	1.5	2
Seismic force-resisting systems with $R > 3$	1.4	1.4	1.5	2
Seismic force-resisting systems with $R \leq 3$	1.8	2.2	1.5	1.75
Other systems	2.2	2.8	1.5	1.5
DISTRIBUTION SYSTEM SUPPORTS				
Tension-only and cable bracing	1	1	1.5	2
Cold-formed steel rigid bracing	1	1	1.5	2
Hot-rolled steel bracing	1	1	1.5	2
Other rigid bracing	1	1	1.5	2
Lateral resistance provided by rods in flexure	1.8	2.2	1.5	1.75
Vertical cantilever supports such as pipe tees and moment frames above and supported by a floor or roof	1.8	2.2	1.5	1.75
DISTRIBUTION SYSTEMS				
Piping in accordance with ASME B31 (2001, 2002, 2008, 2010), including in-line components with joints made by welding or brazing	1	1	3	2
Piping in accordance with ASME B31, including in-line components, constructed of high- or limited-deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings	1	1	2	2
Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing	1	1	2	2
Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high- or limited-deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings	1.8	2.2	2	1.75
Piping and tubing constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics	1.8	2.2	1.5	1.75
Duct systems, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing	1	1	2	2

ASCE 7-22 – Mechanical & Electrical parts coefficients

Table 13.6-1 *(Continued)*.

MECHANICAL AND ELECTRICAL COMPONENTS	C_{AR} Supported at or below grade plane	C_{AR} Supported above grade plane by a structure	R_{po}	Ω_{op}[b]
Duct systems, including in-line components, constructed of high- or limited-deformability materials, with joints made by means other than welding or brazing	1	1	1.5	2
Duct systems, including in-line components, constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics	1.8	2.2	1.5	1.75
Electrical conduit, cable trays, and raceways	1	1	1.5	2
Bus ducts	1	1	1.5	2
Plumbing	1	1	1.5	2
Pneumatic tube transport systems	1	1	1.5	2

[a] Components mounted on vibration isolators shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$ if the nominal clearance (air gap) between the equipment support frame and restraint is greater than 0.25 in. (6 mm). If the nominal clearance specified on the construction documents is not greater than 0.25 in. (6 mm), the design force is permitted to be taken as F_p.

[b] Overstrength factor as required for anchorage to concrete and masonry (see Section 13.4.2).

ASCE 7-22 – Nonlinear Response Analysis

13.3.1.5 Nonlinear Response History Analysis In lieu of the forces determined in accordance with Equation (13.3-1), the nonlinear response history analysis procedures of Chapters 16, 17, and 18 may be used to determine the seismic design force for nonstructural components. Where the dynamic properties of the nonstructural component are not explicitly modeled in the nonlinear response history analysis, the seismic design force, *Fp*, shall be calculated as

$$F_p = I_p W_p a_i \left[\frac{C_{AR}}{R_{po}}\right] \quad (13.3\text{-}7)$$

where a_i is the maximum acceleration at level i obtained from the nonlinear response history analysis at the Design Earthquake ground motion. When a_i is determined using nonlinear response history analysis, a suite of not less than seven ground motions shall be used. If the supporting structure is designed using nonlinear response history analysis, the entire suite of ground motions used to design the structure shall be used to determine a_i. The value of the parameter a_i shall be taken as the mean of the maximum values of acceleration at the center of mass of the support level, obtained from each analysis. The upper and lower limits of F_p determined by Equations (13.3-2) and (13.3-3) shall apply.

13.3.1.6 Vertical Seismic Force The component, including its supports and attachments, shall be designed for a concurrent vertical seismic design force equal to E_v per Section 12.4.2.2.

ASCE 7-22 – Period of the parts

13.3.3 Component Period The fundamental period, T_p, of the nonstructural component, including its supports and attachment to the structure, shall be determined by the following equation, provided the component, supports, and attachment can be reasonably represented analytically by a simple single-degree-of-freedom spring-and-mass system:

$$T_p = 2\pi\sqrt{\frac{W_p}{K_p g}} \qquad (13.3\text{-}13)$$

where

T_p = Component fundamental period,
W_p = Component operating weight,
g = Gravitational acceleration, and
K_p = Combined stiffness of the component, supports, and attachments, determined in terms of load per unit deflection at the center of gravity of the component.

Alternatively, the fundamental period of the component, T_p, in seconds is permitted to be determined from experimental test data or by a properly substantiated analysis.

References

ASCE7-22 (2022). Minimum design loads and associated criteria for buildings and other structures. American Society of Civil Engineers.

NZS/TS 1170.5 (2024). Structural design actions, Part 5: Earthquake actions – New Zealand.