# Nonbuilding Structure / Equipment on Grade: ASCE 7-22 Chapter 15

seismic_ch15_nonbuilding_a  ver 1.0  by Tom Irvine

## Model

A single rigid body on a pad: a nonbuilding structure not similar to a building (Section 15.4). Weight $W$, center of gravity at height $h_{cg}$, midway between two anchor lines a distance $L$ apart. $n$ anchors in all, $n_t$ on the tension line.

## Rigid: $T < 0.06$ s (Section 15.4.2)

$V = 0.30\, S_{DS}\, W\, I_e$

## Flexible: $T \geq 0.06$ s (Sections 15.4.1 and 12.8.1.1)

$C_s = \dfrac{S_{DS}}{R/I_e}$  $C_s \leq \dfrac{S_{D1}}{T\,(R/I_e)}$ $(T \leq T_L)$  $C_s \leq \dfrac{S_{D1}\,T_L}{T^2\,(R/I_e)}$ $(T > T_L)$

$C_s \geq 0.044\, S_{DS}\, I_e \geq 0.03$ (Eq. 15.4-1)  $S_1 \geq 0.6$: $C_s \geq \dfrac{0.8\, S_1}{R/I_e}$ (Eq. 15.4-2)  $V = C_s W$

$R$, $\Omega_0$ from Table 15.4-2; $I_e$ from Table 1.5-2 (or Section 15.4.1.1).

## Seismic load effects (Sections 12.4.2 and 12.4.3)

$E_h = Q_E = V$  $E_v = 0.2\, S_{DS}\, W$  $E_{mh} = \Omega_0\, E_h$

## Overturning and anchors (load combination $0.9D - E_v + E_h$)

$M_{OT} = E_h\, h_{cg}$  $M_R = (0.9 - 0.2\, S_{DS})\, W\, \dfrac{L}{2}$  (moments about the compression anchor line)

$T_{anchor} = \dfrac{\max(0,\ M_{OT} - M_R)}{L\, n_t}$  $V_{anchor} = \dfrac{E_h}{n}$  repeat with $E_{mh}$ in place of $E_h$

$M_R/M_{OT} \geq 1$: no net uplift. Check also $1.2D + E_v + E_h$ for the compression side and the supporting pad.

## Units

**English**: $W$, forces lbf; $h_{cg}$, $L$ in; moments lbf-in.  **metric**: N, mm, N-mm.  $S_{DS}$, $S_{D1}$, $S_1$ in g; $T$, $T_L$ in s.

## Notes

Anchors in concrete are designed to ACI 318 Chapter 17, which sets when the $\Omega_0$ forces must be used.
Shear is shared equally by all anchors; tension only by the $n_t$ anchors on the far line (base assumed rigid).
Nonbuilding structures similar to buildings, tanks, and items supported by other structures use other clauses.
Equations and clause numbers are as recalled for ASCE 7-22; check them against the standard before design use.

## Reference

ASCE/SEI 7-22, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, Sections 12.4, 12.8, 15.4.