Story Drift Check: ASCE 7-22 Sections 12.8.6, 12.8.7 and 12.12

story_drift_a ver 1.1 by Tom Irvine

Design story drift (Section 12.8.6)

$$\delta_x = \frac{C_d\,\delta_{xe}}{I_e} \qquad \Delta_x = \delta_x - \delta_{x-1}, \quad \delta_0 = 0$$

δ_{xe} = displacement at level x (top of story x) from an elastic analysis at the strength-design force level, at the center of mass. For torsional irregularity Type 1a or 1b in SDC C-F, use the largest difference of displacements of vertically aligned points along any edge.
The minimum C_s limit on base shear need not be applied when computing drift (12.8.6.1).
C_d deflection amplification factor (Table 12.2-1), I_e seismic importance factor (Table 1.5-2).

Allowable story drift (Section 12.12.1, Table 12.12-1)

$\Delta_x \le \Delta_a = c\,h_{sx}$ h_{sx} = story height below level x

Structure type	*RC I or II*	*RC III*	*RC IV*
Structures, 4 stories or less, walls designed for drift	$0.025\,h_{sx}$	$0.020\,h_{sx}$	$0.015\,h_{sx}$
All other structures	$0.020\,h_{sx}$	$0.015\,h_{sx}$	$0.010\,h_{sx}$
Masonry cantilever shear wall structures	$0.010\,h_{sx}$	$0.010\,h_{sx}$	$0.010\,h_{sx}$
Other masonry shear wall structures	$0.007\,h_{sx}$	$0.007\,h_{sx}$	$0.007\,h_{sx}$

Single-story structures with interior walls, partitions, ceilings and exterior walls designed to accommodate the drift: no limit.
RC = Risk Category. See the notes to Table 12.12-1 for the full definitions.

Moment frames in SDC D, E and F (Section 12.12.1.1)

$\Delta_x \le \Delta_a/\rho$ for seismic force-resisting systems made only of moment frames; ρ = redundancy factor (12.3.4).

P-delta stability coefficient (Section 12.8.7)

$$\theta = \frac{P_x\,\Delta\,I_e}{V_x\,h_{sx}\,C_d} \qquad \theta_{max} = \frac{0.5}{\beta\,C_d} \le 0.25$$

P_x = total vertical design load at and above level x (load factors not over 1.0); V_x = seismic shear between levels x and $x-1$; Δ = design story drift above; β = ratio of shear demand to shear capacity for the story (1.0 if not computed).

$\theta \le 0.10$: P-delta effects need not be considered.
$0.10 < \theta \le \theta_{max}$: multiply the displacements and member forces by $1/(1-\theta)$ (or do a rational analysis).
$\theta > \theta_{max}$: the structure is potentially unstable and shall be redesigned.

Units

English: h_{sx}, δ_{xe}, δ_x, Δ in; P_x, V_x lbf. **metric**: mm and N.
C_d, I_e, ρ, β, θ and the drift ratio Δ/h_{sx} are dimensionless.

Input notes

Story 1 is at the base. δ_{xe} is the total elastic displacement of the level at the top of each story, not the story drift.
Enter $P_x = 0$ or $V_x = 0$ to skip the stability check for a story.
Take δ_{xe} from an elastic analysis such as the Shear Building MRSA or ELF apps in the Seismic list.
From shear_building (MRSA, Story Drift tab, *Story Drift Check* button): modal story drifts Δ_j are combined by CQC, scaled to strength level by I_e/R, and entered as $\delta_{xe} = \sum \Delta_{CQC}$, so that $\delta_x - \delta_{x-1}$ gives the CQC drift.
V_x = CQC story shear $\times\, I_e/R$; P_x = floor weights at and above (replace with $D + L$, factors ≤ 1.0).
Apply the drift scaling of Section 12.9.1.4.2 where it governs.

Reference

ASCE/SEI 7-22, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, Sections 12.8.6, 12.8.7, 12.12.