# FenceDesign.com Wind Formula Methodology

The ASCE 7 methodology is calculation heavy and designed to cover a wide variety of structure types. It's expected to be used by Structural Engineers, and doesn't lend itself to design by non-professionals. The ASCE 7 method results in a force applied to the fence post at the centroid of the fencing material which requires that any post being checked has to be calculated individually which is time consuming.

The FenceDesign.com design guide uses a simplified set of formulas & tables to determine wind forces and size fence posts, but delivers the same end result as the more generalized ASCE 7 methods with much less calculation effort. The table below show the ASCE formulas. The second table shows the rearranged and simplified method used for fencing in this design guide, followed by an explanation of terms and variables.

| ASCE 7 Wind Formulas - $K_e$ is not used in 7-10, so $K_e$ is set to 1.0 in that case - In ASCE 7-22, $K_d$ moves from q to F - no net effect | | |
|---|---|---|
| $q_h = 0.00256 \, K_h \, K_{zt} \, K_d \, K_e \, V^2$ | Wind pressure w/ site modifiers at z = h | Eq. 26.10-1 evaluated at top of structure |
| $q_z = 0.00256 \, K_z \, K_{zt} \, K_d \, K_e \, V^2$ | Wind pressure w/ site modifiers at z = centroid | Eq. 26.10-1 evaluated at centroid of structure |
| $F = (0.6) \, q_h \, G \, C_f \, A_s$ | Force to post in Wind loading for $\varepsilon > 0.7$ | Eq. 29.3-1 for Solid Freestanding Walls & Solid Freestanding Signs using ASD Load Cases |
| $F = (0.7) \, q_h \, G \, C_f \, A_s$ | Force to post in Wind on Ice loading for $\varepsilon > 0.7$ | |
| $F = (0.6) \, q_z \, G \, C_f \, A_f$ | Force to post in Wind loading for $\varepsilon \leq 0.7$ | Eq. 29.4-1 for Open Signs and Single Plane Open Frames using ASD Load Cases |
| $F = (0.7) \, q_z \, G \, C_f \, A_f$ | Force to post in Wind on Ice loading for $\varepsilon \leq 0.7$ | |

| FenceDesign.com Design Procedure - Formulas rearranged to separate wind pressure from site specific modifiers and keep the force application height at the post midpoint which allows for simple post strength tables vs time consuming calculations. | | |
|---|---|---|
| $q_w = (0.6) \, 0.00256 \, K_d \, G \, V_w^2$ | ASD Wind pressure w/o site modifiers | Rearranging formulas allows for tabular wind pressure values applicable to all fence types. |
| $q_i = (0.7) \, 0.00256 \, K_d \, G \, V_i^2$ | ASD Wind on Ice pressure w/o site modifiers | |
| $f_w = q_w \, K_z \, K_{zt} \, K_e \, R_{1w} \, F_{hw} \, C_{fw} \, A_w$ | Forces to mid-height of post based on site specific modifiers and fence design variables. | |
| $f_i = q_i \, K_z \, K_{zt} \, K_e \, R_{1i} \, F_{hi} \, C_{fi} \, A_i$ | | |

ASD - Allowable Stress Design - Load combinations per ASCE 7 §2.4.1 for Wind loading & §2.4.3 for Wind on Ice loading.

Wind Directionality Factor, $K_d$ = 0.85 per Table 26.6-1 for solid freestanding walls and single plane open frames.

Gust Effect Factor, G = 0.85 per §26.9 (7-10) or §26.11 (7-16 & 7-22) for rigid structures ($n_a > 1.0$ Hz).

Velocity Pressure Exposure Coefficients, $K_z$ evaluated at the structure centroid, and $K_h$ evaluated at top of structure (h).
    This design guide uses only $K_z$, but determines the value at ½ h for open fencing and h for solid / mostly solid fencing.

Open Frame Area, $A_f = \varepsilon \, s \, L$     $\varepsilon$ is the solidity ratio     s is the fencing height     L is the post spacing

Solid / Mostly Solid Wall Area, $A_s = s \, L$

Wind Force Coefficient, $C_f$   This is an aerodynamic adjustment value based on the fencing materials and geometry.
    For this design guide, $C_{fw}$ is used for Wind loading, and $C_{fi}$ is used for Wind on Ice loading.

Inverted Fence Opening Reduction Factor, $R_1$        $R_{1w}$ for Wind Loading        $R_{1i}$ for Wind on Ice Loading
    In ASCE 7, the full gross area is used for mostly solid fencing, but to account for the net area being lower, a reduction factor,
    $1 - (1 - \varepsilon)^{1.5}$ is used to reduce the $C_f$ value to partially compensate. This is non-linear with a maximum reduction of only 16%.
    In this design guide, all fencing uses the net area, and the $R_1$ value (the inverse of the reduction factor) is added to increase
    the wind force to account for the required de-rating of the open area in mostly solid fencing per the solid wall table, note 2.

Force Height Adjustment Factor, $F_h$
    In ASCE 7, the force application height varies depending on the fence geometry which requires post strengths to be
    calculated individually.
    This design guide keeps the force application height at the post midpoint and adjusts the forces to allow for the post
    strengths to pre-calculated and presented in a tabular form to reduce the amount of calculations required.

$A_w$ = Net Area for Wind loading

$A_i$ = Net Area for Wind on Ice loading