

Commentary I

Speed-up over Hills and Escarpments

13. Hills and escarpments can significantly amplify wind speeds near the ground and this should be reflected in the exposure factor for buildings located on a hill or escarpment. A method that can be used with both the Static and Dynamic Procedures to reflect this amplification is presented below.
14. Buildings on a hill or escarpment with a maximum slope greater than 1 in 10, particularly near a crest, may be subject to significantly higher wind speeds than buildings on level ground. The exposure factor at height z above the surrounding ground elevation is then equal to that over open level terrain multiplied by a factor $(1 + \Delta S(z))^2$, where $\Delta S(z)$ is the "speed-up factor" for the mean wind speed (this effect is illustrated in Figure I-6). Near the crest, and within a distance $|x| < kL$, the exposure factor is modified as follows:

$$C_e^* = C_e \left\{ 1 + \Delta S_{\max} \left(1 - \frac{|x|}{kL} \right) e^{(-\alpha z/L)} \right\}^2 \quad (3)$$

where

- C_e^* = corresponding modified value for use on the hill or escarpment,
- C_e = exposure factor over open level terrain given in Paragraphs 11 and 12 for the Static Procedure, and in Paragraph 41 for the Dynamic Procedure,
- ΔS_{\max} = relative speed-up factor at the crest near the surface, and
- α = decay coefficient for the decrease in speed-up with height.

The values of α and ΔS_{\max} depend on the shape and steepness of the hill or escarpment. Representative values for these parameters are given in Table I-1.

Table I-1
Parameters for Maximum Speed-up Over Hills and Escarpments

Shape of Hill or Escarpment	$\Delta S_{\max}^{(1)}$	α	k	
			$x < 0$	$x > 0$
2-dimensional ridges (or valleys with negative H)	$2.2 H_h/L_h$	3	1.5	1.5
2-dimensional escarpments	$1.3 H_h/L_h$	2.5	1.5	4
3-dimensional axi-symmetrical hills	$1.6 H_h/L_h$	4	1.5	1.5

(1) For $H_h/L_h > 0.5$, assume that $H_h/L_h = 0.5$ and substitute $2H_h$ for L_h in Equation (3).

15. The definitions of H_h , height, and L_h , length, shown in Figure I-6 are as follows: H_h is the height of the hill or or escarpment, or the difference in elevation between the crest and that of the terrain surrounding the hill or escarpment upwind; L_h is the distance upwind of the crest to where the ground elevation is half of H_h . The maximum slope for rounded hill shapes is roughly $H_h/(2L_h)$. In the expressions above, it is assumed that the wind approaches the hill along the direction of maximum slope, i.e. the direction giving the greatest speed-up near the crest.

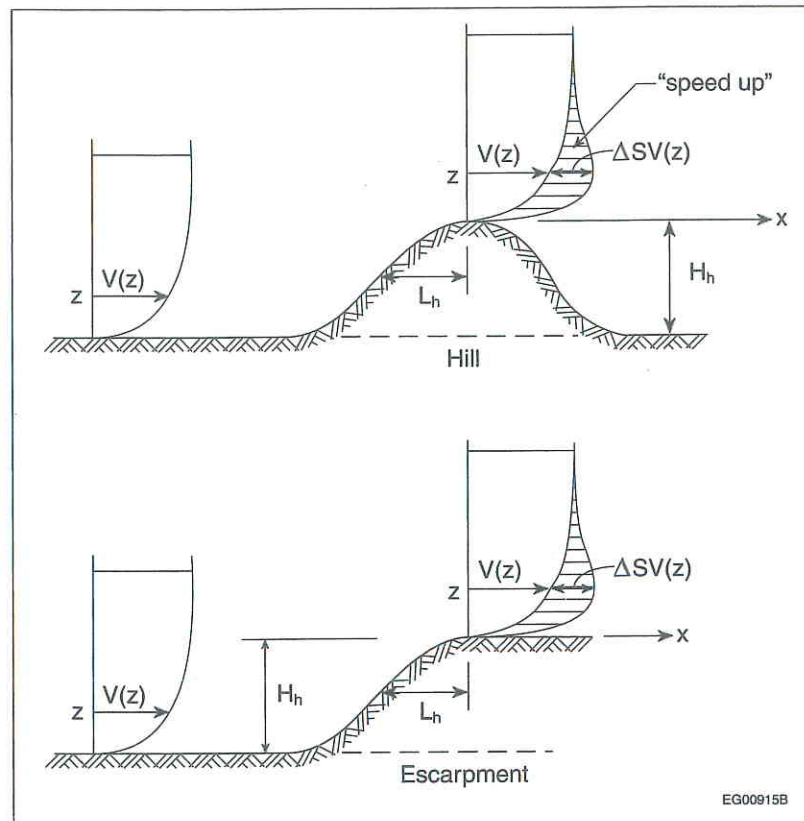


Figure I-6
Definitions for wind speed-up over hills and escarpments

16. Hills and escarpments with slopes less than 1 in 10 are unlikely to produce significant speed-up of the wind. A more detailed discussion of this issue and other simplified models for three-dimensional hills are given in Reference [7]. Background material may be found in References [8] and [9]. Wind tunnel tests and computational methods may be used to obtain design information in other cases.

Gust Effect Factors, C_g and C_{gi}

General

17. In this section, procedures are recommended for determining the external gust effect factor referred to in NBC Sentence 4.1.7.1.(1) and the internal gust effect factor referred to in NBC Sentence 4.1.7.1.(3). These two factors, denoted by C_g and C_{gi} respectively, are defined as the ratio of the maximum effect of the loading to the mean effect of the loading. They take into account:
- (a) random fluctuating wind forces caused by turbulence in the approaching wind and acting for short durations over all or part of the structure,
 - (b) fluctuating forces induced by the wake of the structure itself,
 - (c) additional inertial forces arising from motion of the structure itself as it responds to the fluctuating wind forces, and
 - (d) additional aerodynamic forces due to alterations in the airflow around the structure caused by its motions (aero-elastic effects).
18. All structures are affected to some degree by these forces. The total response may be considered as a superposition of a "background component," which acts quasi-statically, and a "resonant component," which is due to inertial forces arising from excitation close to a natural frequency. For the majority of structures, the resonant component is small and the dynamic effect can be treated by considering only the background component using normal static methods. These structures are amenable to the Static Procedure. For structures that are particularly tall, long, slender, lightweight, flexible or lightly damped, the resonant component may be dominant: these structures should be treated by the Dynamic Procedure.