2020 Interim Revisions

GUIDE DESIGN SPECIFICATIONS FOR BRIDGE TEMPORARY WORKS

2nd Edition | 2017

GSBTW-2-I1 | ISBN 978-1-56051-739-9

American Association of State Highway and Transportation Officials

AASHTO

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AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

AASHTO

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2020 INTERIM REVISIONS INSTRUCTIONS AND INFORMATION

General

AASHTO has issued proposed interim revisions to the *AASHTO Guide Design Specifications for Bridge Temporary Works*, Second Edition (2017). This packet contains the revised pages. They are designed to replace the corresponding pages in the book.

Affected Articles

Underlined text indicates revisions that were approved in 2019 by the AASHTO Committee on Bridges and Structures. ~~Strikethrough text~~ indicates any deletions that were likewise approved by the Committee. A list of affected articles is included below.

All interim pages are displayed on a pink background to make the changes stand out when inserted in the second edition binder. They also have a page header displaying the interim publication year. Please note that these pages may also contain nontechnical (i.e., editorial) changes made by AASHTO publications staff; any changes of this type will not be marked in any way so as not to distract the reader from the technical changes.

2020 Changed Articles

2.3.5.2
APPENDIX C
APPENDIX E

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2.3.4.5.3—Impact

The reaction of equipment shall be increased by 30 percent to allow for impact, unless other values (either larger or smaller) are recommended by the manufacturer, are required by the authority having jurisdiction, or are justified by analysis.

2.3.5—Environmental Loads

The basic reference for computation of environmental loads is the 2010 edition of ASCE 7. The requirements of ASCE 7 shall apply except as modified herein.

2.3.5.1—Risk Category

Unless otherwise required by the authority having jurisdiction, the Risk Category, as defined in ASCE 7, shall be taken as Risk Category II for all environmental loads during construction, regardless of the Risk Category assigned for the design of the completed structure.

C2.3.5.1

During construction, the primary occupancy of a structure is by construction personnel. As such, the risk to loss of human life is comparable to that for Risk Category II buildings as defined in ASCE 7. Circumstances in which the engineer may consider a higher Risk Category, or in which some authorities have required such consideration, include construction work immediately adjacent to essential facilities in which a construction failure would imperil operation of the essential facility.

2.3.5.2—Wind

~~Except as modified herein, wind loads shall be calculated in accordance with procedures in ASCE 7. Select provisions from ASCE 7-10 have been reproduced in Appendix C. Design wind pressures shall be based on design wind speeds calculated in accordance with Section 2.3.5.2.1. The basic wind pressure shall be increased by 5 psf for falsework members over or adjacent to traffic openings.~~

~~**C2.3.5.2**~~

~~If local conditions so dictate, and for certain hazardous construction operations, it may be appropriate to apply a minimum strength level wind pressure, such as 16 psf, to design.~~

~~*2.3.5.2.1—Design Wind Speed*~~

~~The design wind speed shall be taken as the basic wind speed in ASCE 7. Basic wind speed maps from ASCE 7-10 have been reproduced in Appendix C.~~

~~*2.3.5.2.2—Frameworks without Cladding*~~

~~Structures shall resist the effect of wind acting upon successive unenclosed components.~~

~~Treatment of staging, shoring, and falsework with regular rectangular plan as trussed towers in accordance with ASCE 7 shall be permissible. Unless detailed analyses are performed to show that lower loads may be used, no allowance shall be given for shielding of successive rows or towers.~~

~~For unenclosed frames and structural elements, wind loads shall be calculated for each element. Unless detailed analyses are performed, load reductions due to shielding of elements in such structures with repetitive patterns of elements shall be as follows:~~

- ~~The loads on the first three rows of elements along the direction parallel to the wind shall not be reduced for~~

~~*C2.3.5.2.2*~~

~~Even though the design wind speed during construction may be lower than that for the completed structure, the total wind load may actually be higher due to the cumulative effect of wind acting on many more surfaces and often with higher drag coefficients than in the fully enclosed structure. For common arrangements of elements in typical open frames and temporary structures, shielding effects are small. Considering the changing nature of the bridge silhouette and the arrangement of construction materials on the structure, it is prudent not to assume that loads will be reduced due to shielding, except in certain specific cases.~~

~~For open structures with regular patterns of elements, the direction of maximum force on the structure usually is not parallel to the principal axis of the structure. Shielding effects are minimized, and therefore loads are at their~~

~~shielding.~~

- ~~The loads on the fourth and subsequent rows shall be permitted to be reduced by 15 percent.~~

- ~~Wind load allowances shall be calculated for all exposed interior partitions, walls, temporary enclosures, signs, construction materials, and equipment on or supported by the structure. These loads shall be added to the loads on structural elements.~~

~~Calculations shall be performed for each primary axis of the structure. For each calculation, 50 percent of the wind load calculated for the perpendicular direction shall be assumed to act simultaneously.~~

~~*2.3.5.2.3—Accelerated Wind Region*~~

~~Structures placed near building edges and corners shall resist the higher pressures and suctions that will exist in such regions. The design wind speed shall be factored upward from the basic wind speed by the square root of the suction coefficient for cladding as given in ASCE 7. The calculated wind speed shall be used with appropriate drag factors to calculate loads on structures. At building corners, the resulting pressures shall be assumed to act on adjacent staging structures in horizontal directions parallel to and perpendicular to the enclosure surface. At top edges of enclosures, pressures shall be assumed to act upward as well as horizontally.~~

~~highest, when the direction of the wind is not parallel to the column lines. For this reason, the most severe loads on an open structure include components of load in both principal directions of the structure.~~

~~For guidance on shielding effects and loads on open structures, refer to *Crane and Derricks* (2000), *Wind Loading on Falsework, Part I* (1975), *Wind Loading on Open Framed Structures* (1981), and the *Low Rise Building Systems Manual* (1996).~~

2.3.5.2.1—General

The wind load provisions presented herein shall be used with conventional bridges in typical settings.

The latest edition of the ASCE 7 shall be used for the design of temporary bridge works used for the construction of:

- Conventional bridges adjacent to cliffs or building edges and corners.

- Cable-stayed, suspension, and arch bridges.

- Any other nonconventional bridges.

C2.3.5.2.1

Structures placed near building edges and corners are required to be designed to resist the higher pressures and suctions that will exist in such regions. The design wind speed must be factored upward from the basic wind speed by the square root of the suction coefficient for cladding as given in ASCE 7. The calculated wind speed should be used with appropriate drag coefficients to calculate wind loads on such structures. At building corners, the resulting pressures should be assumed to act on adjacent staging structures in horizontal directions parallel to and perpendicular to the enclosure surface. At top edges of enclosures, pressures should be assumed to act upward as well as horizontally.

Wind loads on the superstructure that are transmitted to bridge falsework shall be determined in accordance with Article 2.3.5.2.5.

2.3.5.2.2—Design Wind Speed

The design 3-second gust wind speed, V, used in the determination of design wind loads on bridge temporary works shall be taken as the 3-second gust wind speed specified for Strength III load combination in the *AASHTO LRFD Bridge Design Specifications*.

2.3.5.2.3—Wind Load

2.3.5.2.3a—General

The wind loads on bridge temporary works shall be determined using the procedure specified in the *AASHTO LRFD Bridge Design Specifications* modified as shown in Articles 2.3.5.2.3b, 2.3.5.2.3c, and 2.3.5.2.3d.

The amplification of wind load due to successive unenclosed components shall be determined using Article 2.3.5.2.4.

2.3.5.2.3b—Wind Pressure

The design wind pressure on temporary bridge works shall be determined as:

$$P_Z = 2.56 \times 10^{-6} V^2 K_Z G C_D K_d \qquad (2.3.5.2.3b\text{-}1)$$

where:

P_Z = design wind pressure at a height, z, above ground (ksf). The height, z, to be determined using Table 2.3.5.2.3b-1.
V = design 3-second gust wind speed as determined in Article 2.3.5.2.2 (mph)
K_Z = pressure exposure and elevation coefficient to be taken as specified in *AASHTO LRFD Bridge Design Specifications* Article 3.8.1.2 for Strength III load combination
G = gust coefficient factor to be taken as 0.85
C_D = drag coefficient to be taken from Table 2.3.5.2.3b-2
K_d = wind directionality factor to be taken as 0.95

The design wind pressure calculated using Eq. 2.3.5.2.3b-1 shall be increased by 5 psf for falsework members over or adjacent to traffic openings.

For each axis of the structure, wind load shall be determined using Articles 2.3.5.2.3c. For each primary axis of the structure, 50 percent of the wind load calculated for the perpendicular direction shall be assumed to act simultaneously.

C2.3.5.2.3b

The wind load provisions presented herein are formatted to follow the format of the wind load provisions in *AASHTO LRFD Bridge Design Specifications* and *AASHTO Guide Specifications for Wind Loads on Bridges During Construction*. This is the reason the following differences exist between the provisions presented herein and those in ASCE 7-2010 which form the basis for these provisions:

- The "Force Coefficient" in ASCE 7, C_f, was renamed to "Drag Coefficient", C_D, to match AASHTO documents.
- The gust effect factor, G, and the force coefficient, renamed to drag coefficient, were moved from the equation for the wind force in ASCE 7-10 (Eq. 2.3.5.2.3c-1 herein) to the equation for wind pressure (Eq. 2.3.5.2.3b-1 herein).

The value of the wind directionality factor varies with the configuration of different elements. The specified value is an upper bound of the values used for typical components.

Table 2.3.5.2.3b-1—Design Height, *z*

Type of Structure	Design Height *z* (ft)
Solid Surfaces	The height to the top of the solid surface
Trussed Towers	The height to the centroid of the area of the tower segment being considered
Lattice Frameworks	The height to the centroid of the area of the surface of the structure segment being considered

Table 2.3.5.2.3b-2—Drag Coefficient, C_D

Type of Structure		Drag Coefficient, C_D
Solid Surfaces		2.0
Trussed Towers	Structures with round components	2.5
	Structures with components with flat surfaces	4.0
Lattice Frameworks	Structures with round components	1.3
	Structures with components with flat surfaces	2.0

The values specified for C_D in Table 2.3.5.2.3b-2 are meant to conservatively cover most practical cases. In lieu of these values, the drag coefficients for trussed towers and lattice frameworks may be determined as shown below if approved by the Engineer.

The drag coefficient for trussed towers may be determined using Table C2.3.5.2.3b-1.

Table C2.3.5.2.3b-1—Drag Coefficient for Trussed Towers

Tower Cross-Section	Drag Coefficient, C_D
Square	$4.0\varepsilon^2 - 5.9\varepsilon + 4.0$
Triangle	$3.4\varepsilon^2 - 4.7\varepsilon + 3.4$

For towers with round members, the drag coefficient may be multiplied by a factor equal to:

$$0.51\varepsilon^2 + 0.57 < 1.0$$

For square towers with wind applied parallel to the diagonal of the tower, the drag coefficient shall be increased by a factor equal to:

$$1.0 + 0.75\varepsilon < 1.2$$

where:

ε = ratio of solid area to gross area of one tower face for the segment under consideration

The drag coefficient for lattice frameworks may be determined using Table C2.3.5.2.3b-2.

Table C2.3.5.2.3b-2—Drag Coefficient for Lattice Frameworks

ε	**Flat-Sided Members**	**Round Members**	
		$D\sqrt{p_z} \le 2.5$	$D\sqrt{p_z} > 2.5$
< 0.1	2.0	1.2	0.8
0.1 to 0.29	1.8	1.3	0.9
0.3 to 0.7	1.6	1.5	1.1

where:

ε = ratio of solid area to gross area
D = diameter of a typical round member (ft.)
p_z = design wind pressure at a height *z* above ground (ksf)

2.3.5.2.3c—Wind Load

The wind force for each primary axis of temporary works with shall be determined as:

$$F = P_z A \qquad (2.3.5.2.3c\text{-}1)$$

where:

F = wind force (kips)
P_Z = design wind pressure calculated using Eq. 2.3.5.2.3b-1 (ksf)
A = area of the structure projected on a vertical plane perpendicular to the direction of the wind to be determined using Table 2.3.5.2.3c-1 (ft^2)

Surfaces with openings totaling less than 30 percent of the surface gross area shall be classified as solid surfaces.

Where blockage of openings in some surfaces is expected, the area used in determining wind loads on surfaces with openings shall account for such blockage.

The wind force shall be assumed to act parallel to the wind direction.

C2.3.5.2.3c

Openings may be blocked by tarps, protective shields or temporary signs. They may also be partially blocked by ice build-up.

Table 2.3.5.2.3c-1—Area of the Structure

Type of Structure	Area (ft^2)
Solid Surfaces	Gross Area of the surface
Trussed Towers	Blocked area of the structure taken as the gross area of the surface minus the sum of the areas of the openings
Lattice Frameworks	

2.3.5.2.3d—Point of Wind Load Application

For solid surfaces, two cases of wind load application shall be considered:

Case 1: the wind force shall be applied at the centroid of the gross area of the surface
Case 2: the wind force shall be applied at the following point:

- Vertically, the wind load will be applied at a point located at 0.55 times the height of the gross area of the surface measured from the bottom.

- Horizontally, the wind load shall be applied at a point at a distance 0.2 times the average width of the gross area of the surface measured horizontally from the centroid of the solid surface.

For trussed towers and for lattice frameworks, the wind load shall be applied at the centroid of the area projected to a vertical plane perpendicular to the wind direction.

C2.3.5.2.3d

ASCE 7 specifies a different vertical location of the wind load based on whether the solid surface reaches the ground and a different horizontal location based on whether the wind is blowing perpendicular to the surface. The more severe of the vertical and horizontal locations are specified herein for simplicity.

2.3.5.2.4—Frameworks without Cladding

Structures shall resist the effect of wind acting upon successive unenclosed components.

Treatment of staging, shoring, and falsework with regular rectangular plan as trussed towers in accordance with ASCE 7 shall be permissible. Unless detailed analyses are performed to show that lower loads may be used, no allowance shall be given for shielding of successive rows or towers.

For unenclosed frames and structural elements, wind loads shall be calculated for each element. Unless detailed analyses are performed, load reductions due to shielding of elements in such structures with repetitive patterns of elements shall be as follows:

- The loads on the first three rows of elements along the direction parallel to the wind shall not be reduced for shielding.

- The loads on the fourth and subsequent rows shall be permitted to be reduced by 15 percent.

C2.3.5.2.4

Even though the design wind speed during construction may be lower than that for the completed structure, the total wind load may actually be higher due to the cumulative effect of wind acting on many more surfaces and often with higher drag coefficients than in the fully enclosed structure. For common arrangements of elements in typical open frames and temporary structures, shielding effects are small. Considering the changing nature of the bridge silhouette and the arrangement of construction materials on the structure, it is prudent not to assume that loads will be reduced due to shielding, except in certain specific cases.

For open structures with regular patterns of elements, the direction of maximum force on the structure usually is not parallel to the principal axis of the structure. Shielding effects are minimized, and therefore loads are at their highest, when the direction of the wind is not parallel to the open structure. The analysis should include components of load in both principal directions of the structure.

For guidance on shielding effects and loads on open structures, refer to Crane and Derricks (2000), *Wind*

Loading on Falsework, Phase I (1975), *Wind Loading on Open Framed Structures* (1981), and the *Low Rise Building Systems Manual* (1996).

2.3.5.2.5—Wind Load Transmitted to Temporary Shoring from the Bridge Superstructure

Wind loads on the bridge superstructure that are then transmitted to the bridge temporary shoring shall be calculated in accordance with the following:

- Before the bridge deck is cast: The procedures in the *AASHTO Guide Specifications for Wind Loads on Bridges During Construction* shall apply except that the wind speed reduction factor during construction shall not be taken less than 0.75.

- After the bridge deck is cast: The procedures in the *AASHTO LRFD Bridge Design Specifications* shall apply except that the wind speed reduction factor during construction shall apply. The wind speed reduction factor during construction shall not be taken less than 0.75.

C2.3.5.2.5

The 0.75 specified minimum value for the wind speed reduction factor during construction corresponds to 3-second gust wind speed with 7 percent probability of exceedance in two years or a mean return intervals (MRI) of 28 years.

2.3.5.3—Snow

When snowfall is expected during the construction period, snow loads shall be determined for surfaces on which snow could accumulate in accordance with ASCE 7. If construction will not occur during winter months when snow is to be expected, snow loads need not be considered, provided that the design is reviewed and modified, as appropriate, to account for snow loads if the construction period shifts to include winter months.

Design for snow loads that are lower than those prescribed by this section shall be permissible, provided adequate procedures and means are employed to remove snow before it accumulates to levels that exceed the loads used for design.

2.3.5.4—Earthquake

If required by Section 2.3.5.4.1 and not exempted by Section 2.3.5.4.3, earthquake loads shall be calculated in accordance with procedures in ASCE 7 as modified by Section 2.3.5.4.2. All structures shall be treated as Risk Category II, per Table 1.5-1 of ASCE 7, regardless of the group classification of the completed structure.

C2.3.5.4

The earthquake provisions of ASCE 7 are modeled on the 2009 *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* prepared by the Building Seismic Safety Council.

2.3.5.4.1—Applicability

Earthquake loads need not be considered unless required by the authority having jurisdiction or the mapped Risk-Targeted MCE_R, 5 percent damped, spectral response acceleration parameter at a period of 1 second, S_1, defined in ASCE 7, Section 11.4.1 equals or exceeds 0.40. Maps

C2.3.5.4.1

It is not reasonable to require seismic resistance for temporary works where large earthquakes are infrequent or not considered probable.

APPENDIX C

UNUSED

SELECT ASCE 7 WIND PROVISIONS

This section provides provisions consistent with ASCE 7-10 to determine wind loads on trussed towers, lattice frameworks, and other solid surfaces. For the determination of wind loads on other types of temporary structures, refer to ASCE 7-10 Section 26.

C.1 Basic Wind Speed, *V*

The basic wind speed is the three-second gust wind speed at 33 ft above the ground of Exposure C. Wind speeds correspond to approximately a 7 percent probability of exceedance in 50 years.

The basic wind speed V used in the determination of design wind loads on buildings and other structures shall be given in Figure C.1, except as follows. Mountainous terrain, gorges, and special wind regions shown in Figure C.1 shall be examined for unusual wind conditions as outlined in ASCE 7-10 Section 26.5.2. The estimation of basic wind speeds from regional climatic data shall be allowed as outlined in ASCE 7-10 Section 26.5.3. The basic wind speed used shall be at least 110 mph.

C.2 Design Wind Force, *F*

The wind force for each primary axis of trussed towers and lattice frameworks shall be determined from Eq. C-1:

$$F = q_z G C_f A_f \text{ (lb)} \qquad \text{(C-1)}$$

where:

q_z = velocity pressure = $0.00256 K_z K_{zt} K_d V^2$ (psf)
K_z = velocity pressure exposure coefficient see Section C.3
K_{zt} = topographic factor see Section C.4
K_d = wind directionality factor see Section C.5
V = basic wind speed (mph) see Figure C.1
G = gust-effect factor see Section C.6
C_f = force coefficient see Section C.7
A_f = projected area normal to the wind see Section C.8

The wind force for each primary axis of solid surfaces shall be determined from Eq. C-2:

$$F = q_h G C_f A_g \text{ (lb)} \qquad \text{(C-2)}$$

where:

q_h = velocity pressure = $0.00256 K_z K_{zt} K_d V^2$ (psf), evaluated at height h (defined in Table C.5.)
K_z = velocity pressure exposure coefficient see Section C.3
K_{zt} = topographic factor see Section C.4
K_d = wind directionality factor see Section C.5
V = basic wind speed (mph) see Figure C.1
G = gust-effect factor see Section C.6
C_f = force coefficient see Section C.7
A_g = gross area of solid surface

For each primary axis of the structure, 50 percent of the wind load calculated for the perpendicular direction shall be assumed to act simultaneously.

C.3 Velocity Pressure Exposure Coefficient, K_z

The velocity pressure exposure coefficient shall be determined from Table C.1[1] following the determination of the applicable surface roughness category and exposure category. Surface roughness categories and exposure categories are as follows:

(a) Surface Roughness Categories

Surface Roughness B Surface Roughness B is defined as urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness C Surface Roughness C is defined as open terrain with scattered obstructions having heights generally less than 30 ft. This category includes flat open country and grasslands.

Surface Roughness D Surface Roughness D is defined as flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats, and unbroken ice.

(b) Exposure Categories

Exposure B For structures with a mean roof height of less than or equal to 30 ft., Exposure B shall apply where the ground surface roughness, as defined by Surface Roughness B, prevails in the upwind direction for a distance greater than 1,500 ft. For structures with a mean roof height greater than 30 ft, Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance greater than 2,600 ft or 20 times the height of the structure, whichever is greater.

Exposure C Exposure C shall apply for all cases where Exposures B or D do not apply.

Exposure D Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance greater than 5,000 ft or 20 times the structure height, whichever is greater. Exposure D shall also apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 ft or 20 times the structure height, whichever is greater, from an Exposure D condition as defined in the previous sentence.

C.4 Topographic Factor, K_{zt}

Wind speed-up effects at isolated hills, ridges, and escarpments constituting abrupt changes in the general topography, located in any exposure category, shall be included in the design when buildings and other site conditions and locations of structures meet all of the following conditions:

1. The hill, ridge, or escarpment is isolated and unobstructed upwind by other similar topographic features of comparable height for 100 times the height of the topographic feature (100*H*) or 2 miles, whichever is less. This distance shall be measured horizontally from the point at which the height, *H*, of the hill, ridge, or escarpment is determined.
2. The hill, ridge, or escarpment protrudes above the height of upwind terrain features within a 2-mi radius in any quadrant by a factor of two or more.
3. The structure is located as shown in Figure C.2 in the upper one-half of a hill or ridge or near the crest of an escarpment.
4. $H/L_h \geq 0.2$.
5. *H* is greater than or equal to 15 ft for Exposure C and D and 60 ft. for Exposure B.

[1] Select tables and figures reproduced from ASCE 7-10

The topographic factor, K_{zt}, shall be determined as follows:

$K_{zt} = (1 + K_1K_2K_3)^2$ where K_1, K_2, and K_3 are given in Figure C.2.

If site conditions and locations of structures do not meet all the conditions specified above, then $K_{zt} = 1.0$.

C.5 Wind Directionality Factor, K_d

The wind directionality factor shall be determined from Table C.2.

C.6 Gust-Effect Factor, *G*

The gust-effect factor for a rigid building or other structure is permitted to be taken as 0.85.

C.7 Force Coefficient, C_f

The force coefficient for trussed towers shall be determined from Table C.3. The force coefficient for lattice frameworks shall be determined from Table C.4. The force coefficient for solid surfaces shall be determined from Table C.5.

C.8 Projected Area, A_f

The projected area shall be the solid area of a trussed tower or lattice framework face normal to the wind projected on the plane of that face for the segment under consideration.

Table C.1—Velocity Pressure Coefficient, K_z

Height above ground level, *z* (ft)	Exposure		
	B	C	D
0–15	0.57	0.85	1.03
20	0.62	0.90	1.08
25	0.66	0.94	1.12
30	0.70	0.98	1.16
40	0.76	1.04	1.22
50	0.81	1.09	1.27
60	0.85	1.13	1.31
70	0.89	1.17	1.34
80	0.93	1.21	1.38
90	0.96	1.24	1.40
100	0.99	1.26	1.43
120	1.04	1.31	1.48
140	1.09	1.36	1.52
160	1.13	1.39	1.55
180	1.17	1.43	1.58
200	1.20	1.46	1.61
250	1.28	1.53	1.68
300	1.35	1.59	1.73
350	1.41	1.64	1.78
400	1.47	1.69	1.82
450	1.52	1.73	1.86
500	1.56	1.77	1.89

Notes:
a. Linear interpolation for intermediate values of height *z* is acceptable.
b. Exposure categories are defined above.

Table C.2—Wind Directionality Factor, K_d

Structure Type	K_d
Trussed Towers—triangular, square, or rectangular cross sections	0.85
Trussed Towers—all other cross sections	0.95
Open Signs and Lattice Framework	0.85

Table C.3—Force Coefficients for Trussed Towers, C_f

Tower Cross Section	C_f
Square	$4.0\epsilon^2 - 5.9\epsilon + 4.0$
Triangle	$3.4\epsilon^2 - 4.7\epsilon + 3.4$

Notes:

a. For all wind directions considered, the area, A_f, consistent with the specified force coefficients shall be the solid area of a tower face projected on the plane of that face for the tower segment under consideration.

b. The specified force coefficients are for towers with structural angles or similar flat-sided members.

c. For towers containing rounded members, it is acceptable to multiply the specified force coefficients by the following factor when determining wind forces on such members:

$0.51\epsilon^2 + 0.57$, but not greater than 1.0.

d. Wind forces shall be applied in the directions resulting in maximum member forces and reactions. For towers with square cross-sections, wind forces shall be multiplied by the following factor when the wind is directed along a tower diagonal:

$1 + 0.75\epsilon$, but not greater than 1.2.

e. Wind forces on tower appurtenances such as ladders, conduits, lights, elevators, etc., shall be calculated using appropriate force coefficients for these elements.

f. Loads due to ice accretion shall be accounted for.

g. Notation:
ϵ: ratio of solid area to gross area of one tower face for the segment under consideration.

Table C.4—Force Coefficients for Open Signs & Lattice Frameworks, C_f

ϵ	Flat-Sided Members	Rounded Members	
		$D\sqrt{q_z} \leq 2.5$ $(D\sqrt{q_z} \leq 5.3)$	$D\sqrt{q_z} > 2.5$ $(D\sqrt{q_z} > 5.3)$
< 0.1	2.0	1.2	0.8
0.1 to 0.29	1.8	1.3	0.9
0.3 to 0.7	1.6	1.5	1.1

Notes:

a. Signs with openings comprising 30 percent or more of the gross area are classified as open signs.

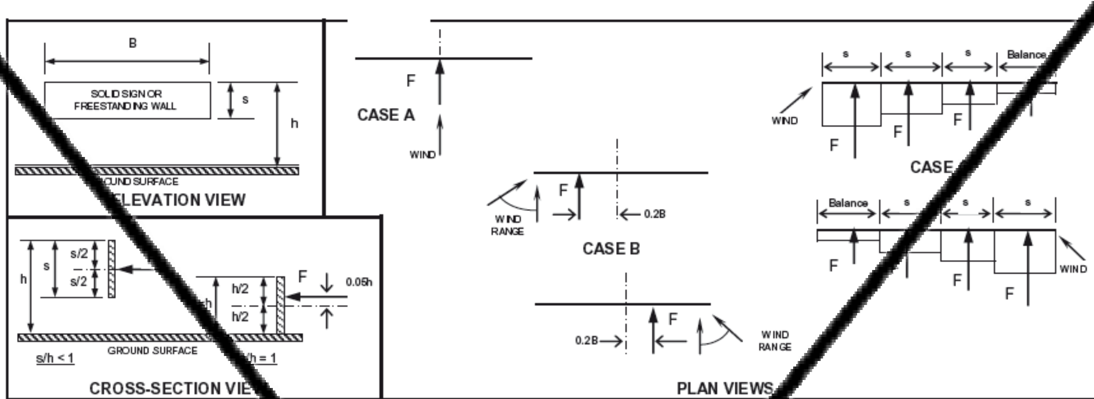
b. The calculation of the design wind forces shall be based on the area of all exposed members and elements projected on a plane normal to the wind direction. Forces shall be assumed to act parallel to the wind direction.

c. The area, A_f, consistent with these coefficients is the solid area projected normal to the wind direction.

d. Notation:
ϵ: ratio of solid area to gross area;
D: diameter of a typical round member, in ft; and
q_z: velocity pressure evaluated at height z above ground in psf.

~~**Table C.5—Force Coefficients for Solid Freestanding Walls and Signs**~~

Design Wind Loads		All Heights
Figure 29.4-1	Force Coefficients, C_f	Solid Freestanding Walls & Solid Freestanding Signs
Other Structures		



C_f, CASE A & CASE B

Clearance Ratio, s/h	Aspect Ratio, B/s											
	≤ 0.05	0.1	[illegible]	0.5	1	2	4	[illegible]	10	20	30	≥ 45
1	1.80	1.70	1.65	1.55	1.45	1.40	1.35	[illegible]	1.30	1.30	1.30	1.30
0.9	1.85	1.75	1.70	1.60	1.55	1.50	1.45	1.45	1.40	1.40	1.40	1.40
0.7	1.90	1.85	1.75	1.70	1.65	1.60	1.60	1.55	1.55	1.55	1.55	1.55
0.5	1.95	1.85	1.80	[illegible]	1.75	1.70	1.70	1.70	1.70	1.70	1.70	1.75
0.3	1.95	1.90	1.85	[illegible]	1.80	1.80	[illegible]	1.80	1.80	1.85	1.85	1.85
0.2	1.95	1.90	1.85	1.80	1.80	1.80	[illegible]	1.80	1.85	1.90	1.90	1.95
≤ 0.16	1.95	1.90	1.85	1.85	1.80	1.80	1.85	1.85	1.85	1.90	1.90	1.95

C_f, CASE C

Region (horizontal distance from windward edge)	Aspect Ratio, B/s									Region (horizontal distance from windward edge)	Aspect Ratio, B/s	
	2	3	4	5	6	7	8	9	10		13	≥ 45
0 to s	2.25	2.60	2.90	3.10*	[illegible]	[illegible]	3.55*	3.65*	3.75*	0 to s	4.00*	4.30*
s to 2s	1.50	1.70	1.90	2.00	[illegible]	2.25	2.30	2.35	2.45	s to 2s	2.60	2.55
2s to 3s		1.15	1.30	1.45	1.55	1.65	1.70	1.75	1.85	2s to 3s	2.00	1.95
3s to 10s			1.10	1.05	1.05	1.05	[illegible]	1.00	0.95	3s to 4s	1.50	1.85
										4s to 5s	1.35	1.85
										5s to 10s	0.90	1.10
										>10s	0.55	0.55

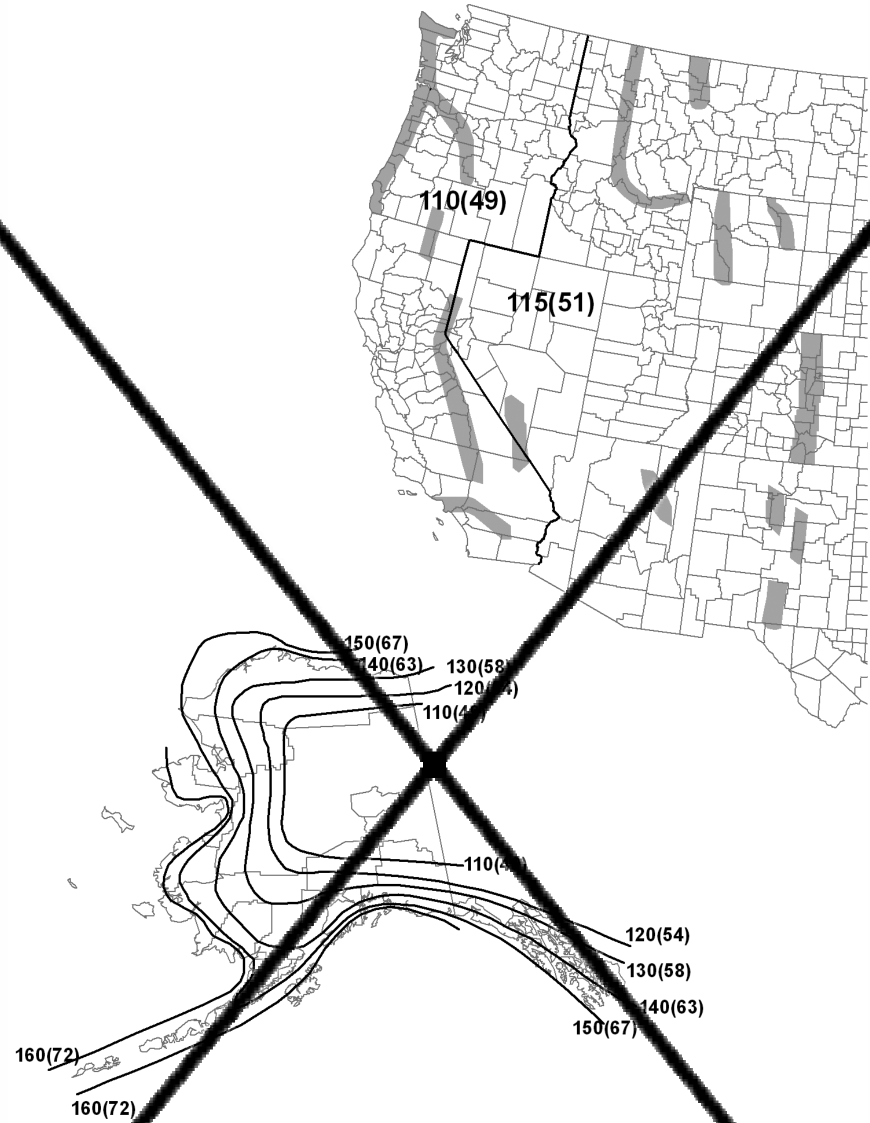
*Values shall be multiplied by the following reduction factor when a return corner is present:

L_r/s	Reduction Factor
0.3	0.90
1.0	0.75
≥ 2	0.60

PLAN VIEW OF WALL OR SIGN WITH A RETURN CORNER (L_r, B, WIND)

Notes:

1. The term "signs" in notes below also applies to "freestanding walls".
2. Signs with openings comprising less than 30% of the gross area are classified as solid signs. Force coefficients for solid signs with openings shall be permitted to be multiplied by the reduction factor $(1 - (1 - \varepsilon)^{1.5})$.
3. To allow for both normal and oblique wind directions, the following cases shall be considered:
   For s/h < 1:
   CASE A: resultant force acts normal to the face of the sign through the geometric center.
   CASE B: resultant force acts normal to the face of the sign at a distance from the geometric center toward the windward edge equal to 0.2 times the average width of the sign.
   For B/s ≥ 2, CASE C must also be considered:
   CASE C: resultant forces act normal to the face of the sign through the geometric centers of each region.
   For s/h = 1:
   The same cases as above except that the vertical locations of the resultant forces occur at a distance above the geometric center equal to 0.05 times the average height of the sign.
4. For CASE C where s/h > 0.8, force coefficients shall be multiplied by the reduction factor (1.8 - s/h).
5. Linear interpolation is permitted for values of s/h, B/s and L_r/s other than shown.
6. Notation:
   B: horizontal dimension of sign, in feet (meters);
   h: height of the sign, in feet (meters);
   s: vertical dimension of the sign, in feet (meters);
   ε: ratio of solid area to gross area;
   L_r: horizontal dimension of return corner, in feet (meters)

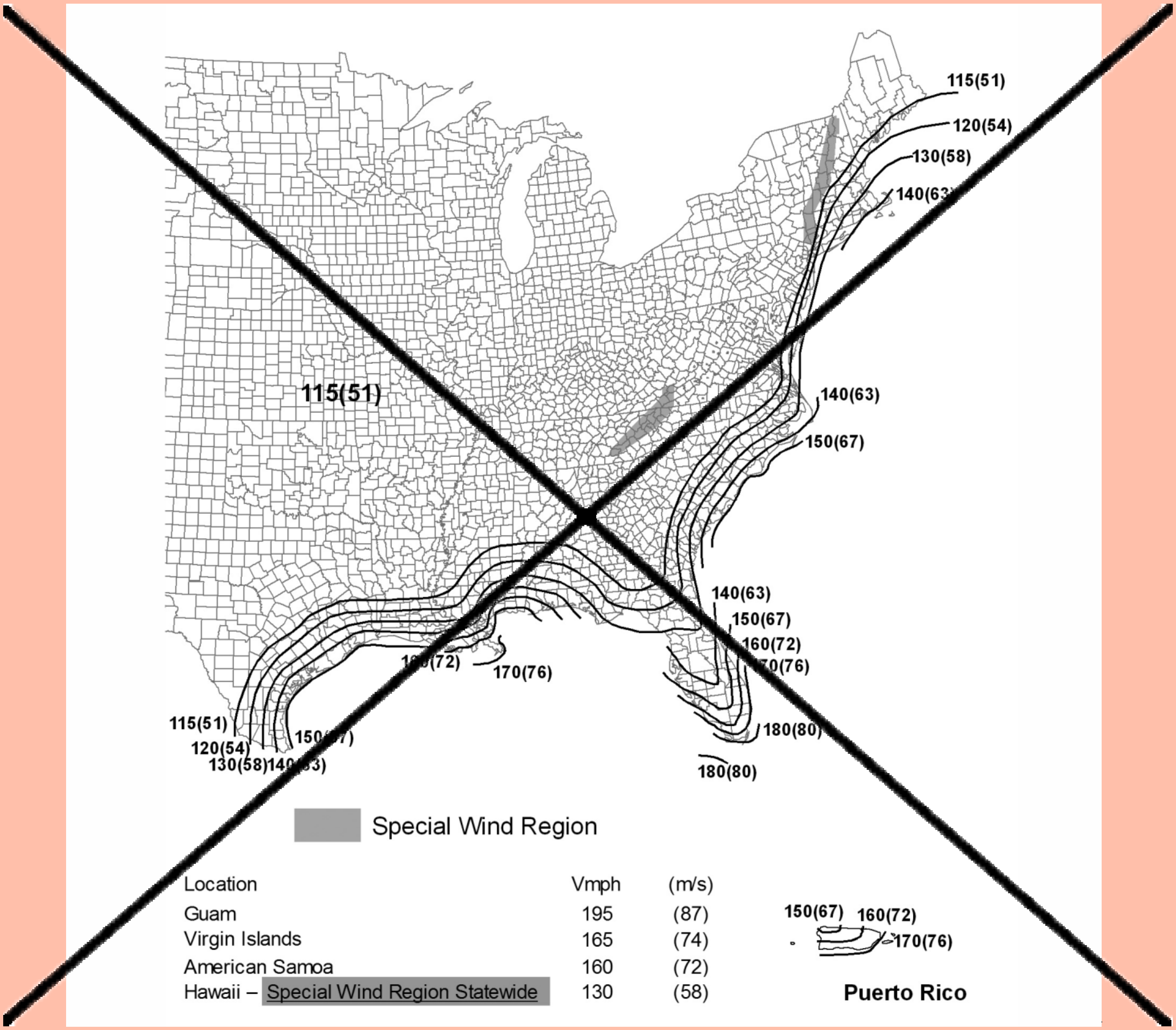


Basic Wind Speeds for Occupancy Category II Buildings and Other Structures.

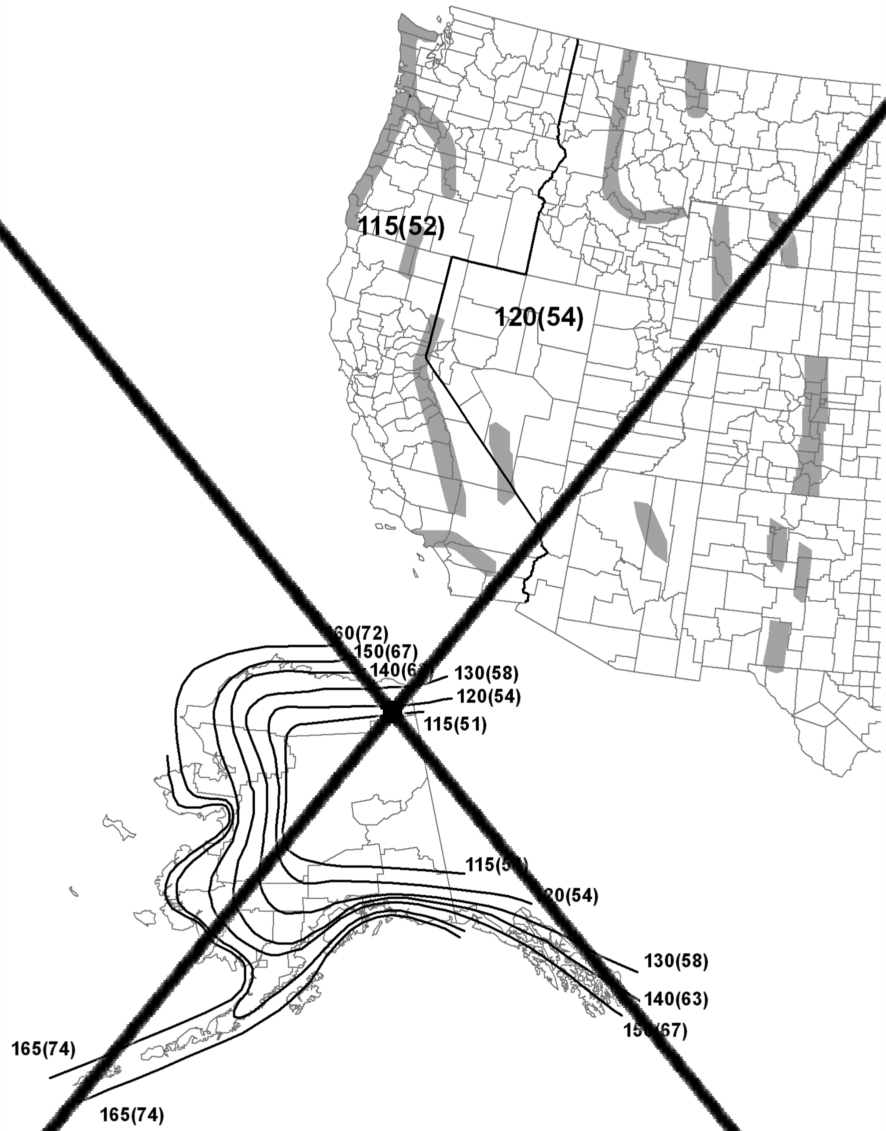
Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

~~**Figure C.1(a)—Basic Wind Speeds for Occupancy Category II Building and Other Structures**~~



~~**Figure C.1(a)—Basic Wind Speeds for Occupancy Category II Building and Other Structures (cont.)**~~

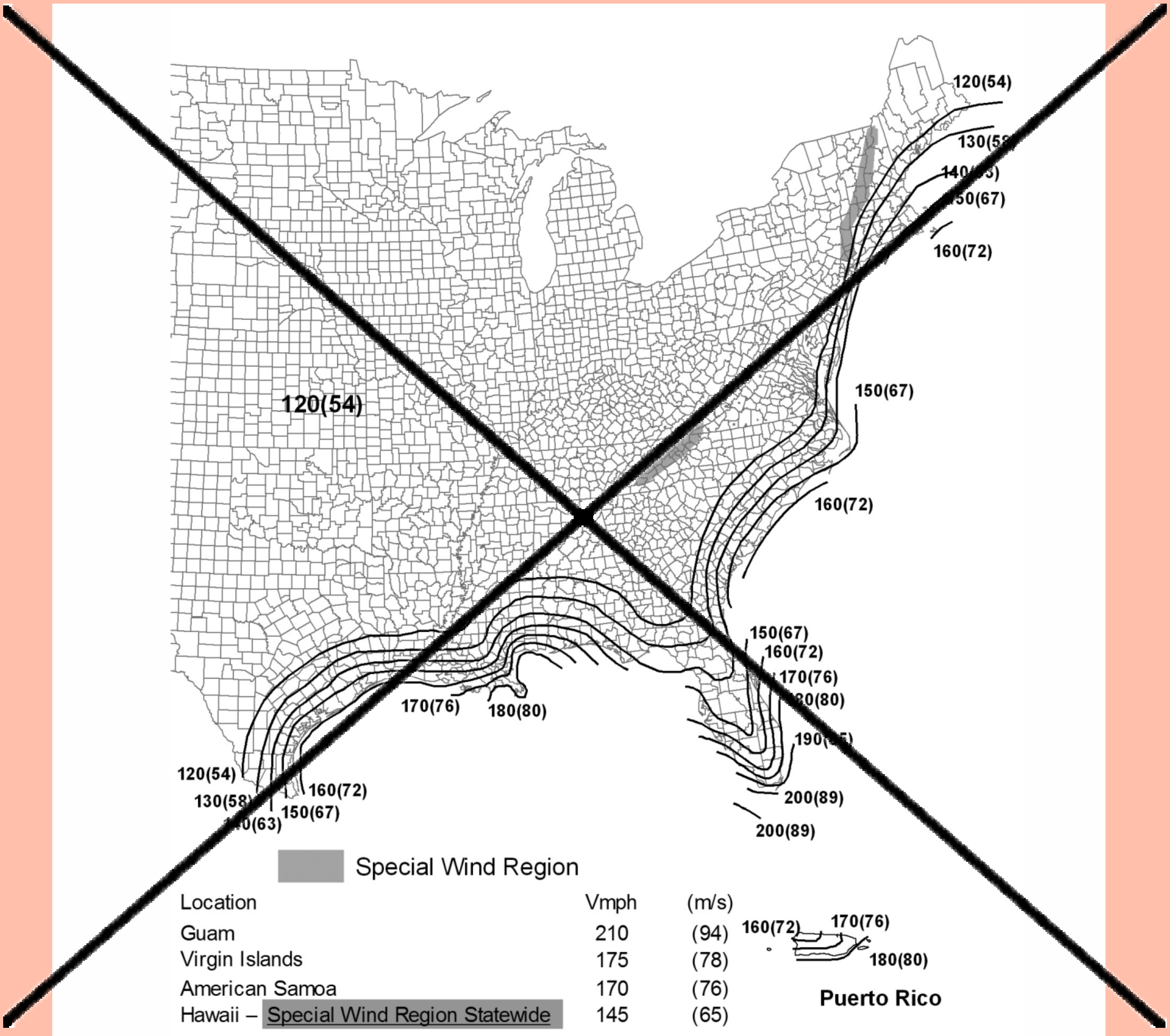


Basic Wind Speeds for Occupancy Category III and IV Buildings and Other Structures.

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.000588, MRI = 1700 Years).

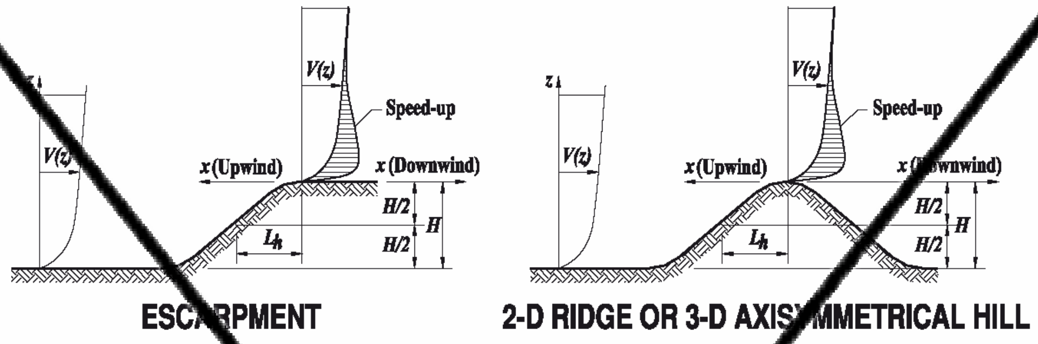
~~Figure C.1(b)—Basic Wind Speeds for Occupancy Category III and IV Buildings and Other Structures~~



~~**Figure C.1(b)—Basic Wind Speeds for Occupancy Category III and IV Buildings and Other Structures (cont.)**~~

Topographic Factor, K_{zt}

Figure 26.8-1



Topographic Multipliers for Exposure C

H/L_h	K_1 Multiplier			x/L_h	K_2 Multiplier		z/L_h	K_3 Multiplier		
	2-D Ridge	2-D Escarp.	3-D Axisym. Hill		2-D Escarp.	All Other Cases		2-D Ridge	2-D Escarp.	3-D Axisym. Hill
0.20	0.29	0.17	0.21	0.00	1.00	1.00	0.00	1.00	1.00	1.00
0.25	0.36	0.21	0.26	0.50	0.88	0.67	0.10	0.74	0.78	0.67
0.30	0.43	0.26	0.32	1.00	0.75	0.33	0.20	0.55	0.61	0.45
0.35	0.51	0.30	0.37	1.50	0.63	0.00	0.30	0.41	0.47	0.30
0.40	0.58	0.34	0.42	2.00	0.50	0.00	0.40	0.30	0.37	0.20
0.45	0.65	0.38	0.47	2.50	0.38	0.00	0.50	0.22	0.29	0.14
0.50	0.72	0.43	0.53	3.00	0.25	0.00	0.60	0.17	0.22	0.09
				3.50	0.13	0.00	0.70	0.12	0.17	0.06
				4.00	0.00	0.00	0.80	0.09	0.14	0.04
							0.90	0.07	0.11	0.03
							1.00	0.05	0.08	0.02
							1.50	0.01	0.02	0.00
							2.00	0.00	0.00	0.00

Notes:

1. For values of H/L_h, x/L_h and z/L_h other than those shown, linear interpolation is permitted.
2. For $H/L_h > 0.5$, assume $H/L_h = 0.5$ for evaluating K_1 and substitute $2H$ for L_h for evaluating K_2 and K_3.
3. Multipliers are based on the assumption that wind approaches the hill or escarpment along the direction of maximum slope.
4. Notation:
   H: Height of hill or escarpment relative to the upwind terrain, in feet (meters).
   L_h: Distance upwind of crest to where the difference in ground elevation is half the height of hill or escarpment, in feet (meters).
   K_1: Factor to account for shape of topographic feature and maximum speed-up effect.
   K_2: Factor to account for reduction in speed-up with distance upwind or downwind of crest.
   K_3: Factor to account for reduction in speed-up with height above local terrain.
   x: Distance (upwind or downwind) from the crest to the building site, in feet (meters).
   z: Height above ground surface at building site, in feet (meters).
   μ: Horizontal attenuation factor.
   γ: Height attenuation factor.

~~**Figure C.2—Topographic Multipliers for Exposure C**~~

Topographic Factor, K_{zt}

Figure 26.8-1 (cont'd)

Equations:

$$K_{zt} = (1 + K_1 K_2 K_3)^2$$

K_1 determined from table below

$$K_2 = \left(1 - \frac{|x|}{\mu L_h}\right)$$

$$K_3 = e^{-\gamma z / L_h}$$

Parameters for Speed-Up Over Hills and Escarpments						
Hill Shape	**$K_1/(H/L_h)$**			**γ**	**μ**	
	Exposure				**Upwind of Crest**	**Downwind of Crest**
	B	**C**	**D**			
2-dimensional ridges (or valleys with negative H in $K_1/(H/L_h)$)	1.30	1.45	1.55	3	1.5	1.5
2-dimensional escarpments	0.75	0.85	0.95	2.5	1.5	4
3-dimensional axisym. hill	0.95	1.05	1.15	4	1.5	1.5

~~**Figure C.2—Topographic Multipliers for Exposure C (cont.)**~~