ASCE 7

Agenda

ASCE 7

(American Society of Civil Engineers)

- Background
  - ASCE 7 and why it is important for roof wind design
  - ASCE 7 and the IBC
- Building Characteristics
  - Location and Use
  - Physical Parameters
- Changes from ASCE 7-10 to ASCE 7-16

Why is ASCE 7 important?

- **The building code (IBC)** requires roof assemblies resist the uplift pressures calculated by the **ASCE 7**
- Independent testing of the assembly **(ANSI/FM 4474)** is used to certify compliance with the **IBC**
- **Rating** achieved by assembly must be **greater than or equal** to the ASCE 7 results.

Background

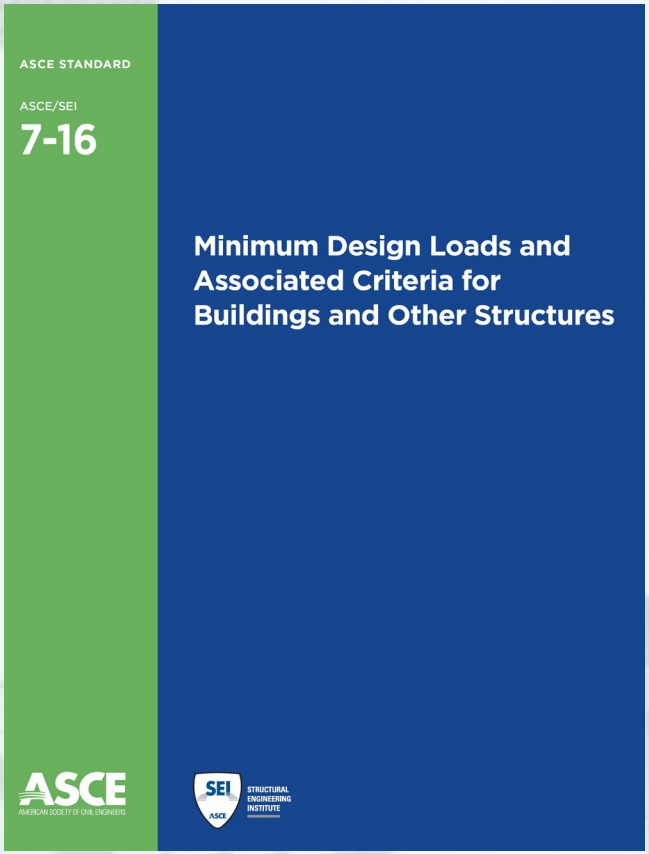
ASCE 7
(American Society of Civil Engineers)

Provides method to calculate building pressure loads (lbs./sqft.) due to:

- Soil
- Hydrostatic Pressure
- Floods
- Snow
- Rain
- Earthquake
- Wind
- Etc.

Standard
ASCE 7
(American Society of Civil Engineers)

- 1988- first edition of the ASCE 7 was published
- Updated – 1993, 1995, 1997, 2002, 2005, 2010, 2016 & 2022
- Latest publication is 889-pages
- Roof Systems uplift, approximate 100-pages, explains method on how to calculated wind loads (lbs./sqft.)



Adoption by State

International Code Council (July 2022)

IBC edition	ASCE-7 edition	States
2018 & 2021	2016	AL, CA, FL, GA, HI, ID, MD, MN, MS, MT, NE, NJ, NY, ND, OK, OR, PA, RI, SC, SD, UT, VA, WA, WV & WY Total 25 States
2012 & 2015	2010	AK, AR, CT, IN, IA, KY, LA, ME, MA, MI, NC, NH, NM, OH, TN, TX, VT & WI Total 18 States & DC*
Adopted by Local Governments	X	AZ, CO, DE, IL, KS, MO, NV Total 7 States

*District of Columbia

Factors to Determine Uplift

ASCE 7

- **Building location**
  - Wind
  - Terrain
- **Building use**
  - Risk Category
- **Building physical parameters**
  - Height
  - Openings

Building Location

Terrain & Wind

Terrain

- Exposure
  - “B” = urban/suburban
  - “C” = open terrain
  - “D” = close to a large body of water
- Hills & Escarpments

Wind

- ASCE 7 Basic Wind Maps
  - Linear interpolation between wind contours is permitted

Risk Categories (Building Use)

Risk Categories & incorporated in the wind speed maps

Risk Category I

Low risk to human life

(Agricultural or storage)

Risk Category II

Not I, III, & IV

(Commercial Buildings)

Risk Category III/IV

Substantial risk to human life

(Schools, Public Buildings, Hospitals, Power Plants, etc.)

For complete definition of each Risk Category, refer to ASCE 7 Table 1.5-1

Building Physical Parameters

Characteristics

Roof Area

- Height & Slope
- Parapets Heights

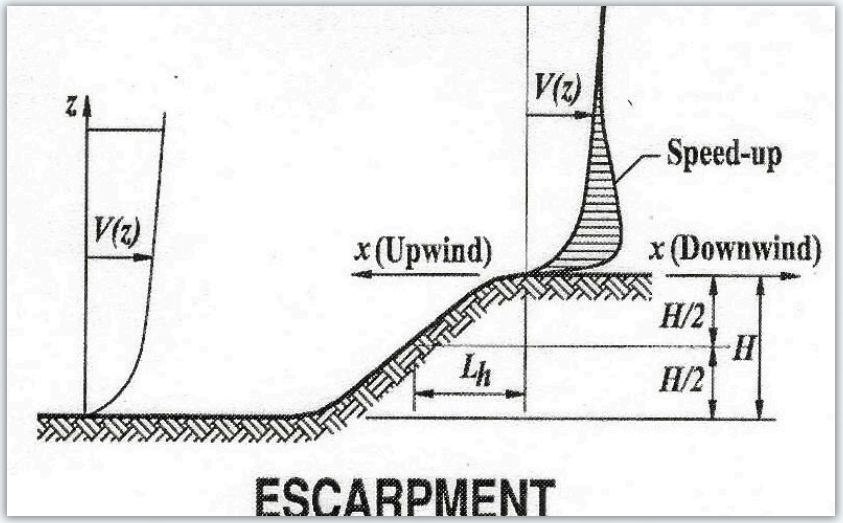
Building Structure

- On a hill or precipices
- Building Openings
  - Open, Partial Enclosed, Enclosed
- Building Overhangs, Interior Pressurized

Building Location

Hills and Escarpments

Special calculations are required for hills and escarpments:



Note: No calculations available for intensified winds at the end of valleys. Local authorities would need to offer assistance.

Building Physical Parameters

Openings

Consider closely, truck dock doors, breakable windows, or other openings on a single wall with a combined total greater than 4-sq.ft.

Building Physical Parameters

Openings

Open Building:

- A building have each wall at least 80% open.

Basic Information to Determine Uplift

Check List

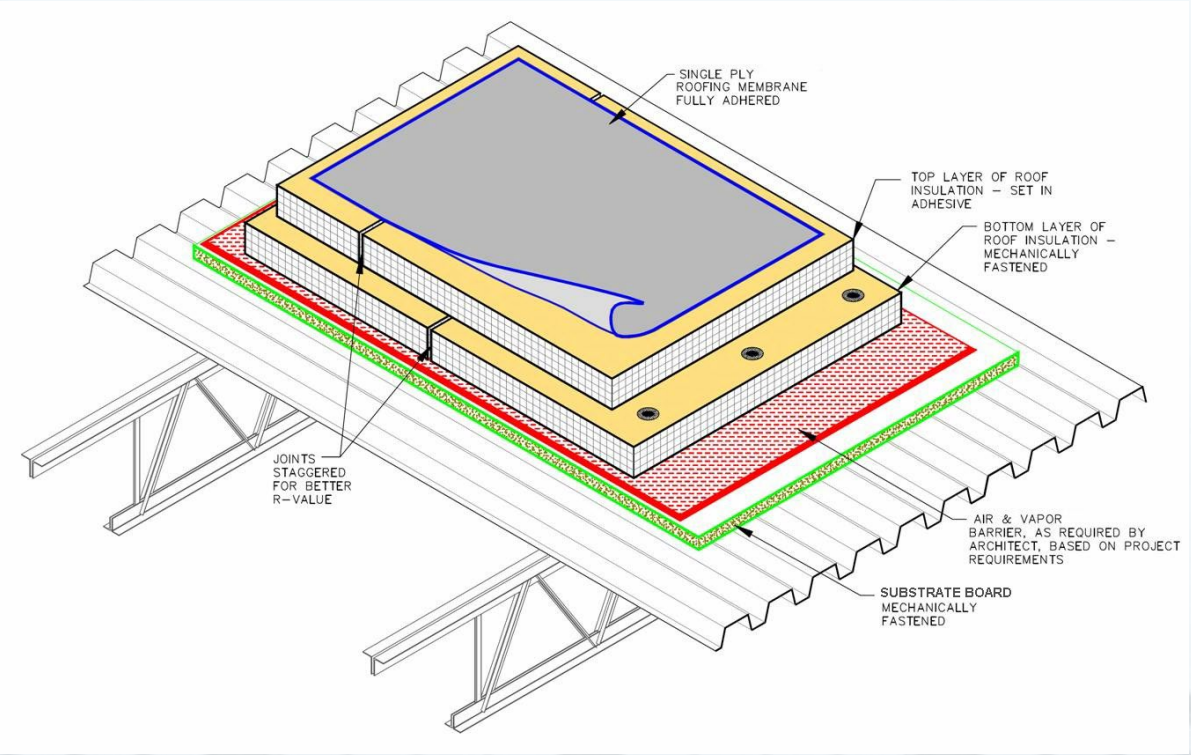
- Applicable Code and Standard
- Building Location for:
  - ASCE 7 wind speed
  - Topography
  - Surrounding Terrain
  - Wind Direction
- Building Use
- Building Physical Parameters
  - Height
  - Openings

ASCE 7-2010 & 7-2016

Minimum Design Loads for Buildings and Other Structures

ASCE 7-10 & 7-16
Cladding and Components

Both standard refer to roofing systems and materials as cladding. Roofing assemblies are not structural members.



ASCE 7 Similarities

Chapters

ASCE-7 edition	2010	2016
Chapter(s)	Chapters 26-31	Chapters 26-31
General Requirements	X	X
MWFRS* (Directional Procedure)	X	X
MWFRS* (Envelope Procedure)	X	X
Appurtenances and Other Structures (Directional Procedure)	X	X
Components and Cladding	X	X
Wind Tunnel Procedure	X	X

*MWFRS: Main Wind Force Resistance System

ASCE 7

Chapter 26 – General Requirements

ASCE-7 edition	2010 & 2016
Scope	X
Definitions	X
Ultimate Wind Speed Maps	X
Exposure	X
Gust Factor	X
Topographic Factor	X

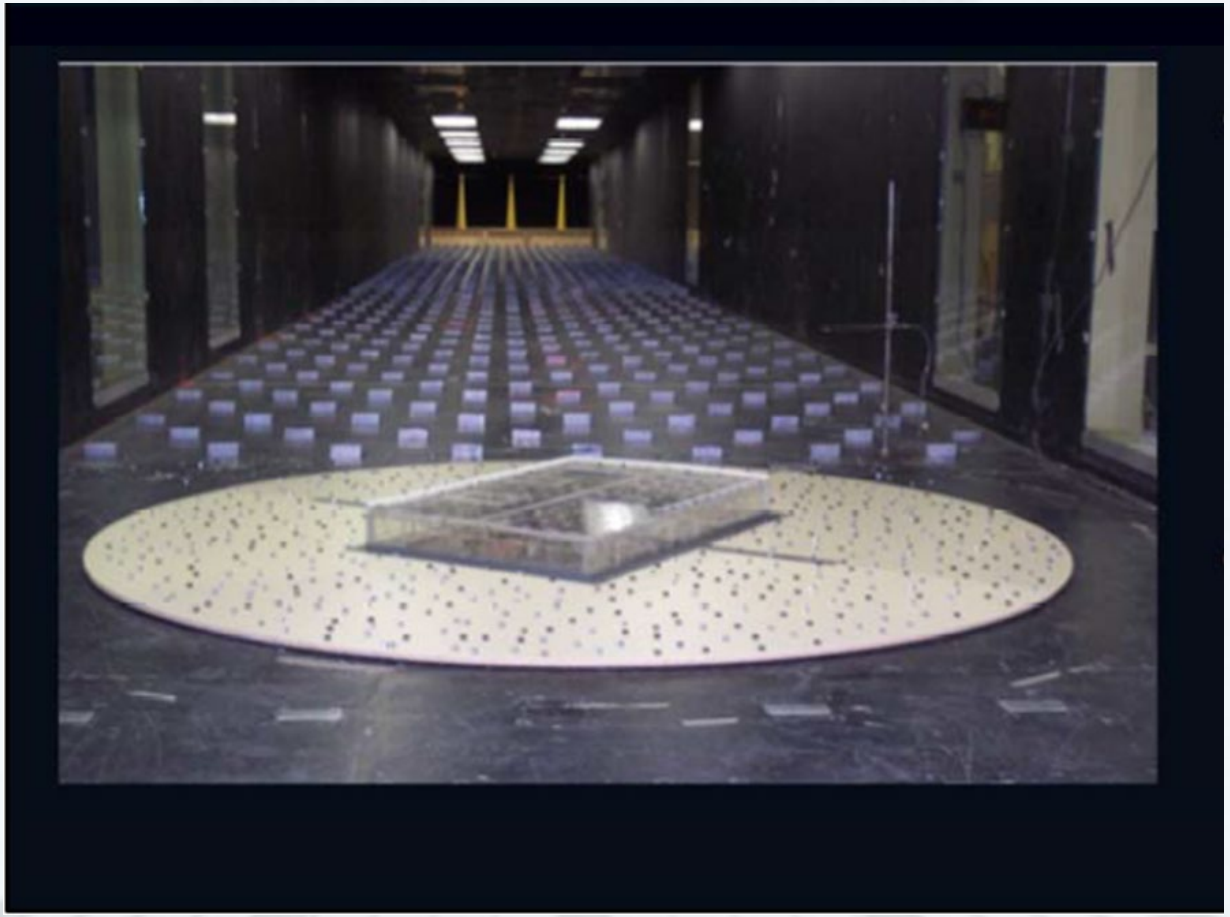
ASCE 7

Chapter 30 – Components & Cladding

ASCE-7 edition	2010 & 2016
Analytical Method (h <= 60-ft)	X
Simplified Method (h<= 60-ft)	X
Analytical Method (h> 60-ft)	X
Simplified Method (h <= 160-ft)	X
Internal Pressure Coefficient (GCpi)	X
External Pressure Coefficient (GCp)	X

ASCE 7-10 & 7-16

Chapter 31 – Wind Tunnel Procedure



ASCE 7-2016

Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASCE 7-16

Adjusted from ASCE 7-10

- **Adjusted** the Calculations
- **Reduced Exposure "B" Kz factor** for roof areas less than 30-ft
- **New** Wind Speed Maps **(4 sets)**
- **New** Roof Area Zones (60-ft or less in height)
- **Five New** Roof Area Zone Layouts
- **Higher GCp** for 60-ft or less height

[Special ratio of Hight/Width < 1 for 61-ft to 89-ft high]

Incorporate in IBC 2018 & 2021

ASCE 7-16

Modified Uplift Equation

ASCE 7-10

$$qz = 0.00256 \times Kz \times Kzt \times Kd \times V2$$

ASCE 7-16

$$qz = 0.00256 \times Kz \times Kzt \times Ke \times Kd \times V2$$

Ke = Ground Elevation Factor

ASCE 7-16

Table 26.9-1 Ground Elevation Factor, K_e

Ground Elevation above Sea Level ft	
<0	See note 2
0	1.00
1,000	0.96
2,000	0.93
3,000	0.90
4,000	0.86
5,000	0.83
6,000	0.80
>6,000	See note 2

Note:

1. The conservative approximation Ke = 1.00 is permitted in all cases
2. The factor Ke shall be determined using interpolation or from another formula

Can reduce uplift from 4% to 20% depending on elevation above sea level

ASCE 7-16

Modified Kz Factor for less than 30-ft high

Table 26.10-1 Velocity Pressure Exposure Coefficients, K_h and K_z

Exposure		
B	C	D
0.57 (0.70)[a]	0.85	1.03
0.62 (0.70)[a]	0.90	1.08
0.66 (0.70)[a]	0.94	1.12
0.70	0.98	1.16

ASCE 7-10 & 7-16 Wind Maps

Risk Category Based

ASCE 7-10

Based on Risk Categor

- Risk Cat
- Risk
- Ris

ASCE 7-1

Based on R

- Risk Cat
- Risk Cat II:
- Risk Cat III: 1,700-year MRI (US = 100-mph <)
- Risk Cat IV: 3,000-year MRI (US = 105-mph <)

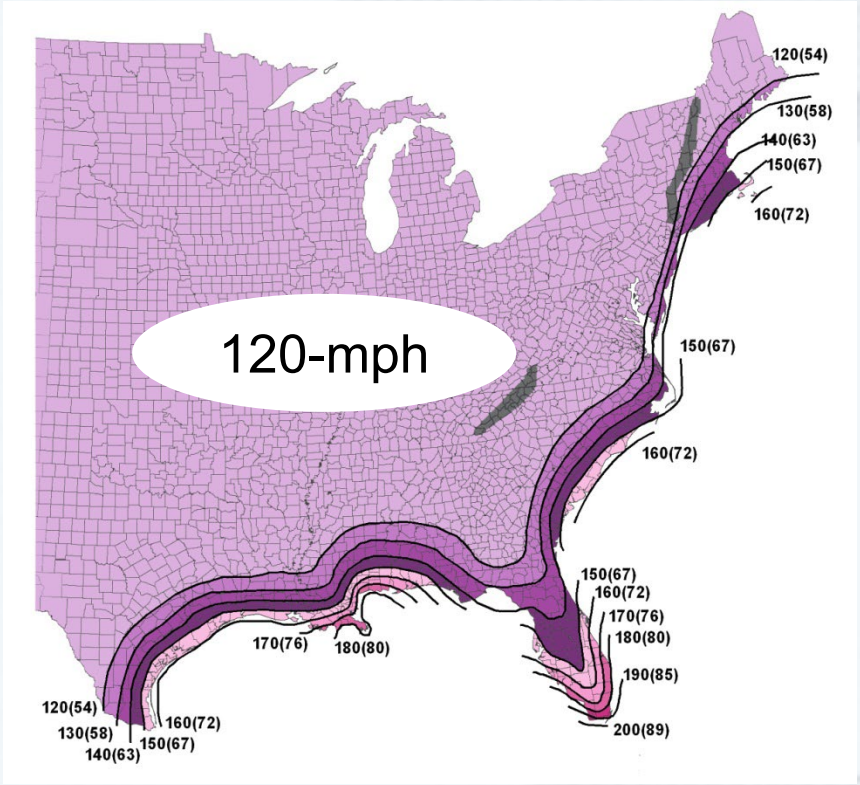
3,000-year MRI means

1/3000 chance in one year of wind of this wind speed may happen.

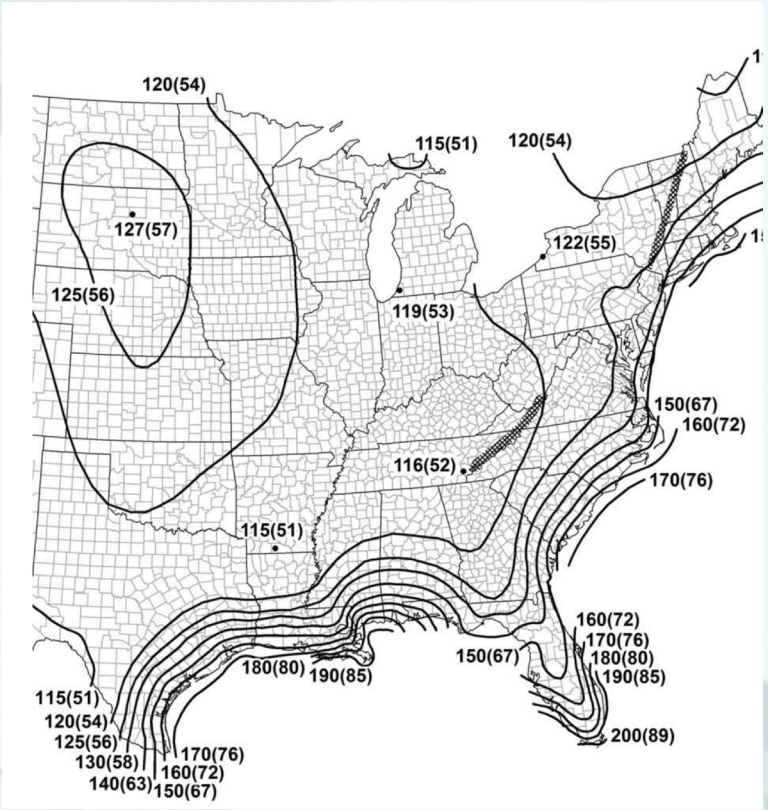
(0.00033)

ASCE 7-10 & 7-16 Wind Maps

3-Sec Peak Gust Wind



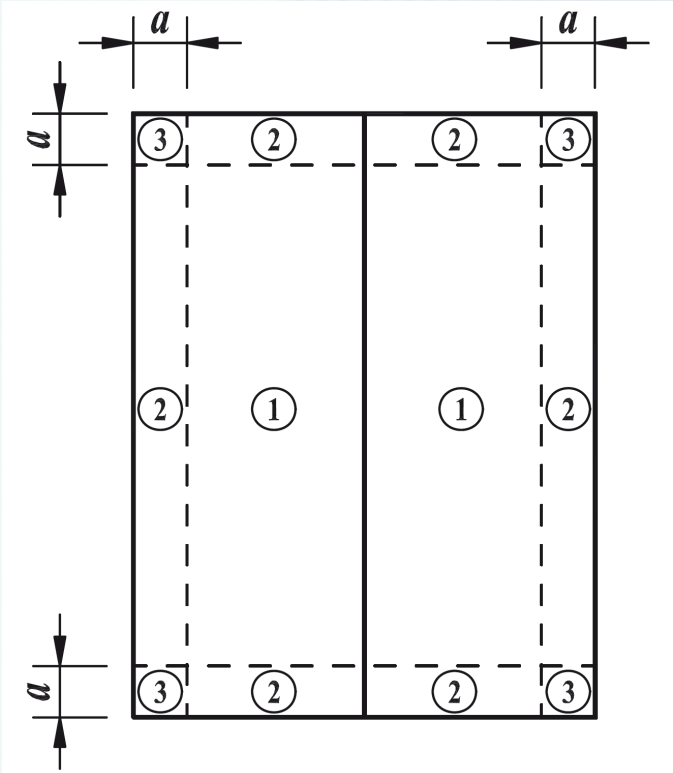
ASCE 7-2010
Risk Category III/IV



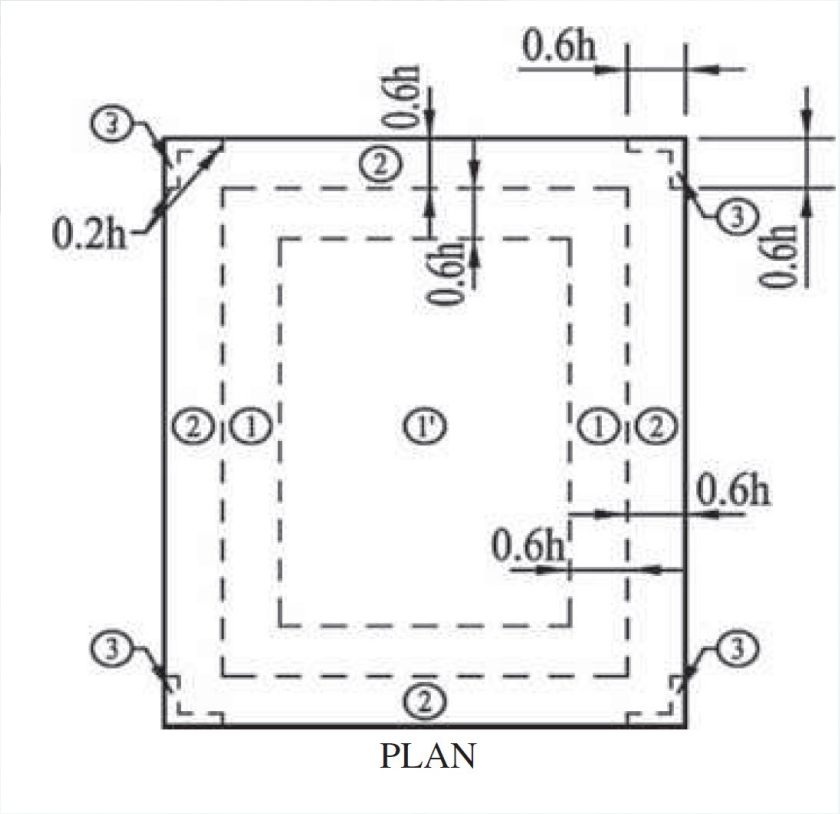
ASCE 7-2016
Risk Category IV

ASCE 7-10 & 7-16

Roof Zone Layout (60-ft or less)



- a = 0.4 x ht or 0.1 x width, whichever is less, but not less than 0.04 x width



- Zone 1’ = “One Prime”
- 0.6 x height for all areas, except corner which is 0.2 x height

ASCE 7-16

GCp = external pressure coefficient

qz = 0.00256 x Kz x Kzt x Kd x Ke x V2

Roof Zones for Bldgs. 60 or less	Location	ASCE 7-10 GCp Coefficient
Zone 1	Field	1
Zone 2	Perimeter	1.8
Zone 3	Corner	2.8

- GCp is determined based on roof zones.

Roof Zones for Bldgs. 60 or less	Location	ASCE 7-16 GCp Coefficient
Zone 1’	Interior Zone	0.9
Zone 1	Field	1.7
Zone 2	Perimeter	2.3
Zone 3	Corner	3.2

ASCE 7-16

GCpi = internal pressure coefficient

Opening Types	Amount of Openings	ASCE 7-16 GCpi Coefficient
Enclosed	Less than 10%	.18
Partially Enclosed	10% to 20%	.55
Partially Open	Does not comply with the others	.18
Open	80%	0

ASCE 7 Calculations

Wind Loads on the Roof

Examples

Determine the forces exposed to a roof using ASCE 7-16 Calculations

Chapter 30 Components and Cladding Examples

- **Part 1 – Analytical method for h ≤ 60 ft**
- **Part 2 – Simplified method for h ≤ 60 ft**
- Part 3 – Analytical method for h > 60 ft
- Part 4 – Simplified method for h ≤ 160 ft

Building Configuration

Location: Raleigh, NC
Building Elevation: 347-ft

Exposure Category: “C” Flat open terrain

Building Height: 40-ft

Parapet Height: 18-inches

Roof Width: 200-ft

Roof Length: 400-ft

Enclosure Type: Enclosed

Occupancy: Risk Category IV

ASCE 7-16 Maps: 128-mph

Example
Analytical Method for
$h \leq 60$ ft

ASCE 7-16 Calculation for Wind Loads on a Roof

ASCE 7-16

$qz = 0.00256 \times Kz \times Kzt \times Ke \times Kd \times V^2$

- 0.00256 = numerical coefficient to be used except where sufficient climatic data are available
- Kz = velocity pressure exposure coefficient evaluated at height z = h
- Kzt = Topographic factor
- Ke = Elevation above sea level
- Kd = wind directionality factor
- V^2 = basic ultimate wind speed base on Risk Category

$P\ (pressure) = q_z\ [(GC_p) - (GC_{pi})]$

- GC_p = external pressure coefficient & gust-effect factor
- GC_{pi} = internal pressure coefficient & gust-effect factor

Kz

(TABLE 26.10-1)

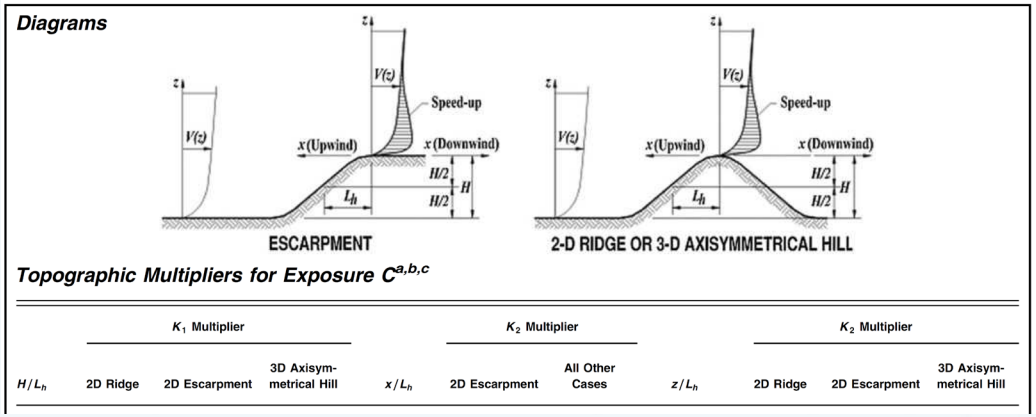
Table 26.10-1 Velocity Pressure Exposure Coefficients, K_h and K_z

Height above Ground Level, *z*		Exposure		
ft	m	B	C	D
0–15	0–4.6	0.57 (0.70)[a]	0.85	1.03
20	6.1	0.62 (0.70)[a]	0.90	1.08
25	7.6	0.66 (0.70)[a]	0.94	1.12
30	9.1	0.70	0.98	1.16
40	12.2	0.76	1.04	1.22
50	15.2	0.81	1.09	1.27
60	18.0	0.85	1.13	1.31

Kzt

Topographical Factor

Figure 26.8-1



Topographic Multipliers for Exposure C[a,b,c]

	K_1 Multiplier				K_2 Multiplier			K_2 Multiplier		
H/L_h	2D Ridge	2D Escarpment	3D Axisymmetrical Hill	x/L_h	2D Escarpment	All Other Cases	z/L_h	2D Ridge	2D Escarpment	3D Axisymmetrical Hill

$$Kzt = (1+K_1K_2K_3)^2$$

- K1 = Factor to account for shape of topographic feature and maximum speed-up effect.
- K2 = Factor to account for reduction in speed-up with distance upwind or downwind of crest.
- K3 = Factor to account for reduction in speed-up with height above local terrain.

Ke

Elevation Factor

Table 26.9-1 Ground Elevation Factor, K_e

Ground Elevation above Sea Level		Ground Elevation Factor
ft	m	K_e
<0	<0	See note 2
0	0	1.00
1,000	305	0.96
2,000	610	0.93
3,000	914	0.90
4,000	1,219	0.86
5,000	1,524	0.83
6,000	1,829	0.80
>6,000	>1,829	See note 2

Notes

1. The conservative approximation $K_e = 1.00$ is permitted in all cases.
2. The factor K_e shall be determined from the above table using interpolation or from the following formula for all elevations:
   $K_e = e^{-0.0000362 z_g}$ (z_g = ground elevation above sea level in ft).
   $K_e = e^{-0.000119 z_g}$ (z_g = ground elevation above sea level in m).
3. K_e is permitted to be take as 1.00 in all cases.

Kd

Wind Directionality

Table 26.6-1

Table 26.6-1 Wind Directionality Factor, K_d

Structure Type	Directionality Factor K_d
Buildings	
Main Wind Force Resisting System	0.85
Components and Cladding	0.85
Arched Roofs	0.85
Circular Domes	1.0[a]
Chimneys, Tanks, and Similar Structures	
Square	0.90
Hexagonal	0.95
Octagonal	1.0[a]
Round	1.0[a]
Solid Freestanding Walls, Roof Top Equipment, and Solid Freestanding and Attached Signs	0.85
Open Signs and Single-Plane Open Frames	0.85
Trussed Towers	
Triangular, square, or rectangular	0.85
All other cross sections	0.95

[a]Directionality factor $K_d = 0.95$ shall be permitted for round or octagonal structures with nonaxisymmetric structural systems.

Velocity pressure calculation

$qz = 0.00256 \times Kz \times Kzt \times Ke \times Kd \times V^2$

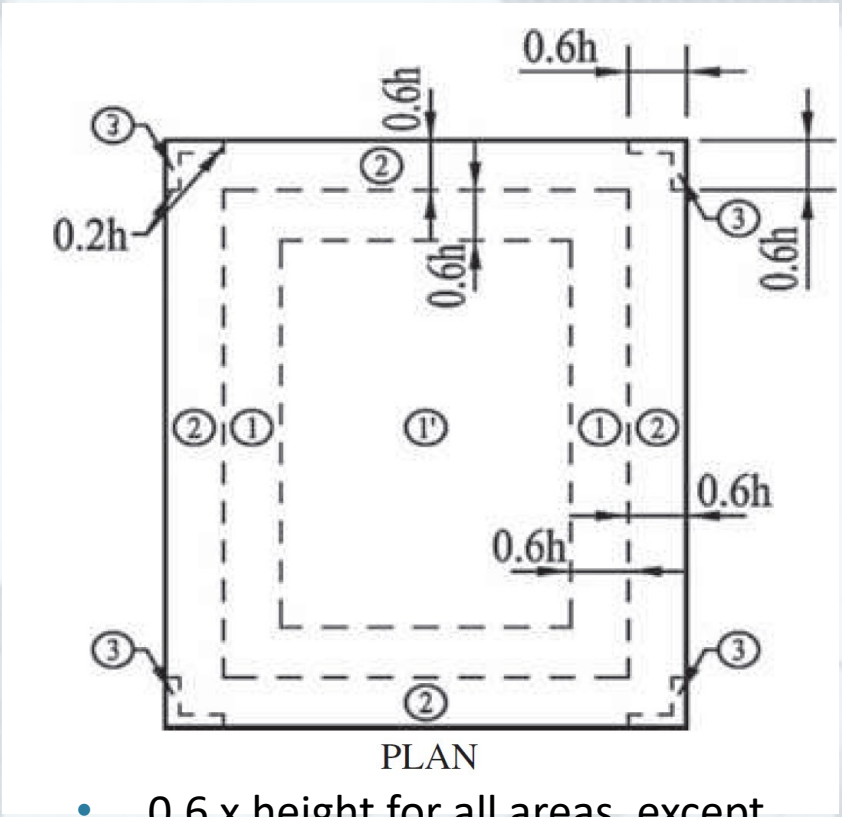
Variable	Building	ASCE-7 10
Kz	Height & Terrain	1.04
Kzt	Topography	1
Kd	Wind Directionality	0.85
V	Risk Cat Maps	130-mph
q_z	**Results**	**38.2-lbs/sqft**

Wind Load

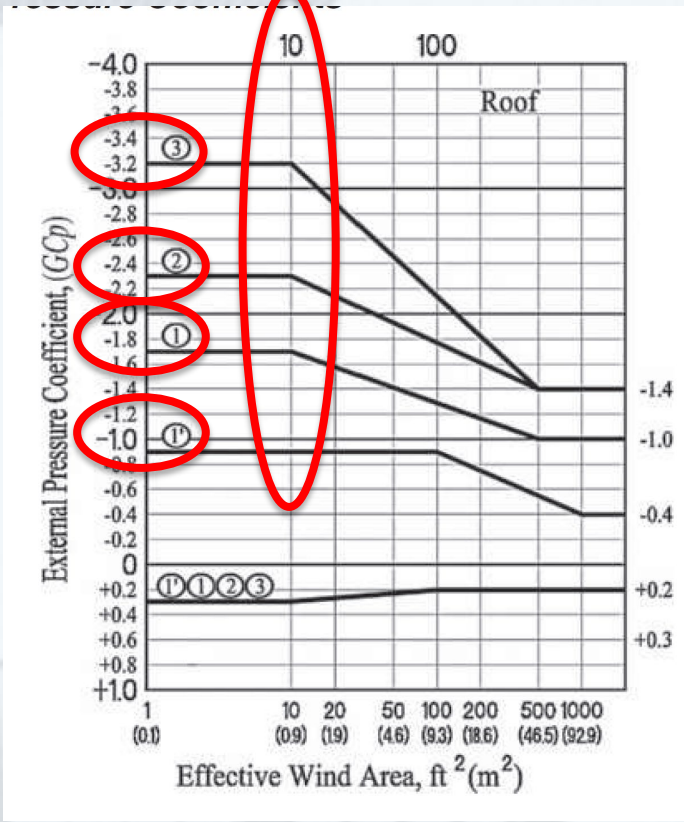
Calculating Uplift Pressure

P = qz { GCp – Gcpi }

- Gcp = External Pressure Coefficient (Table 30.3-2A)



- 0.6 x height for all areas, except corner which is 0.2 x height



ASCE 7-16

Wind Load

Calculating Uplift Pressure

P = qz { GCp – GCpi }

- GCpi = Internal Pressure Coefficient (Table 26.13-1)

Table 26.13-1 Main Wind Force Resisting System and Components and Cladding (All Heights): Internal Pressure Coefficient, (GC_{pi}), for Enclosed, Partially Enclosed, Partially Open, and Open Buildings (Walls and Roof)

Enclosure Classification	Criteria for Enclosure Classification	Internal Pressure	Internal Pressure Coefficient, (GC_{pi})
Enclosed buildings	A_o is less than the smaller of $0.01A_g$ or 4 sq ft (0.37 m) and $A_{oi}/A_{gi} \leq 0.2$	Moderate	+0.18 −0.18
Partially enclosed buildings	$A_o > 1.1A_{oi}$ and $A_o >$ the lesser of $0.01A_g$ or 4 sq ft (0.37 m) and $A_{oi}/A_{gi} \leq 0.2$	High	+0.55 −0.55
Partially open buildings	A building that does not comply with Enclosed, Partially Enclosed, or Open classifications	Moderate	+0.18 −0.18
Open buildings	Each wall is at least 80% open	Negligible	0.00

Notes

1. Plus and minus signs signify pressures acting toward and away from the internal surfaces, respectively.
2. Values of (GC_{pi}) shall be used with q_z or q_h as specified.
3. Two cases shall be considered to determine the critical load requirements for the appropriate condition:
   a. A positive value of (GC_{pi}) applied to all internal surfaces, or
   b. A negative value of (GC_{pi}) applied to all internal surfaces.

Calculating Uplift Pressure

$$P = qz \{ GCp - GCpi \}$$

Roof Area	qz	GCp	GCpi	Ult. Strength Result
Zone 1’	38.2	-0.9	0.18	-41.3
Zone 1	38.2	-1.7	0.18	-71.9
Zone 2	38.2	-2.3	0.18	-94.8
Zone 3	38.2	-3.0	0.18	-129.3

ASCE 7-16 Wind Maps

ASCE 7-05 to ASCE 7-10 & ASCE 7-16

7-05 Based on Allowable Stress Design, while 7-10 & 7-16 based on Ultimate Strength

Allowable Stress Design (Vasd)

Are nominal loads for cladding so as not to exceed the structure. Roofing assemblies are defined as cladding

Ultimate Strength (Vult)

Are the strength loads necessary for structural members

ASCE 7-16 Wind Maps

Allowable vs. Ultimate

- 7-05 Allowable Stress Design winds increase by a sqrt (1.6) = 1.26
- ASCE 7-10 & 7-16 Results are Ultimate Strength Pressures

But…

Cladding uses Allowable Stress Design Pressures, how is this determined?

ASD = ASCE 7-16 Ult. results x 0.6

Or

Convert wind speed back to Allowable for Calculations

ASCE 7-10 Wind Maps

IBC 2012 & 2015

1609.3.1 Wind speed conversion. When required, the ultimate design wind speeds of Figures 1609A, 1609B and 1609C shall be converted to nominal design wind speeds, V_{asd}, using Table 1609.3.1 or Equation 16-33.

$$V_{asd} = V_{ult}\sqrt{0.6}$$ = Vult x 0.775 **(Equation 16-33)**

TABLE 1609.3.1
WIND SPEED CONVERSIONS[a, b, c]

V_{ult}	100	110	120	130	140	150	160	170	180	190	200
V_{asd}	78	85	93	101	108	116	124	132	139	147	155

Design Pressure

Roof Area	ASCE 7-10
Zone 1’	-41.3 x 0.6= **-24.8**
Zone 1	-71.9 x 0.6 = **-43.1**
Zone 2	-94.8 x 0.6 = **-56.9**
Zone 3	-129.3 x 0.6 = **-77.6**

Ultimate or strength based wind speeds are used in the wind speed maps. Must apply the 0.625 factor for allowable stress design

Example 2
Simplified Procedure for
$h \leq 60$ ft
ASCE 7-16 Calculation for Wind Loads on a Roof

ASCE 7-16 Simplified Procedure (Part 2)

Can use if:

- Building height is ≤ 60 ft
- The building is a regular-shaped building as defined in Section 26.2
- The building is enclosed and conforms to the wind-borne debris provisions of Section 26.12.3
- The building has either a flat roof, a gable roof or a hip roof
- The building does not have response characteristics that make it subject to across-wind loading, vortex shedding, or instability caused by galloping or fluttering; nor does it have a site location for which channeling effects or buffeting in the wake of upwind obstructions warranty special consideration.

ASCE 7-16 Simplified Procedure (Part 2)

Table 30.4-1 Steps to Determine C&C Wind Loads for Enclosed Low-Rise Buildings (Simplified Method)

Step 1: Determine risk category; see Table 1.5-1.

Step 2: Determine the basic wind speed, V, for applicable risk category; see Figs. 26.5-1 and 26.5-2.

Step 3: Determine wind load parameters:

- Exposure category B, C, or D; see Section 26.7.
- Topographic factor, K_{zt}; see Section 26.8 and Fig. 26.8-1.

Step 4: Enter figure to determine wind pressures at $h = 30$ ft, p_{net30}; see Fig. 30.4-1.

Step 5: Enter figure to determine adjustment for building height and exposure, λ; see Fig. 30.4-1.

Step 6: Determine adjusted wind pressures, p_{net}; see Eq. (30.4-1).

ASCE 7-16

Figure 30.4-1 Design Wind Pressure

Net Design Wind Pressure, p_{net30}, in lb/ft^2, for Exposure B at h = 30 ft, V= 95–130 mph

	Zone	Effective Wind Area (ft^2)	Basic Wind Speed (mph)													
			95		100		105		110		115		120		130	
Flat/Hip/Gable Roof 0 to 7 Degrees	1	10	6.6	–25.9	7.3	–28.7	8.1	–31.6	8.9	–34.7	9.7	–37.9	10.5	–41.3	12.4	–48.4
	1	20	6.2	–24.2	6.9	–26.8	7.6	–29.5	8.3	–32.4	9.1	–35.4	9.9	–38.5	11.6	–45.2
	1	50	5.6	–21.9	6.3	–24.3	6.9	–26.8	7.6	–29.4	8.3	–32.1	9.0	–34.9	10.6	–41.0
	1	100	5.2	–20.2	5.8	–22.4	6.4	–24.7	7.0	–27.1	7.7	–29.6	8.3	–32.2	9.8	–37.8
	1′	10	6.6	–14.9	7.3	–16.5	8.1	–18.2	8.9	–19.9	9.7	–21.8	10.5	–23.7	12.4	–27.8
	1′	20	6.2	–14.9	6.9	–16.5	7.6	–18.2	8.3	–19.9	9.1	–21.8	9.9	–23.7	11.6	–27.8
	1′	50	5.6	–14.9	6.3	–16.5	6.9	–18.2	7.6	–19.9	8.3	–21.8	9.0	–23.7	10.6	–27.8
	1′	100	5.2	–14.9	5.8	–16.5	6.4	–18.2	7.0	–19.9	7.7	–21.8	8.3	–23.7	9.8	–27.8
	2	10	6.6	–34.1	7.3	–37.8	8.1	–41.7	8.9	–45.7	9.7	–50.0	10.5	–54.4	12.4	–63.9
	2	20	6.2	–31.9	6.9	–35.4	7.6	–39.0	8.3	–42.8	9.1	–46.8	9.9	–50.9	11.6	–59.8
	2	50	5.6	–29.0	6.3	–32.2	6.9	–35.5	7.6	–38.9	8.3	–42.5	9.0	–46.3	10.6	–54.4
	2	100	5.2	–26.8	5.8	–29.7	6.4	–32.8	7.0	–36.0	7.7	–39.3	8.3	–42.8	9.8	–50.2
	3	10	6.6	–46.5	7.3	–51.5	8.1	–56.8	8.9	–62.3	9.7	–68.1	10.5	–74.2	12.4	–87.1
	3	20	6.2	–42.1	6.9	–46.7	7.6	–51.4	8.3	–56.5	9.1	–61.7	9.9	–67.2	11.6	–78.9
	3	50	5.6	–36.3	6.3	–40.2	6.9	–44.4	7.6	–48.7	8.3	–53.2	9.0	–57.9	10.6	–68.0
	3	100	5.2	–31.9	5.8	–35.4	6.4	–39.0	7.0	–42.8	7.7	–46.8	8.3	–50.9	9.8	–59.8

ASCE7-16

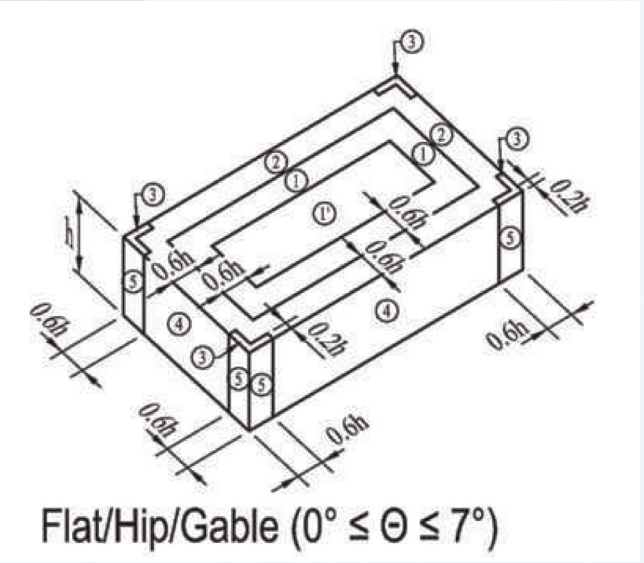
Figure 30.5.1 Adjustment Factor

Adjustment Factor for Building Height and Exposure, λ

Mean Roof Height (ft)	Exposure		
	B	C	D
15	0.82	1.21	1.47
20	0.89	1.29	1.55
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

ASCE7-16 Part 2 Simplified Method

Roof Area	ASCE7-16 (Results)
Zone 1’	-27.8 x 1.49 = **-41.5**
Zone 1	-48.4 x 1.49 = **-72.2**
Zone 2	-63.9 x 1.49 = **-95.3**
Zone 3	-87.1 x 1.49 = **-129.8**



Flat/Hip/Gable (0° ≤ Θ ≤ 7°)

Ultimate to Allowable Stress

Roof Area	ASCE7-10 (Part 2)
Zone 1’	-41.5 x 0.6= **-24.9**
Zone 1	-72.2 x 0.6 = **-43.4**
Zone 2	-95.3 x 0.6 = **-57.2**
Zone 3	-129.8 x 0.6 = **-77.9**

Ultimate or strength based wind speeds are used in the wind speed maps. Must apply the 0.625 factor for allowable stress design

Comparison of the Two Methods

Roof Areas	Analytical	Simplified Procedure
Zone 1’	-24.8	-24.9
Zone 1	-43.1	-43.4
Zone 2	-56.9	-57.2
Zone 3	-77.6	-77.9

ASCE 7-2022

Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASCE 7-22

Adjusted from ASCE 7-16

- **Adjusted** the Calculations (moving wind directionality factor)
- **Removed Simplified Methods** to determine uplift pressures
- **New** Roof Area Zones for Steep Sloped Roofs
- **New Chapter 32 on Tornados Loads**
- **New Calculations** for tornados
- **New Maps** for tornados

Incorporate in IBC 2024

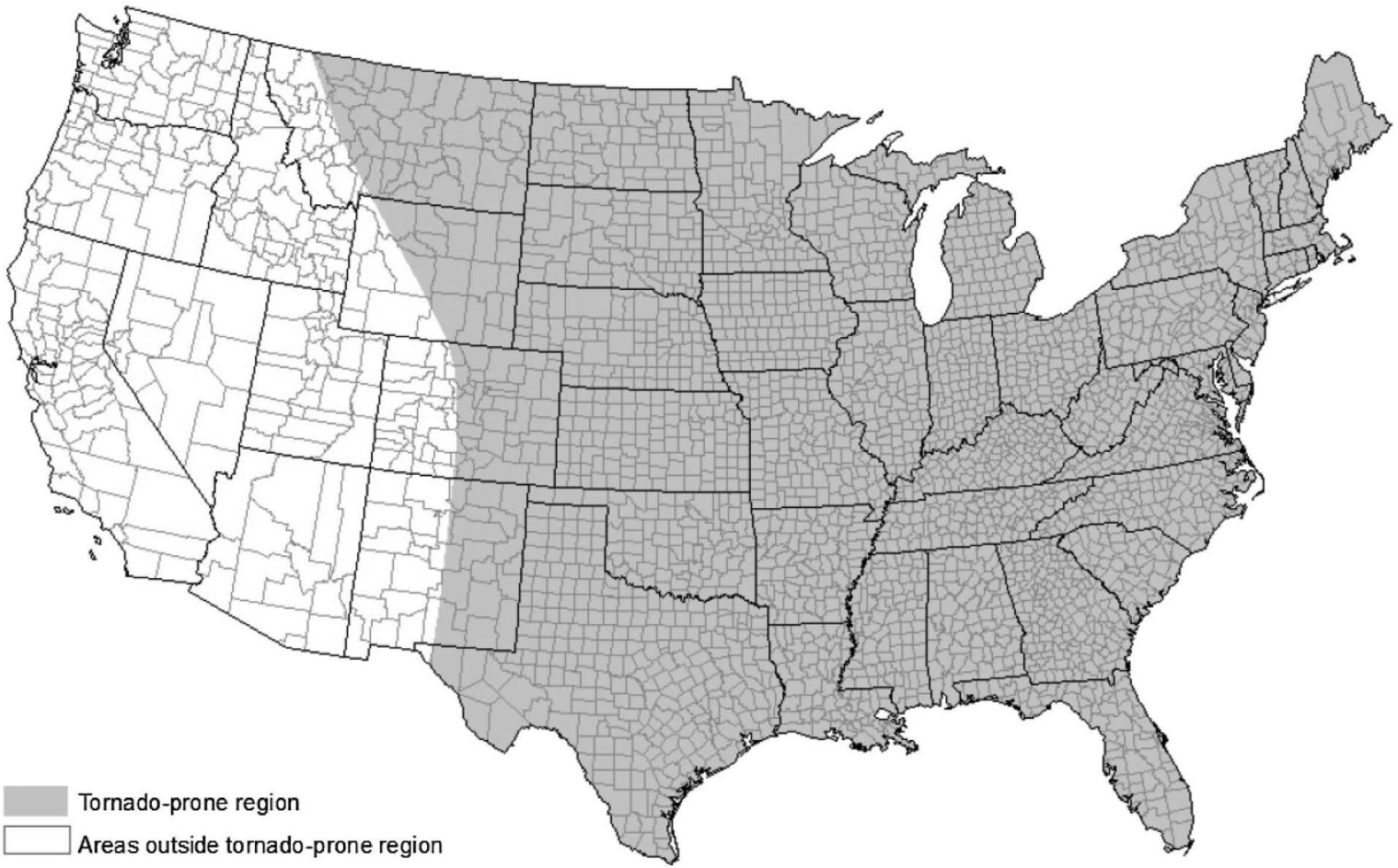
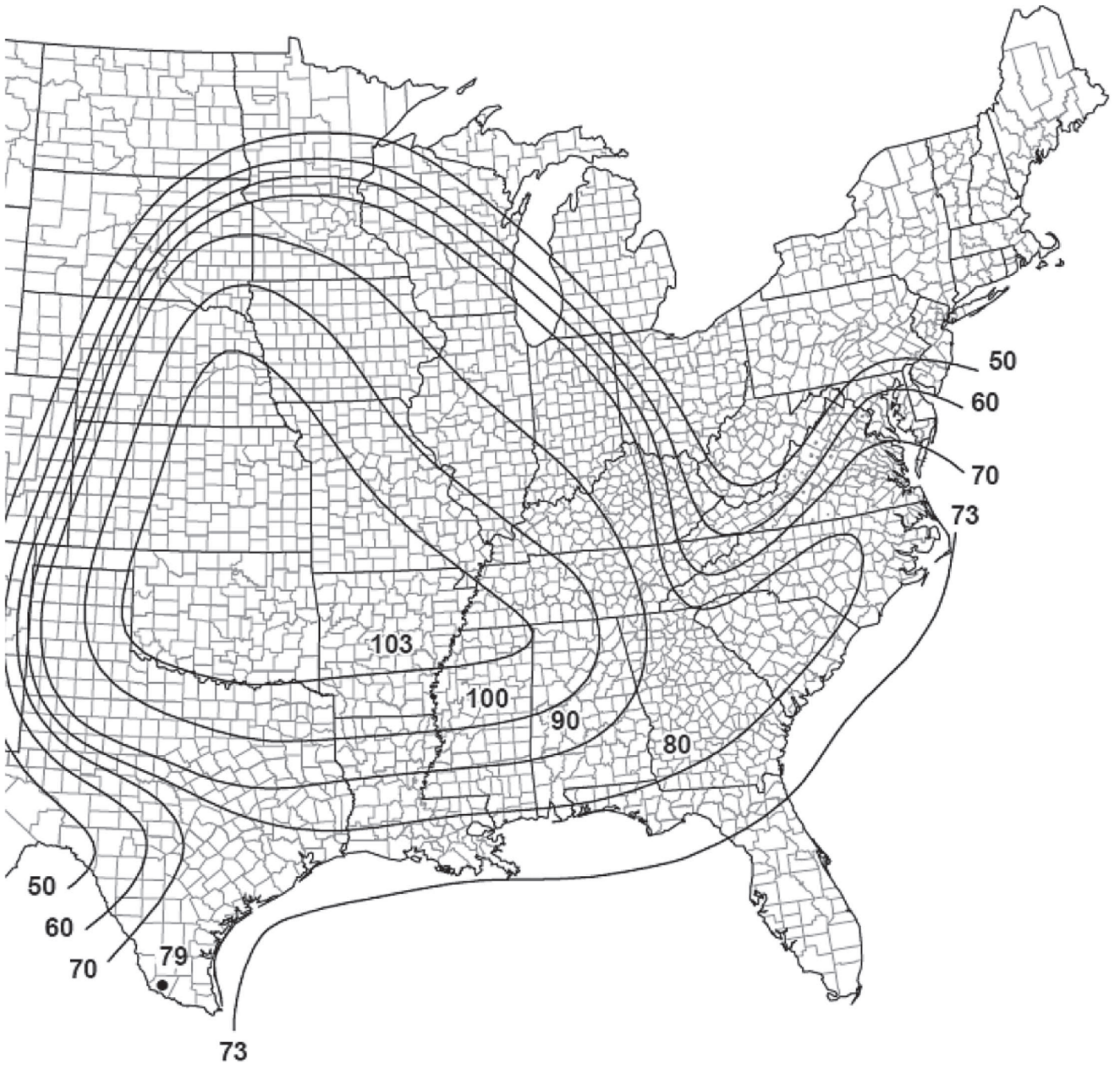


Figure 32.1-1. Tornado-prone region.



4. Islands, coastal areas, and land boundaries outside the last contour shall use the last tornado speed contour.
5. Tornado speeds correspond to approximately a 1.7% probability of exceedance in 50 years (annual exceedance probability = 0.00033, MRI = 3,000 years).
6. Location-specific tornado speed is permitted to be determined using the ASCE Tornado Design Geodatabase, available at the ASCE 7 Hazard Tool (http://asce7hazardtool.online) or approved equivalent.

Figure 32.5-2D (*Continued*). Tornado speeds for Risk Category IV buildings and other structures, for effective plan area of 40,000 ft^2 (3,716 m^2).