Roofing Issues: Decks to Dockets
September 7-9, 2017 – Colorado Springs, CO

Tech talk: Observations from the field

presented by

Mark S. Graham
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National Roofing Contractors Association (NRCA)

1

Number of assemblies in FM's RoofNav

- February 2017: 931,585
- September 6, 2017: 968,934
- September 8, 2017: 969,206

2

Converting wind speed to uplift pressure

- Basic energy equation:

  $KE = \frac{1}{2} m v^2$

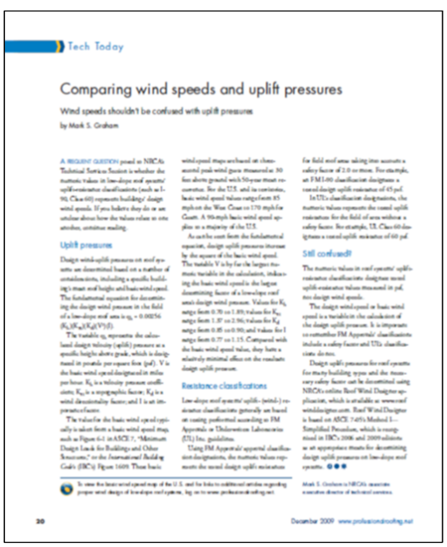
- Applying that to wind speed:

  $q_h = 0.00256 (K_z) (K_{zt}) (K_d) (V^2)$

  Where:

  K_d = wind directionality factor
  K_z = velocity pressure exposure coefficient
  K_{zt} = topographic factor
  V = wind speed (mph)
  q_h = velocity pressure (psf)

3



Tech Today

Comparing wind speeds and uplift pressures

Wind speeds shouldn't be confused with uplift pressures

by Mark S. Graham

Link

Professional Roofing,
December 2009

4

FM's hail designations

- MH: Moderate hail
- SH: Severe hail
- VSH: Very severe hail

Link

5

Moisture on concrete roof decks

RESEARCH+TECH

Moisture in concrete roof decks

Normal-weight and lightweight structural concrete cause some concern

by Mark S. Graham

20 www.professionalroofing.net SEPTEMBER 2017

Professional Roofing,
Sept. 2017

6

“Fully” adhered


TECH TODAY

The fully adhered misnomer

Terminology can create unrealistic expectations within the roofing industry

by Mark S. Graham

NRCA recommends the term “fully adhered” be avoided

Professional Roofing,
January 2017

7

Thickness variations in polyio. insulation


RESEARCH+TECH

Not quite measuring up

Polyisocyanurate insulation thicknesses seem to vary

by Mark S. Graham

Professional Roofing,
July 2017

Thickness variations

Polyisocyanurate insulation

- Measured thicknesses notably less than nominal
- Reports from throughout the U.S.
- More common with thicker product
  - For example, 3.5 inch (nominal) measures less than 3¼-inch thick
- Most reports specific to one manufacturer
  - Multiple plants from the one manufacturer
  - Limited reports from other manufacturers

3.5 inch (nominal)

2.0 inch (nominal)

Allowable tolerances

ASTM C1289 (Polyisocyanurate insulation)

8. Dimensions

8.1 *Dimensional Tolerances*—The length and width tolerances shall not exceed ±¼ in. (6.4 mm), the thickness tolerance shall not exceed ⅛ in. (3.2 mm), and the thickness of any two boards shall not differ more than ⅛ in. (3.2 mm) when measured in accordance with Test Method C303.

8.3 *Edge Trueness in the x/y Direction*—Unless otherwise specified, the thermal insulation board shall be furnished with straight edges and edges shall not deviate more than 1⁄32 in./ft (2.6 mm/m) when examined in accordance with Practice C550.

8.4 *Shiplap Edges*—When specified, the insulation board shall be fabricated with shiplap edges along its longest dimensions.

8.4.1 The nominal depth of each shiplap shall be the sum of its thickest facer dimension plus one half the thickness of its core foam dimension.

8.4.2 For boards 2 in. (50.8 mm) or greater in nominal thickness, the width of the shiplap shall be 1 in. (25.4 mm). For boards less than 2 in. (50.8 mm) in thickness, the nominal width of the shiplap shall be one half the thickness of the faced board product.

8.5 *Face Trueness*—The thermal insulation boards shall not depart from absolute flatness more than ⅛ in./ft (10 mm/m) of length or width when examined in accordance with Practice C550.

8.6 *Available Sizes*—The thermal insulation boards are normally supplied in sizes of 4 by 4 ft (1.22 by 1.22 m), and 4 by 8 ft (1.22 by 2.44 m) for use in roofing applications. For sheathing applications the thermal insulation boards are normally supplied in sizes of 4 by 8 ft (1.22 by 2.44 m), 4 by 9 ft

8.7 *Crushings and Depressions*—The thermal insulation boards shall have no crushed or depressed areas on any surface exceeding ⅛ in. (3.2 mm) in depth on more than 10 % of the total surface area.

The issues…

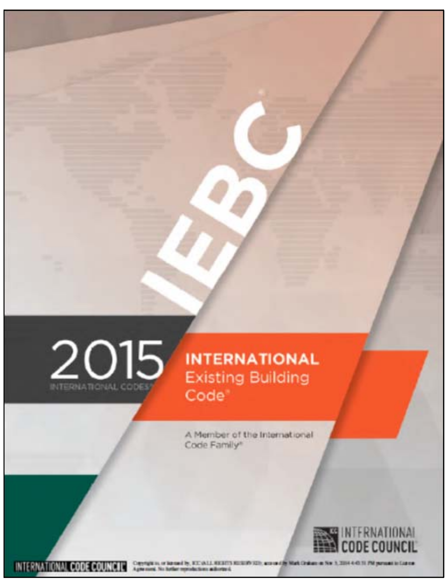
Thickness variations in polyiso. insulation

- Most physical properties are thickness related
- R-value loss:
  - R-value decreases about 0.7 per ⅛-inch thickness loss (assuming an LTTR of 5.6 per inch)
- Insulation thickness does not match established wood blocking heights

NRCA's recommendations

Thickness variations in polyio. insulation

- Distributors and contractors should measure board edge thicknesses upon delivery, preferably while the insulation still is on the truck
- Contact the manufacturer or distributor if thicknesses are less (or more) than specified
- Also contact NRCA Technical Services



International Existing Building Code, 2015 Edition

IEBC 2015

Scope:

"…shall apply to the *repair, alteration, change of occupancy, addition* to and relocation of *existing buildings*."

Classifications:

- Level 1: Removal and replacement of materials
- Level 2: Reconfiguration or extension
- Level 3: Exceeds 50 percent of *building area*

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

SECTION 706
REROOFING

[BS] 706.1 General. Materials and methods of application used for recovering or replacing an existing roof covering shall comply with the requirements of Chapter 15 of the *International Building Code*.

> **Exception:** Reroofing shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section 1507 of the *International Building Code* for roofs that provide positive roof drainage.

[BS] 706.2 Structural and construction loads. Structural roof components shall be capable of supporting the roof-covering system and the material and equipment loads that will be encountered during installation of the system.

[Continued…]

Similar to IBC 2012, Section 1510-Reroofing

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

SECTION 707
STRUCTURAL

[BS] 707.1 General. Where *alteration* work includes replacement of equipment that is supported by the building or where a reroofing permit is required, the provisions of this section shall apply.

[BS] 707.2 Addition or replacement of roofing or replacement of equipment. Where addition or replacement of roofing or replacement of equipment results in additional dead loads, structural components supporting such reroofing or equipment shall comply with the gravity load requirements of the *International Building Code*.

Exceptions:

1. Structural elements where the additional dead load from the roofing or equipment does not increase the force in the element by more than 5 percent.
2. Buildings constructed in accordance with the *International Residential Code* or the conventional light-frame construction methods of the *International Building Code* and where the dead load from the roofing or equipment is not increased by more than 5 percent.
3. Addition of a second layer of roof covering weighing 3 pounds per square foot (0.1437 kN/m2) or less over an existing, single layer of roof covering.

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

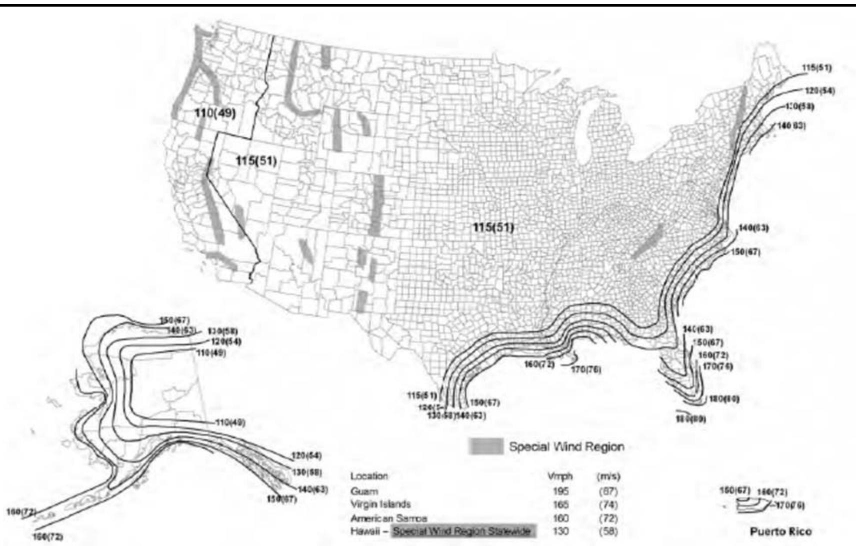
[BS] 707.3 Additional requirements for reroof permits. The requirements of this section shall apply to *alteration* work requiring reroof permits.

[BS] 707.3.1 Bracing for unreinforced masonry bearing wall parapets. Where a permit is issued for reroofing for more than 25 percent of the roof area of a building assigned to Seismic Design Category D, E or F that has parapets constructed of unreinforced masonry, the work shall include installation of parapet bracing to resist the reduced *International Building Code* level seismic forces as specified in Section 301.1.4.2 of this code, unless an evaluation demonstrates compliance of such items.

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

[BS] 707.3.2 Roof diaphragms resisting wind loads in high-wind regions. Where roofing materials are removed from more than 50 percent of the roof diaphragm or section of a building located where the ultimate design wind speed, V_{ult}, determined in accordance with Figure 1609.3(1) of the *International Building Code*, is greater than 115 mph (51 m/s) or in a special wind region, as defined in Section 1609 of the *International Building Code*, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the *International Building Code*, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the *International Building Code*.



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 1609.3(1)
ULTIMATE DESIGN WIND SPEEDS, V_{ult}, FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES

<u>International Existing Building Code, 2015 Edition</u>

Chapter 7-Alterations-Level I

SECTION 708
ENERGY CONSERVATION

708.1 Minimum requirements. Level 1 *alterations* to *existing buildings* or structures are permitted without requiring the entire building or structure to comply with the energy requirements of the *International Energy Conservation Code* or *International Residential Code*. The *alterations* shall conform to the energy requirements of the *International Energy Conservation Code* or *International Residential Code* as they relate to new construction only.

TECH TODAY

New roofing rules

IEBC 2015 presents challenges when reroofing

by Mark S. Graham

For the first time, the *International Existing Building Code, 2015 Edition* (IEBC 2015) includes specific code requirements applicable to reroofing. IEBC 2015 also provides additional and sometimes more complex code requirements than those contained in the International Building Code (IBC) and International Residential Code (IRC).

Reroofing requirements

IBC and IRC were developed and are maintained with the primary intent of applying to new construction. One exception is both codes also address reroofing—re-covering and replacing existing roof coverings on existing buildings.

Where adopted, IEBC 2015's structural reroofing requirements may be more stringent

For example, in IBC 2015, reroofing is addressed in Chapter 15—Roof Assemblies and Rooftop Structures, Section 1511—Reroofing. Similar requirements are included in IRC's Chapter 9—Roof Assemblies where Section R908—Reroofing specifically addresses re-covering and replacing existing roof coverings.

Additional requirements

IEBC 2015's scope indicates it "... shall apply to the *repair, alteration, change of occupancy, addition* to and relocation of *existing buildings*." Italicized terms are defined in Chapter 2—Definitions.

New definitions have been added in IEBC 2015 for reroofing, roof re-cover, roof repair and roof replacement. The terms and their definitions are the same as those in IBC.

IEBC 2015 classified work on existing buildings into three categories: Level 1, Level 2 and Level 3.

Level 1 alterations include the removal and replacement or the covering of existing materials, elements, equipment or fixtures using new materials, elements, equipment or fixtures that serve the same purpose. Reroofing projects are considered Level 1 alterations.

Level 2 and Level 3 alterations are larger in scope. For example, Level 3 alterations apply when the work area exceeds 50 percent of the building (floor) area.

IEBC 2015's Chapter 7—Alterations—Level 1 includes a new section, Section 706—Reroofing, that was not included in IEBC's previous editions. This section's requirements are identical to those of IBC 2012's Section 1510—Reroofing.

IEBC 2015's Section 707—Structural includes some additional requirements applicable to reroofing.

Section 707.2—Addition or Replacement of Roofing or Replacement of Equipment indicates when roof system replacement results in additional dead load; structural components supporting the new roofing materials need to comply with IBC. Exceptions to this requirement include where the dead load does not increase element forces by more than 5 percent; buildings designed in accordance with IBC's conventional light-frame construction methods or IRC; or where the new second layer weighs less than 3 pounds per square foot.

Section 707.3—Additional Requirements for Reroof Permits provides additional structural requirements for projects where the authority having jurisdiction (AHJ) requires reroofing permits.

Section 707.3.1 requires unreinforced masonry parapets for buildings where more than 25 percent of the roof area is being reroofed in Seismic Design Category D, E or F to have new parapet bracing installed to resist IBC's seismic forces.

Section 707.3.2 requires buildings located in high-wind regions (V_{ult} greater than 115 mph or in special wind regions) that are designed with roof diaphragms (roof decks) to be evaluated for structural adequacy. This requirement applies when more than 50 percent of the diaphragm is exposed during roof system replacement. The roof diaphragm, connections of the roof diaphragm to roof framing members and roof-to-wall connections are required to be evaluated using the current code's wind loads. If the diaphragm and connections are not capable of resisting 75 percent of the current code's wind loads, they must be strengthened or replaced according to IBC's requirements.

Being knowledgeable

Where adopted, IEBC 2015's structural reroofing requirements may be more stringent than IBC's and IRC's reroofing provisions.

Designers should determine whether IEBC 2015 is applicable and clearly indicate any additional work that is required for compliance in the construction documents.

The International Code Council, publisher of IEBC 2015, indicates the code currently applies in California and Colorado and in specific jurisdictions in Massachusetts, Mississippi, Oklahoma, Washington, West Virginia and Wyoming. Local AHJs can verify whether IEBC 2015 applies.

MARK S. GRAHAM is NRCA's vice president of technical services.

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Professional Roofing,
September 2016

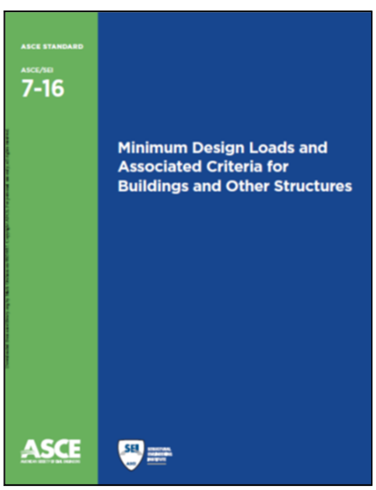
New model building code

2018 I-codes

New I-codes will be available in Sept.

New wind design method

ASCE 7-16



- Published in June
- Referenced in IBC 2018

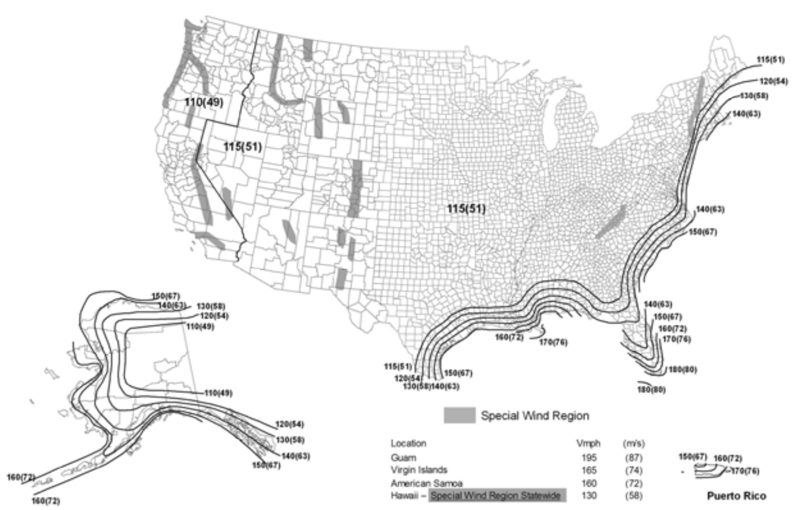
ASCE 7-16's major revisions

- Revised basic wind speed map
- Changes (and new) pressure coefficients
- Revised perimeter and corner zones

Expect higher field, perimeter and corner uplift pressures

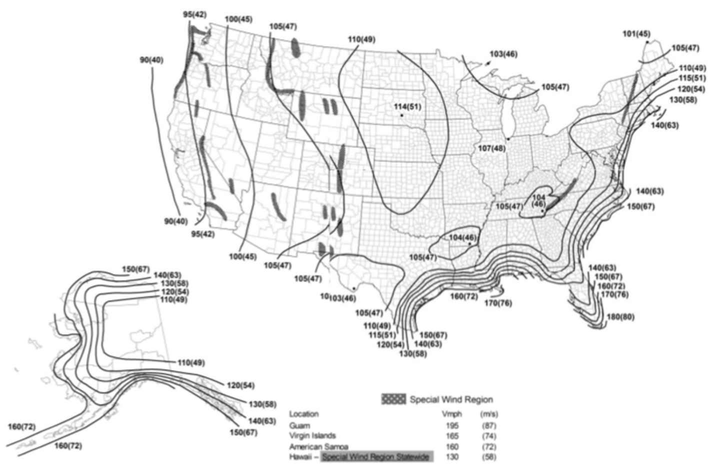
ASCE 7-10 basic wind speed map

Fig. 1607A--V_{ult} for Risk Category II Buildings



ASCE 7-16 (draft) basic wind speed map

Risk Category II Buildings



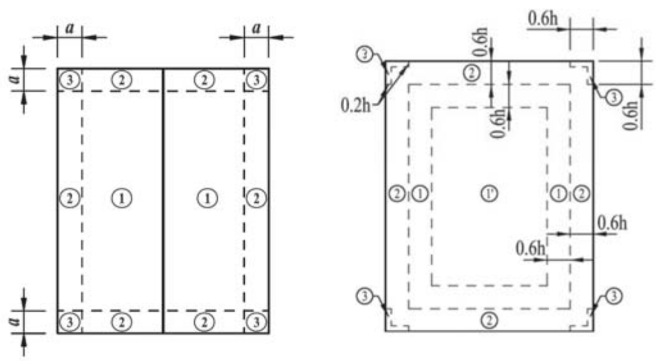
GC_p pressure coefficients

h ≤ 60 ft., gable roofs ≤ 7 degrees

Zone	ASCE 7-10	ASCE 7-16
1 (field)	-1.0	-1.7
1’	--	-0.9
2 (perimeter)	-1.8	-2.3
3 (corners)	-2.8	-3.2

Zones

h ≤ 60 ft., gable roofs ≤ 7 degrees



ASCE 7-10 **ASCE 7-16**

Comparing FM 1-28, ASCE 7-05, ASCE 7-10 and ASCE 7-16

Example: A manufacturing building located in New Orleans, LA. The building is an enclosed structure with a low-slope roof system and a roof height of 33 ft. The building is located in an area that is categorized as Exposure Category C.

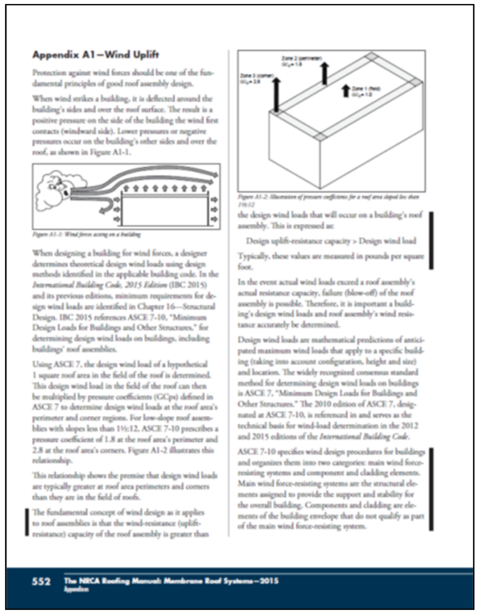
Comparing FM 1-28, ASCE 7-05, ASCE 7-10 and ASCE 7-16

Document	Basic wind speed (mph)	Design wind pressure (psf)		
		Zone 1 (Field)	Zone 2 (Perimeter)	Zone 3 (Corner)
FM 1-28 (without SF)	v = 120	43	72	108
ASCE 7-05	v = 120	38	63	95
ASCE 7-10 Strength design	v_{ULT} = 150	59	99	148
ASCE 7-10 ASD	v_{ASD} = 116	35	59	89
ASCE 7-16 Strength Design	V_{ULT} = 160 mph	1' = 60.2 1 = 105	138.1	188.6
ASCE 7-16 ASD		1' = 36.1 1 = 63.0	83.1	113.2

Proper wind design (which is oftentimes avoided) is getting even more complicated…

Additional references

The NRCA Roofing Manual: Membrane Roof Systems-2015 (July 2016 Update)



Appendix A1—Wind Uplift

Protection against wind forces should be one of the fundamental principles of good roof assembly design.

When wind strikes a building, it is deflected around the building's sides and over the roof surface. The result is a positive pressure on the side of the building the wind first contacts (windward side). Lower pressures or negative pressures occur on the building's other sides and over the roof, as shown in Figure A1-1.

Figure A1-1: Wind forces acting on a building

When designing a building for wind forces, a designer determines theoretical design wind loads using design methods identified in the applicable building code. In the *International Building Code, 2015 Edition* (IBC 2015) and its previous editions, minimum requirements for design wind loads are identified in Chapter 16—Structural Design. IBC 2015 references ASCE 7-10, "Minimum Design Loads for Buildings and Other Structures," for determining design wind loads on buildings, including buildings' roof assemblies.

Using ASCE 7, the design wind load of a hypothetical 1 square roof area in the field of the roof is determined. This design wind load in the field of the roof can then be multiplied by pressure coefficients (GCps) defined in ASCE 7 to determine design wind loads at the roof area's perimeter and corner regions. For low-slope roof assemblies with slopes less than 1½:12, ASCE 7-10 prescribes a pressure coefficient of 1.8 at the roof area's perimeter and 2.8 at the roof area's corners. Figure A1-2 illustrates this relationship.

This relationship shows the premise that design wind loads are typically greater at roof area perimeters and corners than they are in the field of roofs.

The fundamental concept of wind design as it applies to roof assemblies is that the wind-resistance (uplift-resistance) capacity of the roof assembly is greater than

Figure A1-2: Illustration of pressure coefficients for a roof area sloped less than 1½:12

the design wind loads that will occur on a building's roof assembly. This is expressed as:

Design uplift-resistance capacity > Design wind load

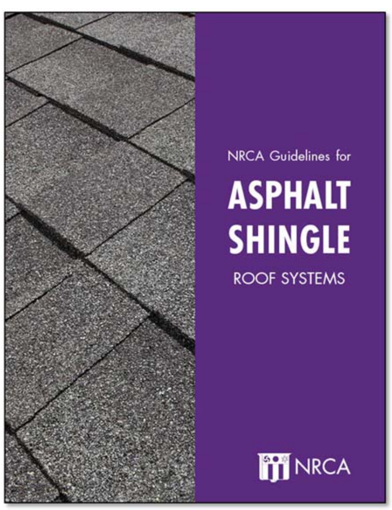
Typically, these values are measured in pounds per square foot.

In the event actual wind loads exceed a roof assembly's actual resistance capacity, failure (blow-off) of the roof assembly is possible. Therefore, it is important a building's design wind loads and roof assembly's wind resistance accurately be determined.

Design wind loads are mathematical predictions of anticipated maximum wind loads that apply to a specific building (taking into account configuration, height and size) and location. The widely recognized consensus standard method for determining design wind loads on buildings is ASCE 7, "Minimum Design Loads for Buildings and Other Structures." The 2010 edition of ASCE 7, designated at ASCE 7-10, is referenced in and serves as the technical basis for wind-load determination in the 2012 and 2015 editions of the *International Building Code*.

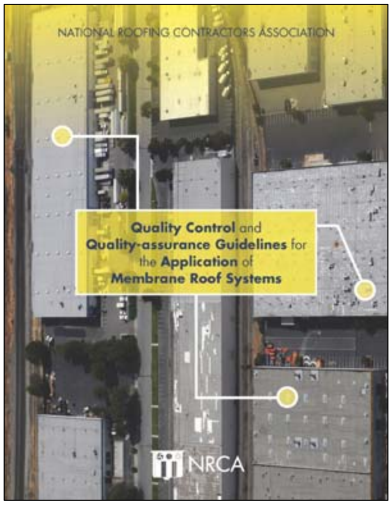
ASCE 7-10 specifies wind design procedures for buildings and organizes them into two categories: main wind force-resisting systems and component and cladding elements. Main wind force-resisting systems are the structural elements assigned to provide the support and stability for the overall building. Components and cladding are elements of the building envelope that do not qualify as part of the main wind force-resisting system.

552 The NRCA Roofing Manual: Membrane Roof Systems—2015
Appendix

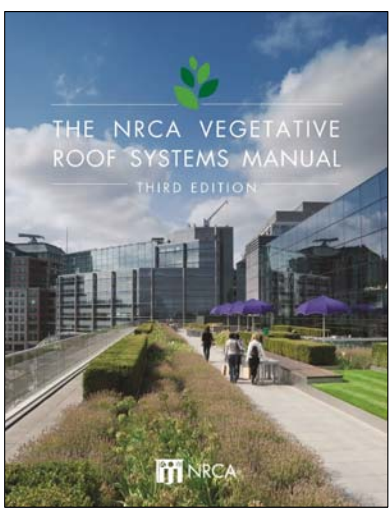


Link

NRCA Guidelines for Asphalt Shingle Roof Systems



Quality Control and Quality-assurance Guidelines for the Application of Membrane Roof Systems



The NRCA Vegetative Roof Systems Manual

Don't do stupid things…

Roofing specific

For example, some "not too smart" things are:

- Incur someone else's liability
- Accept a roof deck
  - Insert the word "surface" and it's not too bad
- Lightweight structural concrete roof decks
- Mechanically attach insulation or a roof membrane into a concrete deck

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- Wind warrantees
- "…fully adhered…"
- Field uplift-testing
- Mechanical fasteners through a vapor retarder or air retarder
- "Self-sealing" adhered underlayment
- In attics, installing more NFVA at the ridge than at the soffits
  - Your attic will "suck"
- Signing an applicator agreement (or revision) without modifications because "…everyone signs it…"

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Two more…

Things that are "…not too smart…"

- Not implement into your business something have learned at the NRLRC Annual Conference
- Not call NRCA Technical Services if you need assistance

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