NERCA webinar
October 13, 2016

Wind uplift testing

presented by

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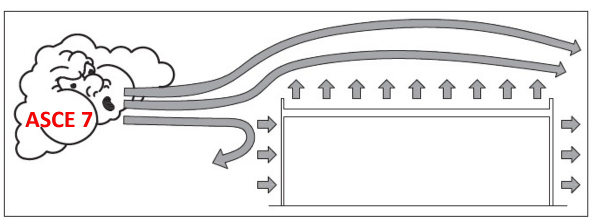
The fundamental concept



Wind creates pressures/forces
on building elements

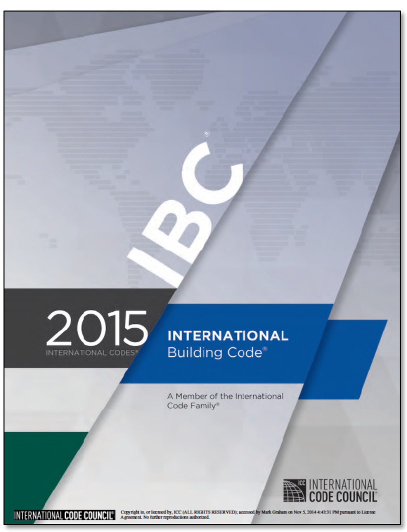
2

<u>Fundamental premise</u>

Wind resistance ≥ Design wind load

FM or UL rating ≥ ASCE 7

3



The Code establishes <u>minimum</u> requirements for building construction (and reroofing)

IBC 2015:

- Ch. 15-Roof Assemblies
  - Sec. 1511-Reroofing
- Ch. 16-Structural Design
  - Sec. 1609-Wind Loads

4

SECTION 1504
PERFORMANCE REQUIREMENTS

1504.1 Wind resistance of roofs. Roof decks and roof coverings shall be designed for wind loads in accordance with Chapter 16 and Sections 1504.2, 1504.3 and 1504.4.

1504.3 Wind resistance of nonballasted roofs. Roof coverings installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the roof deck shall be designed to resist the design wind load pressures for components and cladding in accordance with Section 1609.

1504.3.1 Other roof systems. Built-up, modified bitumen, fully adhered or mechanically attached single-ply roof systems, metal panel roof systems applied to a solid or closely fitted deck and other types of membrane roof coverings shall be tested in accordance with FM 4474, UL 580 or UL 1897.

5

1609.5 Roof systems. Roof systems shall be designed and constructed in accordance with Sections 1609.5.1 through 1609.5.3, as applicable.

1609.5.1 Roof deck. The roof deck shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

1609.5.2 Roof coverings. Roof coverings shall comply with Section 1609.5.1.

Exception: Rigid tile roof coverings that are air permeable and installed over a roof deck complying with Section 1609.5.1 are permitted to be designed in accordance with Section 1609.5.3.

Asphalt shingles installed over a roof deck complying with Section 1609.5.1 shall comply with the wind-resistance requirements of Section 1504.1.1.

1609.5.3 Rigid tile. Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:

$$M_a = q_h C_L b L L_a [1.0 - GC_p] \quad \textbf{(Equation 16-34)}$$

6

SECTION 1603
CONSTRUCTION DOCUMENTS

1603.1 General. *Construction documents* shall show the size, section and relative locations of structural members with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.8 shall be indicated on the *construction documents*.

1603.1.4 Wind design data. The following information related to wind loads shall be shown, regardless of whether wind loads govern the design of the lateral force-resisting system of the structure:

1. Ultimate design wind speed, V_{ult}, (3-second gust), miles per hour (km/hr) and nominal design wind speed, V_{asd}, as determined in accordance with Section 1609.3.1.
2. *Risk category*.
3. Wind exposure. Applicable wind direction if more than one wind exposure is utilized.
4. Applicable internal pressure coefficient.
5. Design wind pressures to be used for exterior component and cladding materials not specifically designed by the *registered design professional* responsible for the design of the structure, psf (kN/m^2).

7

ASCE 7-10, “Minimum Design Loads for buildings and Other Structures”

8

Fundamental pressure equation

ASCE 7-10, Equation 30.3-1

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

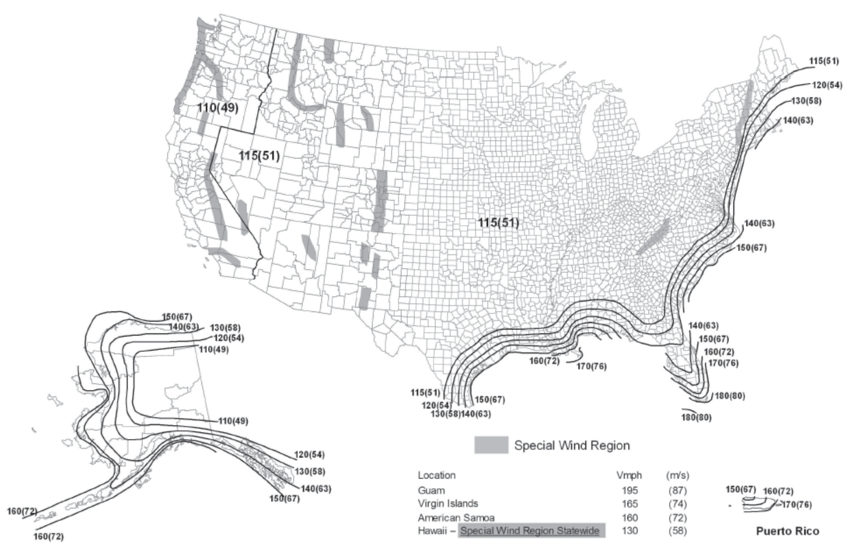
Where:

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

9

Basic wind speed

ASCE 7-10, Occupancy Category II Buildings



10

Design parameters

For the "Simplified procedures" (Part 2 and Part 4)

- Mean roof height (h)
- Enclosed building
- Wind-borne debris region (hurricane coastline)
- Regular-shaped building
- Topographical factor (K_{zt})
- Risk Category (Occupancy Category II most common)
- Basic wind speed (map)
- Exposure Category (Exposure C most common)
- Effective wind area (assume 10 ft^2)
- Wind zones (GC_p)

11

Pressure coefficients (GC_p)

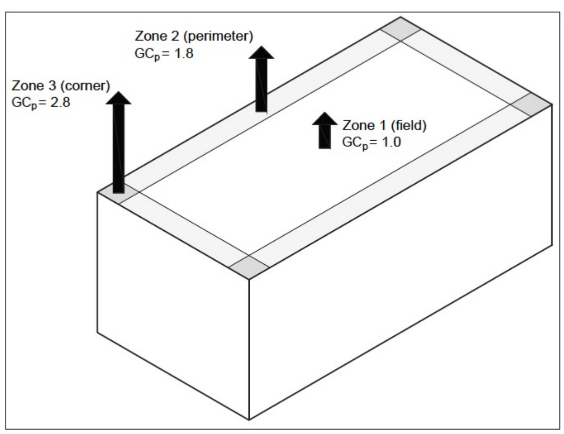


Illustration based upon ASCE 7-10, Fig. 30.4-2A (θ ≤ 7°); Effective wind area = 10 ft^2

12

ASCE 7-10

Strength design method vs. Allowable stress method

- ASCE 7-10 is based upon the strength design method
  - Increased wind speeds on map
  - Load factor of 1.6
- ASCE 7-10 allows for conversion of allowable stress design (ASD) method:

  ASD value = Strength design value x 0.6
- ASCE 7-05 and previous editions were based upon the ASD method

13

Additional references

Professional Roofing, March 2007

15

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.

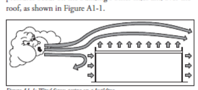


Figure A1-1: Wind forces acting on a building

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

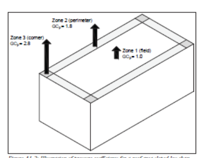


Figure A1-2: Illustration of pressure coefficients for a roof area sloped less than 1½:12

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*.

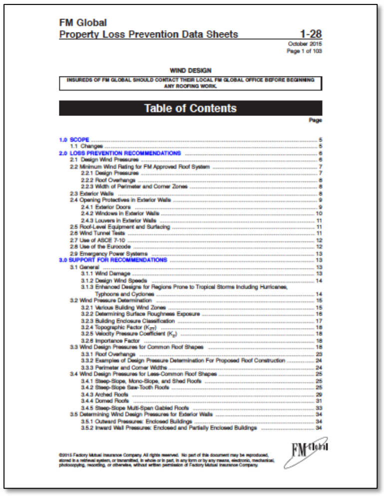
ASCE 7-10 specifies wind design procedures for buildings and organizes them into two categories: main wind force-resisting systems and component and cladding elements. Main wind force-resisting systems are the structural elements assigned to provide the support and stability for the overall building. 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
Appendixes

16

FM 1-28 has been updated

www.fmglobaldatasheets.com



FM Global
Property Loss Prevention Data Sheets 1-28
October 2015
Page 1 of 103

WIND DESIGN

INSUREDS OF FM GLOBAL SHOULD CONTACT THEIR LOCAL FM GLOBAL OFFICE BEFORE BEGINNING ANY ROOFING WORK.

Table of Contents

- Use RoofNav's ratings calculator
- Apply a 2.0 safety factor
- Roof overhang factors (Table 7)
- Windborne debris separation distances
- Roof-mounted equipment (ASCE 7-10)
- Tornado-resistant design (Appendix)

TECH TODAY

A new consideration

FM 1-28 has been updated, further complicating wind designs

by Mark S. Graham

FM Global recently updated its Property Loss Prevention Data Sheet 1-28, "Wind Design" (FM 1-28). The data sheet provides general guidance to building designers regarding wind considerations for highly protected buildings insured by FM Global.

FM 1-28's revisions

The new edition of FM 1-28 is dated October 2015 and was first publicly distributed in late November 2015. The document's previous edition was published in April 2011.

FM 1-28 typically results in higher design wind pressures and recommended resistance ratings

FM 1-28 has been completely revised and reformatted and expanded. The current edition consists of 103 pages; the previous edition had 72 pages.

FM 1-28's wind design guidance continues to be based on ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," though FM 1-28 contains some enhancements that typically result in higher design wind pressures and recommended resistance ratings. Conversely, the 2012 and 2015 editions of the International Building Code® (IBC) reference ASCE 7's 2010 edition, which can result in notably different design wind loads from those derived using FM 1-28.

FM 1-28 recommends roof field, perimeter and corner design wind pressures be determined using the ratings calculator in FM Approvals' RoofNav® online application (www.RoofNav.com). FM 1-28's previous editions included specific calculation procedures and tables for determining design wind pressures.

Not included in FM 1-28's new edition is Table 8 from FM 1-28's previous edition, which provided FM Global's recommended resistance ratings based on design wind pressures. When determining recommended resistance ratings, FM 1-28 now directs users to multiply basic uplift pressures by the applicable pressure coefficients, apply a 2.0 safety factor and round up the resulting values to the next highest 15-pound-per-square-foot increment. This procedure likely will cause some user confusion. The RoofNav ratings calculator already includes the recommended safety factor and rounding.

FM 1-28's recommendations for roof overhangs have been reworked, and some roof overhang factors (Table 7) have been increased, which will result in higher design wind pressures at roof overhangs with roof slopes of 1.5:12 and greater.

FM 1-28's Section 3.7-Designing for Windborne Debris includes a specific calculation procedure for determining separation distances between buildings in locations prone to tropical storms where aggregate roof surfacings are used.

FM 1-28's Section 3.8-Roof-mounted Equipment adds guidance to determine resistance to uplift, sliding and overturning in high winds for rooftop equipment. The guidelines for roof-mounted equipment generally are consistent with ASCE 7-10.

FM 1-28's Appendix D-Optional Guidance for Tornado-resistant Design and Construction provides optional guidance for important facilities that may warrant additional property protection in locations subject to tornadoes.

FM 1-28 and ASCE 7-10

FM 1-28 includes a discussion and example comparisons of the differences in design wind pressures using FM 1-28 and ASCE 7-10 (as well as IBC 2012 and IBC 2015).

FM 1-28 uses basic wind speeds based on a 50-year mean recurrence interval (MRI) and approaching a 100-year MRI along coastal areas, as well as an importance factor of 1.15 and recommended safety factor of 2.0. Conversely, ASCE 7-10's strength design method for components and claddings uses ultimate wind speeds based on 300-, 700- and 1,700-year MRIs.

ASCE 7-10 also provides a method for converting strength design method results to allowable stress design (ASD) method values, which are more comparable to FM 1-28's results.

FM 1-28 typically results in higher—sometimes notably higher—design wind pressures and recommended resistance ratings than those derived using ASCE 7-10's strength design or ASD methods.

Closing thoughts

The revision of FM 1-28 has resulted in changes to FM Global's recommendations to designers of highly protected buildings insured by FM Global.

Designers using FM 1-28 need to realize it typically results in higher design wind pressures and recommended resistance ratings than when using ASCE 7-10, IBC 2012 and IBC 2015.

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

ON *the* WEB

For a link to download FM 1-28 and example calculations comparing the differences between FM 1-28 and ASCE 7-10, log on to www.professionalroofing.net.

14 www.professionalroofing.net MARCH 2016

Professional Roofing, March 2016

FM 1-29 has just been updated

www.fmglobaldatasheets.com

FM Global
Property Loss Prevention Data Sheets 1-29

January 2016
Interim Revision April 2016
Page 1 of 49

ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS

Note to Insureds of Factory Mutual Insurance Company: Contact the local FM Global office before beginning any roofing work.

Table of Contents

List of Figures

FM Global

Revised/now criteria:

- Steel roof decks:
  - Uniformly-distributed loading
  - Concentrated loading
- Lightweight structural concrete

FM Global
Property Loss Prevention Data Sheets 1-29

January 2016
Interim Revision April 2016
Page 1 of 49

2.2.3.2 When designing the steel deck, give consideration to the needed wind rating, and how the load is applied (concentrated vs. uniformly distributed) from the above-deck components to the deck. Where the distance between rows of roof cover fasteners is greater than half the deck span, treat as a concentrated load.

As an alternative to using Tables 1A or 1B for concentrated loads, a performance-based approach may be used if calculations are conducted by a licensed S.E. or P.E. in structural engineering. This applies to situations where the distance between rows of roof cover fasteners is greater than one-half the deck span. Make the following assumptions:

A. Assume a 3-span structural condition.

B. Assume the first row of roof cover fasteners is located at mid-point of the first deck span.

C. Assume maximum allowable stresses are determined using allowable strength design (ASD) in accordance with AISI S100-2012, or comparable standard outside the United States

Due to the more brittle nature of higher grade steels, the maximum yield stress used in the analysis is 60,000 psi (414 MPa), even for 80,000 psi (552 MPa) yield stress steel. Use Tables 1A through 1E as follows to facilitate deck selection:

Table 1A. Use for roof covers or base plies that are mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is more than half the deck span and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with a minimum yield stress of 33,000 psi (228 MPa).

Table 1B. Use for roof covers or base plies that are mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is more than half the deck span and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with a minimum yield stress of 60,000 psi (414 MPa).

Note: Where the minimum specified yield stress is between 33,000 psi (228 MPa) and 60,000 psi (414 MPa), it is reasonably accurate to interpolate the maximum deck span linearly based on Tables 1A and 1B.

Table 1C. Use for roof covers or base plies that are adhered to insulation or cover board, or mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is one-half the deck span or less and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with minimum yield stresses of 33,000 psi (228 MPa) and ultimate wind ratings of from 60 to 225 psf (2.9 to 10.8 kPa).

20

FM Global
Property Loss Prevention Data Sheets 1-29
January 2016
Interim Revision April 2016

Table 1C. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, Wide Rib (Type B) Steel Deck with an Adhered Roof Cover, for Wind Ratings from 60 to 225 psf (2.9 to 10.8 kPa)
(NOTE: Use this table when the distance between rows of roof cover fasteners is one-half the deck span or less. Green font indicates that deflection governs over bending stress.)

Yield Stress psi	*Deck Gauge*	*Ultimate Wind Rating per RoofNav (psf)*											
		Maximum Span (ft)											
		60	75	90	105	120	135	150	165	180	195	210	225
33,000	22	7.10	7.10	7.10	7.10	7.07	6.67	6.33	6.03	5.78	5.55	5.35	5.17
	20	7.78	7.78	7.78	7.78	7.78	7.43	7.05	6.72	6.44	6.18	5.96	5.76
	18	9.08	9.08	9.08	9.08	9.08	8.66	8.22	7.84	7.50	7.21	6.95	6.71
	16	10.36	10.36	10.36	10.36	10.36	9.89	9.38	8.94	8.56	8.23	7.93	7.66
40,000	22	7.10	7.10	7.10	7.10	7.10	7.10	6.96	6.64	6.35	6.10	5.88	5.68
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.76	7.40	7.08	6.80	6.56	6.33
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.04	8.62	8.25	7.93	7.64	7.38
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.32	9.84	9.42	9.05	8.72	8.43
45,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.04	6.74	6.48	6.24	6.03
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.51	7.22	6.95	6.72
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	8.76	8.41	8.11	7.83
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	9.99	9.60	9.25	8.94
50,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.93	6.66	6.42	6.20
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.72	7.42	7.15	6.91
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.00	8.65	8.33	8.05
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.28	9.87	9.51	9.19
55,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.90	6.67
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.69	7.43
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	8.97	8.66
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.24	9.89
60,000 +	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.97
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.77
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.06
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.34
Green font indicates that deflection governs over bending stress.													

21

FM Global
Property Loss Prevention Data Sheets 1-29
January 2016
Interim Revision April 2016

Table 1A. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, 33,000 psi (228 MPa) Yield Stress with a Mechanically Fastened Roof Cover (continued)
(Note: Use this table when the distance between rows of roof cover fasteners is more than one-half the deck span.)

Max Deck Spans By Wind Rating/Fastener Spacing, Sheet Gauge for 33 ksi, 1½ in. Deep Wide Rib Deck																				
Roof Cover Fastener Row Spacing (ft)	Gauge	Wind Rating [psf]																		
		330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
8	18	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5.5	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	6
8.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	6
9	18	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5
9.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	4.5	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5
10	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5
10.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5
11	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5
11.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
12	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		4	5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			4
Roof Cover Fastener Row Spacing	Gauge	330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
		Wind Rating [psf]																		

22

TECH TODAY

Updated guidelines

FM 1-29's revisions affect many roof deck designs

by Mark S. Graham

FM Global (FM) has updated its Loss Prevention Data Sheet 1-29, "Roof Deck Securement and Above-deck Roof Components," which provides general design guidance regarding wind resistance for membrane roof assemblies on highly protected buildings insured by the company.

A roof deck that complies with FM's guidelines is essential

FM 1-29's revisions

A revised edition of FM 1-29 was published in January, and an updated version containing some editorial changes was published in April. The document's previous edition was published in September 2010.

With the latest changes, FM 1-29 has been completely reformatted, revised and expanded. The revised scope of the data sheet indicates it provides guidance to structural engineers for determining the proper span and securement of roof decks to supporting members to provide wind resistance. The data sheet also provides roofing professionals with guidance regarding the proper design and installation of above-deck roof components for wind resistance and fire classification.

FM 1-29's Sec. 2.2.3 contains new guidelines for designing steel roof decks. It indicates a structural engineer needs to consider the necessary wind rating and how uniformly distributed vs. concentrated loads from above-deck components are applied to steel roof decks. When the distance between rows of membrane sheet fasteners is greater than half the deck span (seam-fastened mechanically attached single-ply membrane roof systems), the deck's design for wind uplift should be based on concentrated loads.

ON *the* WEB

For a link to download FM 1-29, go to www.professionalroofing.net.

New tables provide maximum deck spans for 18-, 20- and 22-gauge steel roof decks used with mechanically attached roof systems, resulting in concentrated loads. Table 1A applies to steel roof decks with 33-kip-per-square-inch (ksi) yield strengths, and Table 1B applies to steel roof decks with 60-ksi or greater yield strengths. For calculation purposes, FM allows only a maximum 60 ksi be used for higher-yield (80-ksi) grade steels because of these steels' more brittle nature.

As an alternative to using Tables 1A or 1B, FM allows a performance-based design approach if calculations are conducted by a licensed professional engineer or structural engineer. These calculations should be based on assuming a three-span deck condition; the first row of roof cover fasteners should occur at the first deck span's midpoint, and maximum allowable stresses should be determined using the allowable strength design method from AISI S100-12, "North American Specification for the Design of Cold-formed Steel Structural Members."

New Tables 1C, 1D and 1E provide maximum deck spans for 1½-inch Type B and 3-inch Type N steel decks used in uniformly distributed loading (adhered roof coverings) situations.

Also, FM's guidelines for enhanced deck attachment to resist increased loads in corner regions now are provided in Tables 2 and 3. FM 1-29's previous editions provided narrative guidelines for enhanced deck attachment.

FM 1-29's Sec. 2.2.4.2 provides new guidelines for lightweight structural concrete decks. FM recommends use of the lowest water-to-cement ratio as possible in concrete mix design.

FM recommends mechanically fastened modified bitumen base sheets be used directly over lightweight structural concrete roof decks followed by use of an adhered FM-approved roof system. As an alternative, FM recommends dryness be ensured for lightweight structural concrete roof decks; FM acknowledges this could take months and recommends all stakeholders first agree on dryness test procedures and acceptance criteria.

Using FM 1-29

Although FM's Loss Prevention Data Sheets are intended to specifically apply to highly protected buildings insured by FM, FM 1-29 contains some information that should be useful to roof assembly designers for many buildings.

FM 1-29's guidance for designing steel roof decks for wind uplift particularly is useful because these guidelines are not discussed in other design methods. Similarly, FM 1-29's discussion of lightweight structural concrete roof decks contains new guidance not contained in other design methods.

NRCA encourages roofing professionals to forward a copy of this column and FM 1-29 to general contractors, construction managers and design professionals when FM-approved roof systems are specified and steel roof decks or lightweight structural concrete roof decks are encountered. Providing a roof deck that complies with FM's guidelines is essential to providing FM-compliant roof assemblies.

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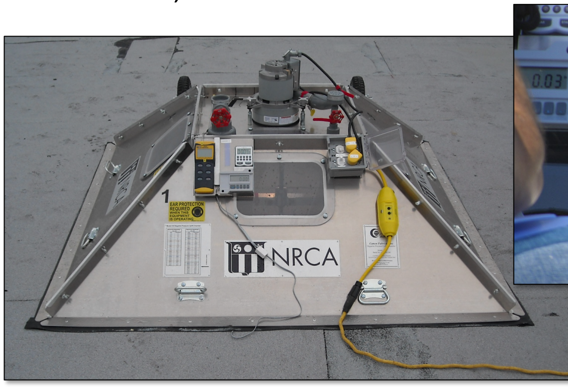
12 www.professionalroofing.net JULY 2016

Professional Roofing, July 2016

Field uplift testing

- ASTM E907, "Standard Test Method for Field Testing Uplift Resistance for Adhered membrane Roofing Systems"
- FM 1-52, "Field Verification of Roof Wind Uplift Resistance"



24

INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Field-uplift testing

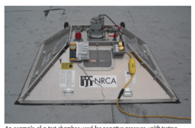
ASTM E907 and FM 1-52 tests continue to be problematic

June 2015

NRCA continues to receive a significant number of reports from roofing contractors, manufacturers and designers regarding the use of and problems associated with field-uplift tests as post-installation quality assurance measures for membrane roof systems. NRCA has addressed these testing issues a number of times during the years. Following is a summary of NRCA's previous discussions, as well as updated information and recommendations.

ASTM E907/FM 1-52

There are two recognized field test methods for determining adhered membrane roof systems' uplift resistances: ASTM E907, "Standard Test Method for Field Testing Uplift Resistance of Adhered Membrane Roofing Systems," and FM Global Loss Prevention Data Sheet 1-52 (FM 1-52), "Field Verification of Roof Wind Uplift Resistance."



An example of a test chamber used for negative-pressure uplift testing

Both test methods are similar and provide for affixing a 5- by 5-foot dome-like chamber to a roof surface's topside and applying a defined negative (uplift) pressure inside the chamber to the roof system's exterior-side surface using a vacuum pump (see photo). During the test, membrane surface deflection inside the chamber is visually monitored and measured to determine whether a roof system passes or is "suspect."

Using ASTM E907, a roof system is considered to be suspect if the deflection measured during the test is 25 mm (about 1 inch) or greater. During FM 1-52 testing, a roof system is suspect if the measured deflection is between ¼ of an inch and $\frac{15}{16}$ of an inch depending on the maximum test pressure; 1 inch where a thin topping board (cover board) is used; or 2 inches where a thin cover board or flexible, mechanically attached insulation is used.

If an ASTM E907 or FM 1-52 test yields a suspect result, a test cut should be taken in the test area to determine whether failure has occurred and the specific failure mode.

ASTM E907 and FM 1-52 differ notably in their test cycles and maximum test pressures for determining roof system deflections and whether a roof system passes or is suspect. ASTM E907 testing is conducted in 15-pounds per square foot (psf) pressure intervals up to the calculated design wind (uplift) pressure for the specific roof system being evaluated. FM 1-52 testing is conducted using an initial 15-pounds psf pressure followed by 7.5-pound psf increments up to a maximum test pressure of 1.25 times the design uplift pressure for the specific roof system being evaluated.

Considering maximum test loading and allowable test deflections in combination, FM 1-52 requires 25 percent higher test loads, yet only allows as little as ¼ the test deflection of ASTM E907. That said, FM 1-52 is a significantly more stringent test than ASTM E907.

ASTM E907 originally was published as a recognized consensus standard in 1983, and it was revised in 1996. In 2013, ASTM withdrew ASTM E907 because a consensus could not be reached regarding necessary revisions—most significantly, defining the test method's precision and bias (accuracy). ASTM E907-96 still is available for use and can be obtained directly from ASTM's website, www.astm.org.

FM 1-52 is an FM Global-promulgated evaluation method and not a recognized industry-consensus test standard. FM 1-52's scope indicates it only is intended to confirm acceptable wind-uplift resistance on completed roof systems in hurricane-prone regions, where a partial blow-off has occurred or where inferior roof system construction is suspected or known to be present.

FM 1-52 originally was published by FM Global in October 1970. The negative-pressure uplift test was added in August 1980 and has been revised several times. The current edition is dated July 2012 and includes an option for "visual construction observation (VCO)" as an alternative to negative-pressure uplift testing. VCO provides for full-time, third-party monitoring of a roof system application to verify roof system installation in accordance with contract documents.

NRCA "Industry Issue Update," June 2015

NRCA's experience:

- Most tests not conducted in accordance with ASTM E907 or FM 1-52.
- No correlation between field test vs. lab. results/classifications
- NRCA survey: 55% passing

25

NRCA recommendations

- Consider avoiding projects where field-uplift testing is indicated in the contract documents as a basis for acceptance of roofing work
- Add proposal/contract language (see Industry Issue Update).

26

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