



Spring Technical Session
April 26, 2018 – Troy, MI

NRCA technical issues update

presented by

Mark S. Graham

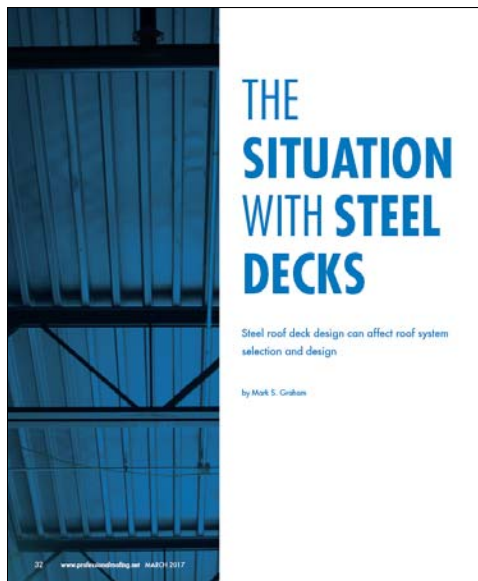
Vice President, Technical Services
National Roofing Contractors Association



Topics

- Steel roof decks
- Polyiso. insulation
- ASCE 7-16
- Metal stud-framed parapets

Steel roof decks



Professional Roofing
March 2017
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CONSTRUCTION ISSUES

discussion of construction issues and techniques

Are Your Roof Members Overstressed?

By James M. Fisher, Ph.D., P.E., DNS, M.ASCE and Thomas Shaw, Ph.D., P.E., S.E., FASCE

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30 March 2017

Membrane roof systems installed on steel roof decks traditionally result in a uniform transfer of wind (uplift) loads from the roof membrane to the steel roof deck and underlying supporting structure (e.g., steel joist). For example, in a built-up membrane roof system — which has been used commonly in the U.S. roofing industry for more than 125 years — the built-up membrane is continuously adhered to rigid roof insulation. The rigid roof insulation, which is used to span the steel deck's flutes, is mechanically attached to the steel roof deck in a closely-spaced pattern (e.g., 1 fanner per every 2 square feet), resulting in a near uniform uplift load path. Polymer-modified bitumen roof systems and adhered single-ply membrane roof systems are installed in similar configurations and result in a similar uniform uplift load path.

In the 1950s, single-ply membrane roof systems were first introduced into the U.S. roofing market. By the late 1970s, the seam-fanned, mechanically attached method of installation was first introduced. With this membrane method, the single-ply membrane sheet is mechanically attached along its outer edges into the roof deck, which results in a larger arbitrary uplift load per fanner and placement of fanfanners in linear, non-uniform loading configurations of the roof deck and underlying supporting structure. When first introduced, membrane sheet widths in seam-fanned single-ply membrane roof systems typically were five feet wide, resulting in rows of mechanical fanfanners spaced at six feet on-center. Since the early 2000s, single-ply membrane sheet widths have become wide, with 16-foot-wide sheets now commonplace, resulting in rows of mechanical fanfanners spaced at 16 feet on-center.

Currently, single-ply membrane roof systems have clearly overtaken conventional built-up and polymer-modified bitumen membrane systems in market share. The seam-fanned, mechanically attached method of installation also has mechanical fasteners traditionally adhered method of application. The National Roofing Contractors Association (NRCA) annual market survey shows seam-fanned, mechanically attached single-ply membrane roof systems make up the majority of all membrane roof systems currently installed.

With the present emphasis on wind resistance in design, a closer look at how seam-fanned, mechanically attached single-ply membrane roof systems interact with steel roof deck and joint construction is in order.

A common method of single-ply membrane sheet layout is shown in Figure 1. A common placement of mechanical fasteners is shown in Figure 2. These concentrated line loads can severely overstress the steel deck and may also cause the steel joist below the deck to be overstressed under uplift loading. The behavior of such fastening systems, when the roof system is subjected to uplift loading, is shown in Figure 3. The current trend to accommodate for the membrane installer to mechanically fasten the membrane to the deck only along the edge of the sheet ends to speed up the roof installation, thereby lowering installation costs. Unfortunately, the Structural Engineers of Record, and the steel deck and joint supplier, are usually unaware of the concentrated load patterns of the roof membrane attachment. In fact, the architect of record may not be aware of the ramifications of such attachments. The Architectural roofing specifications may simply state that the roof membrane shall be installed per manufacturer recommendations. The roofing installer/contractor is the one who generally decides on the exact layout of the membrane sheets on the roof. This decision is made based on what layout can be installed in the fastest and least expensive

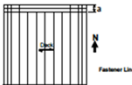


Figure 1. Typical membrane layout by roofline.




Figure 2. Seam-fanned layout of membrane sheets.

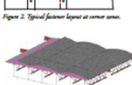


Figure 3. Line attached membrane under uplift. Courtesy of the Steel Deck Institute.

Structure magazine

March 2017

www.structuremag.org

Steel roof deck design

- SDI Design Manual
- AISI S100, “Specifications for the Design of Cold-formed Steel structural Members”
- ANSI/SDI RD1.0-2006, “Standard for Steel Roof Deck”
- ANSI/SDI RD-2010, “Standard for Steel Roof Deck”
- SDI Roof Deck Design Manual, First Edition (Nov. 2012)


Steel roof deck design

Wind uplift resistance

- Minimum 30 psf uplift (uniform loading)
- Minimum 45 psf uplift (uniform loading) at roof overhangs

SDI bulletin

2009


STEEL DECK INSTITUTE
Pittsburgh, Pennsylvania

ATTACHMENT OF ROOFING MEMBRANES TO STEEL DECK

This document has been published by the Steel Deck Institute (SDI) as a position paper in response to discussions taking place in the roofing community about the screw attachment of roofing membranes to steel deck following line patterns with large spacing. The impetus for this paper is in response to testing carried out by the Special Interest Group for Dynamic Evaluation of Roofing Systems (SIGDERG) at the Institute for Research in Construction, National Research Council of Canada. The mandate of the SIGDERG joint research program is to carry out generic, pre-competitive research on the performance of flat roofing systems subjected to dynamic wind loading. The objective is to develop improved roofing systems and design methods.

The SIGDERG research is looking at roofing systems that incorporate wide membrane sheets attached to the steel deck following line patterns spaced at up to 12 ft (3.65 m). While the membrane itself has the performance characteristics to accommodate this size of tributary loading, the existing design methods for steel deck under wind uplift are typically based on the uniform application of the wind suction to the deck. The large majority of the steel roof deck used for commercial buildings in North America is profiled with 1 1/2" (38 mm) deep flutes, with the structural supports usually spaced between 5' (1.52 m) and 6' (1.83 m). Under uplift conditions, the attachment of the roofing membrane along lines with large spacing could produce localized loads that can exceed the capacity of the deck, whereas those same loads applied uniformly on the surface of the deck would be acceptable.

The strength of screwed connection between the membrane and the steel deck, as well as the strength of screwed, nailed or welded attachment of the steel deck to the structural supports can be compared according to the North American Specification for the Design of Cold-Formed Steel Structural Members. These design values are based on the specified minimum mechanical properties (i.e. base steel thickness and yield strength) specified for the steel sheet roof deck, and should be lower than the strength determined by field testing. The use of field test results for properties such as the pull-out strength of a screw into a steel deck needs to recognize that the properties of the steel deck can be higher than the minimum limits required by the steel specifications. Therefore, field testing results must be adjusted accordingly to account for the difference between the actual properties of the deck and the minimum properties of the steel according to the material specification used in design.

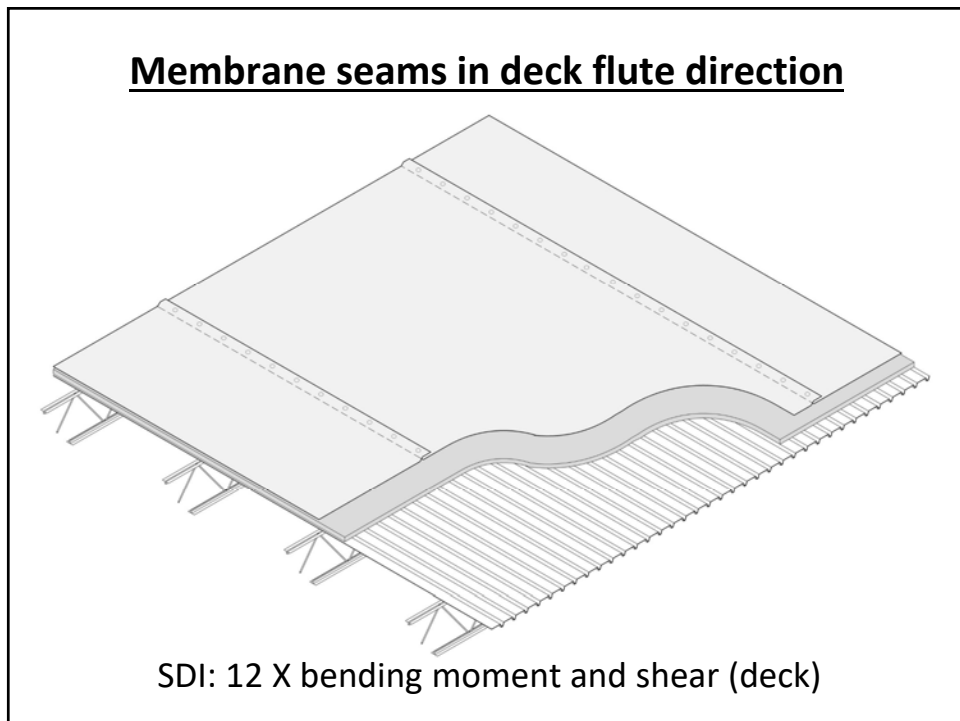
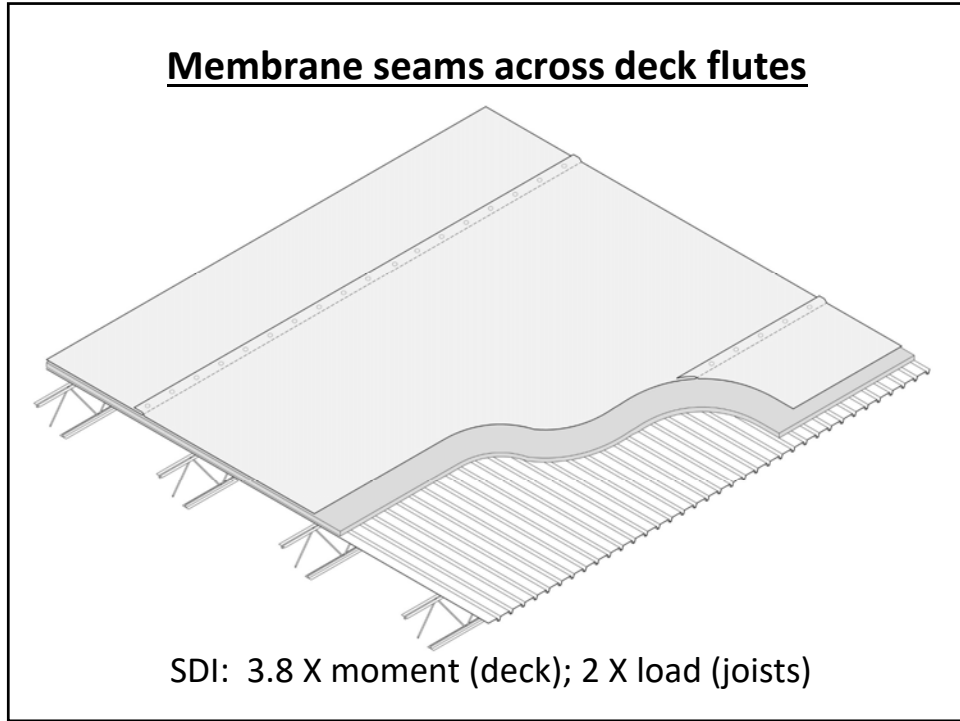
The screw fastening of wide roofing membranes (up to 12 ft) and the corresponding spacing of the lines of screws holding the membrane on the deck, will have a very different effect on the deck and structural supports than a membrane that is adhered over its entire surface. The screws will produce a line load along the deck instead of a uniform load of the entire deck surface. The line loads can be perpendicular or parallel to the deck flutes depending on the orientation of the membrane each condition can have different implications of the loading that is applied to the deck.

If the roofing membrane seam is perpendicular to the flutes of the deck, as illustrated in Figure 1, there are two special conditions that need to be considered:

1. if the membrane seam occurs at the mid-span of the steel deck; and
2. if the membrane seam occurs at the structural support (joist).

1

- Decks designed for joist spacing between 5' and 6' 8" o.c.
- Decks designed for uniform loading
- Seam-fastened single-ply membranes are a concern



SDI bulletin -- Conclusion

“...SDI does not recommend the use of roofing membranes attached to the steel deck using line patterns with large spacing unless a structural engineer has reviewed the adequacy of the steel deck and the structural supports to resist to wind uplift loads transmitted along the lines of attachment. Those lines of attachment shall only be perpendicular to the flutes of the deck.”

FM's guidelines

- FM 4451, 1978 edition (Steel roof deck)
- FM 4451, June 2012 edition (Steel roof deck)
 - Incorporates AISI S100-07
- FM 4470, June 2012 edition (Roof systems)



Changes reduce some FM classifications

FM 4470 has been revised, resulting in different uplift resistance criteria
by Mark S. Graham

FM Approvals has revised its criteria for determining the uplift resistance of membrane and liquid-applied roof assemblies. Because many roofing professionals rely on FM Approval classifications when designing and specifying low-slope roof assemblies, you should be aware of the changes made and their effects on specific roof assembly classifications.

FM 4470
FM 4470, "Approved Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction," is the basis for FM Approval classifications used for low-slope membrane and liquid-applied roof assemblies. In June 2012, FM Approvals revised FM 4470; the effective date of the new standard was Dec. 31, 2012. The revisions include adding NFPA 220, "Standard Method for the Tests for Determining the Heat Release Rate of Building Assemblies with Combustible Above-Deck Roofing Components," as a determination methodology below the roof deck; changes to the conditions of acceptance for wind uplift and hail damage resistance testing and adding an alternative test method for determining fastener retention resistance.

One of the more significant changes to FM 4470 is how roof deck are evaluated. With the revised standard, roof deck criteria moved for alternative means provided for in AISI S100, "North American Specification for the Design of Cold-Formed Steel Structural Members." The maximum allowable deflection for roof decks is based on a 200-pound point load previously a 300-pound point load was used. Also, minimum design of roof decks now are based on

a minimum 0.7-mm-thick (slightly less than 22 gauge), 33-ksi yield strength steel. Previous minimum 0.75-mm-thick (22 gauge) steel complying with the ASTM International specification was used for evaluation.

The method of analyzing attachments of roof decks also has been revised. Check fasteners are no longer for tension "pull-out" (grip strength) of the deck material. Also, some calculations are performed on both steel decks and fastener heads, and the lower of the two values is used as the basis for classification.

FM 4470 also now includes additional provisions allowing for optional ratings for dynamic pressure resistance of roof coverings. www.nrcanorth.com for roof fasteners and solar reflectance of roof surfaces.

All products tested after Dec. 31, 2012, are required to satisfy the new standard's requirements. Products FM Approvals already approved under previous editions of FM 4470 also need to comply with the current edition by the effective date of faster classification.

What this means
If a specific classified assembly results in an unclassified roof deck, FM Approvals has, upon consultation with the manufacturer, either changed the assembly's parameters to compensate for the deck weakness or reduced the assembly's wind rating to a level where the deck no longer is a concern. Assembly parameters likely changed include reducing the deck span and/or increasing the deck's steel thickness and/or yield strength (from 33 ksi to 60 ksi).

For assemblies where the wind rating has

been reduced, the assemblies' previous Roof-Nor members have been withdrawn and new Roof-Nor members issued to avoid confusion.

If you use the new version of FM 4470 for an allowed roof assembly applied to a 190-ksi-thick, 22-gauge steel deck at a 6-foot maximum span, FM Approvals has indicated maximum classifications are limited to 1:105 when using a 33-ksi steel deck and 1:300 when using an 80-ksi steel deck. For non-ferrous mechanically attached single-ply membrane assemblies, classifications will vary based on assembly parameters and some former new spacing, but generally classifications will be noticeably lower than with FM 4470's previous version.

Proceed cautiously
Roof system designers and specifiers need to be aware of FM 4470's revision and its effect on assembly parameters, uplift ratings and Roof-Nor members for membrane and liquid-applied roof assemblies using roof decks.

For roofing projects designed before the implementation date but that will be installed after the implementation date, clarification needs to be sought regarding which version of FM 4470 applies. If the current version applies, changes to the roof assembly specification may be necessary and affect a project's cost.

For ongoing roof system designs and specifiers and roofing contractors to work closely with manufacturers when determining changes to specific assembly parameters, uplift ratings and Roof-Nor members. ■■■

MARK S. GRAHAM is NRCA's executive associate director of technical services.

Professional Roofing

January 2013
www.professionalroofing.net

12

www.professionalroofing.net JANUARY 2013

FM's guidelines

- FM 4451, 1978 edition (Steel roof deck)
- FM 4451, June 2012 edition (Steel roof deck)
 - Incorporates AISI S100-07
- FM 4470, June 2012 edition (Roof systems)
- FM 1-29, January/April 2016 (Securement)

FM 1-29 updated

www.fmglobaldatasheets.com

FM Global
Property Loss Prevention Data Sheets 1-29
January 2016
Interim Revision April 2018
Page 1 of 66

ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS

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

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New criteria for steel roof deck uplift:

- Uniformly-distributed loading
- Concentrated loading

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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:

- Assume a 3-span structural condition.
- Assume the first row of roof cover fasteners is located at mid-point of the first deck span.
- 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 80,000 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).

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		Table 1B. Maximum Steel Deck Span (ft) for 1 1/2 in. (38 mm) Deep, Yield Stress \geq 60,000 psi (414 MPa) 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 80 ksi, 1 1/2 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
8.5	18	-	-	-	-	-	4	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	4	4	4.5	5.5	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6
9	18	-	-	-	-	-	-	4	4	4.5	5	5.5	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6
9.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6
	20	-	-	-	-	-	-	4	4	4.5	5	5.5	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6
10	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5
10.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
11	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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

Changing from 33 ksi to 80 ksi --> 6 ft. to 9.5 ft. seam spacing

		FM Global Property Loss Prevention Data Sheets																		
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	20	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	5.5	5.5	5.5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6
4	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	4.5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
4.5	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	4	4	4.5	5	5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
5	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	4.5	5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	-	-	4	4	4.5	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6	6
5.5	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
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	22	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6
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7	18	-	4	4	4.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6
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	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.5	18	-	-	-	4	4.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6
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	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

In summary

Hypothetical analysis using FM 1-29

- Adhered (uniform loading) roof system:
 - 6 ft. joist spacing → Class 165
- Seam-fastened (nonuniform, linear load) roof system:
 - 6 ft. seam spacing → Class 90 (33 ksi steel deck)
 - 9.5 ft. seam spacing → Class 90 (80 ksi steel deck)
 - 6 ft. seam spacing → Class 165 (80 ksi steel deck)

Seam spacing wider than joist spacing begins to get problematic

NRCA's recommendations

Uniformly-loaded vs. non-uniform, linear pattern loaded steel roof decks

New construction:

- Structural engineer awareness of roof system design
 - Note load pattern and steel's yield strength on structural drawings and shop drawings
- Roof system designer awareness of steel roof deck design

NRCA's recommendations – cont.

Uniformly-loaded vs. non-uniform, linear pattern loaded steel roof decks

Reroofing:

- Realize steel roof decks are not likely designed to current SDI, FM Global and FM Approvals' standards
- If steel deck design cannot be verified:
 - Use narrow fastener row/seam spacing (rows/seams \leq joist spacing)
 - Use a uniform uplift loading roof system (BUR, MB, adhered single ply)

Fastener pull-out tests...

There is little correlation between fastener pull-out resistance and a steel roof deck's yield strength and uplift (bending) strength

Although roofing contractors sometimes are given the responsibility of inspecting and accepting steel roof decks to receive a new roof system, determining a roof deck's design adequacy is beyond the expertise of most roofing contractors.

This determination is best made during a project's design phase.

Structure magazine

March 2017



Reasons for few reported deck/joist failures to date:

- A majority of roofs have not seen ASCE 7 design uplift loads (no major hurricanes in 10+ years)
- Design uplift of deck-to-joist does not exceed the fasteners' safety factor
- Decks likely have actual yield strengths higher than the 33 ksi design yield strength (60 ksi vs. 33 ksi can increase deck flexural strength by about 70%)

Polyisocyanurate insulation

Knit line, thickness and dimensional stability concerns



Professional Roofing

February 2016

www.professionalroofing.net

Knit lines



Knit lines -- continued





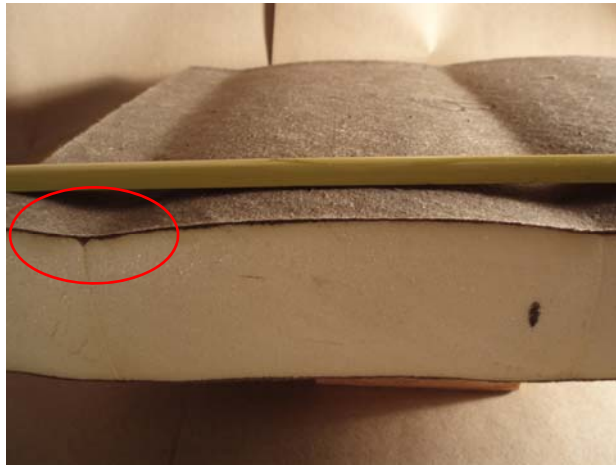
Photo from manufacturer's product literature

Thickness and knit lines



As delivered by manufacturer.

Knit lines -- continued



After conditioning: 158 ± 4 F and $97 \pm 3\%$ RH for 7 days

Knit lines – cont.



Knit line and V-groove close-up (after conditioning)

“NRCA recommends the use of a suitable cover board layer over polyisocyanurate insulation before the installation of roof membrane.”

-The NRCA Roofing Manual: Membrane Roof Systems-2015

Thickness variations in polyio. insulation

RESEARCH+TECH



Not quite measuring up
Polyisocyanurate insulation thicknesses seem to vary

by Mark S. Graham

NRCA has received a handful of reports of hard, rigid foam polyisocyanurate insulation with thicknesses less than what was specified and indicated on the manufacturer's packaging being delivered from manufacturers to distributors and job sites. Following is information about these reports, as well as information about recognized allowable thickness tolerances and NRCA recommendations to roofing contractors for handling these situations.

Reports

NRCA has received reports of some installed polyisocyanurate insulation being received directly from polyisocyanurate insulation manufacturers with thicknesses notably less than nominal dimensions. Reports have been received from the East Coast to the Rocky Mountains and as far north as Wisconsin and south to Texas.

Reports have been received about various specified nominal thicknesses of polyisocyanurate insulation, however, the problem appear to be more common with thicker polyisocyanurate insulation products than thinner ones. For example, NRCA has received multiple reports of 30-p inch nominal thickness polyisocyanurate insulation measuring

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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 $\pm 1/4$ in. (6.4 mm), the thickness tolerance shall not exceed $1/8$ in. (3.2 mm), and the thickness of any two boards shall not differ more than $1/8$ in. (3.2 mm) when measured in accordance with Test Method C303.

<p>1. Scope</p> <p>1.1 This specification covers thermal insulation boards of polyisocyanurate, polyurethane, and polyurethane foam products.</p> <p>1.2 This specification covers structural panels of polyisocyanurate.</p>	<p>8.3 Edge Trueness in the <i>xy</i> Direction—Unless otherwise specified, the thermal insulation board shall be furnished with straight edges and edges shall not deviate more than $1/2$ in./ft (2.6 mm/m) when examined in accordance with Practice C550.</p> <p>8.4 Shiplap Edges—When specified, the insulation board shall be fabricated with shiplap edges along its longest dimensions.</p> <p>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.</p> <p>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.</p>	<p>1.4 The values in this specification are in inches and millimeters. The values in inches are not for conversion purposes.</p>
--	---	--

8.5 Face Trueness—The thermal insulation boards shall not depart from absolute flatness more than $1/8$ in./ft (10 mm/m) of length or width when examined in accordance with Practice C550.

<p>1.4 The values in this specification are in inches and millimeters. The values in inches are not for conversion purposes.</p>	<p>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</p>	<p>1.4 The values in this specification are in inches and millimeters. The values in inches are not for conversion purposes.</p>
--	--	--

8.7 Crushings and Depressions—The thermal insulation boards shall have no crushed or depressed areas on any surface exceeding $1/8$ in. (3.2 mm) in depth on more than 10 % of the total surface area.

The issues...

Thickness variations in polyiso. insulation

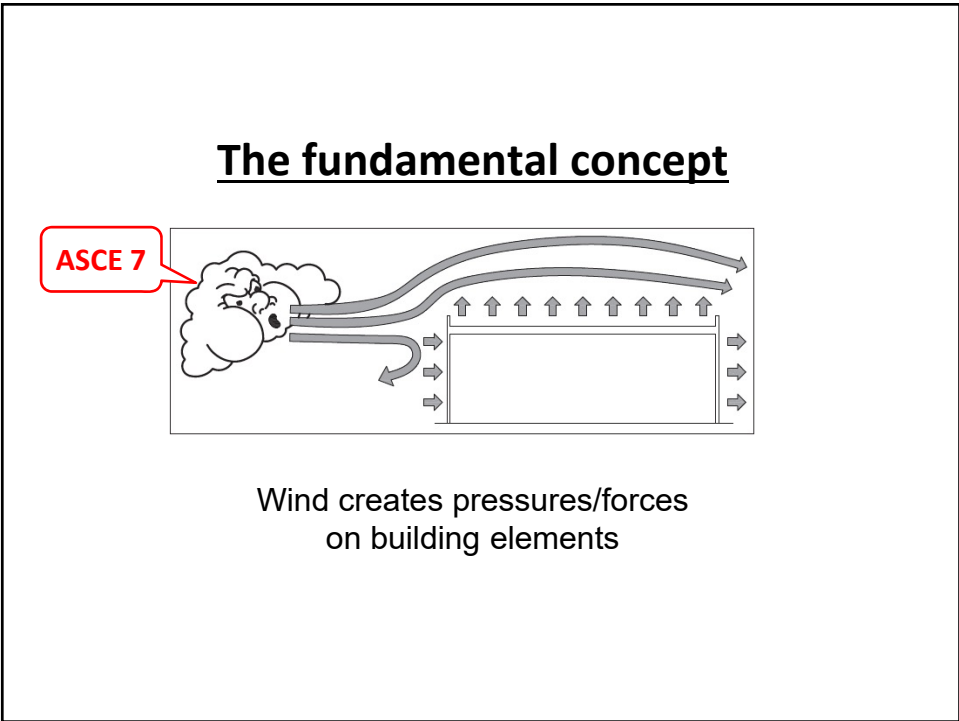
- Most physical properties are thickness related
- R-value loss:
 - R-value decreases about 0.7 per 1/8-inch thickness loss (assuming an LTTR of 5.6 per inch)
- Insulation thickness does not match established wood blocking heights

NRCA's recommendations

Thickness variations in polyiso. 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

ASCE 7-16
Design wind uplift



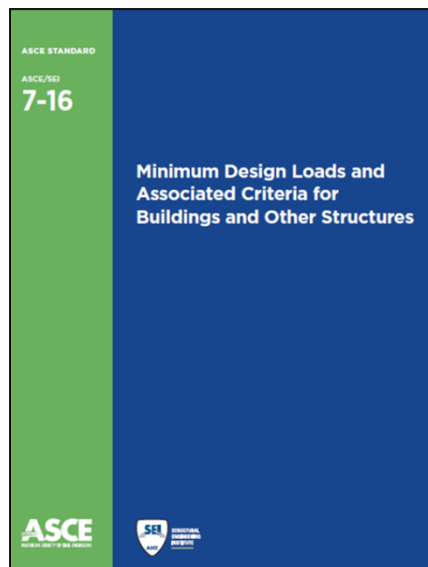
Fundamental concept -- continued

Adhesion or attachment \geq Uplift pressure

FM rating

UL classification \geq ASCE 7

Engineering



American Society of Civil Engineers Standard 7, “Minimum design loads and associated criteria for buildings and other structures” (ASCE 7-16)

Noteworthy changes in ASCE 7-16

Compared to ASCE 7-10

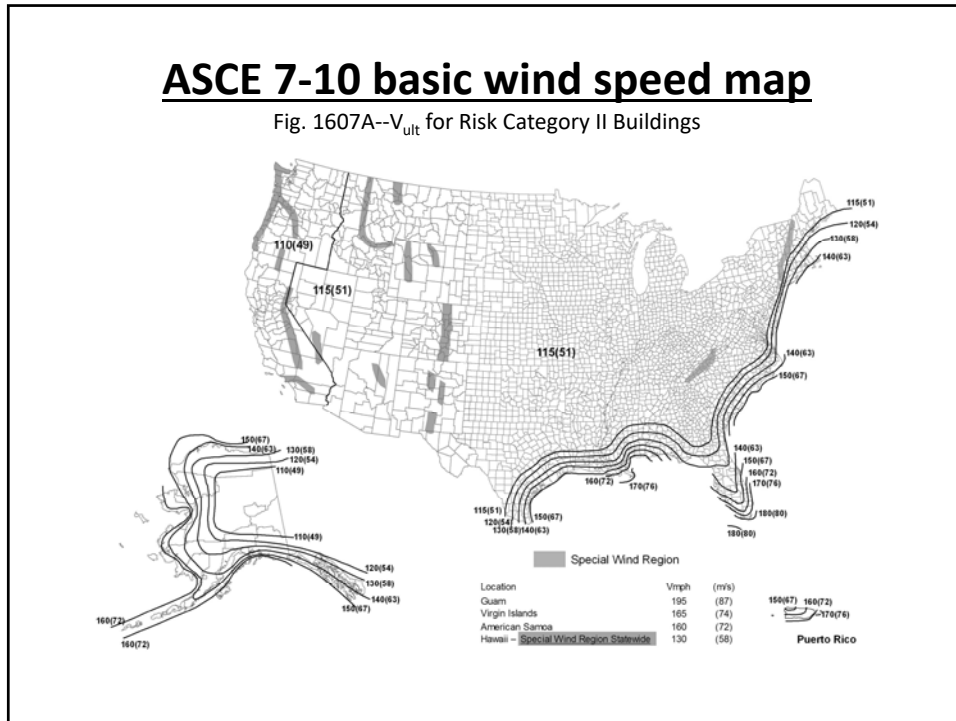
Noteworthy changes in ASCE 7-16

Compared to ASCE 7-10

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

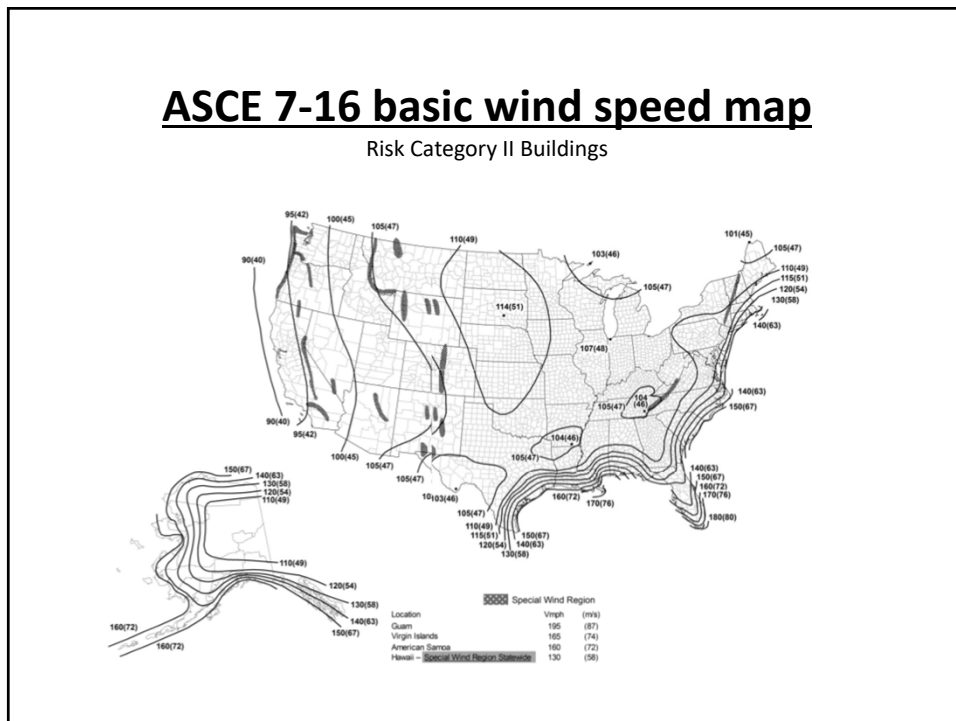
ASCE 7-10 basic wind speed map

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



ASCE 7-16 basic wind speed map

Risk Category II Buildings



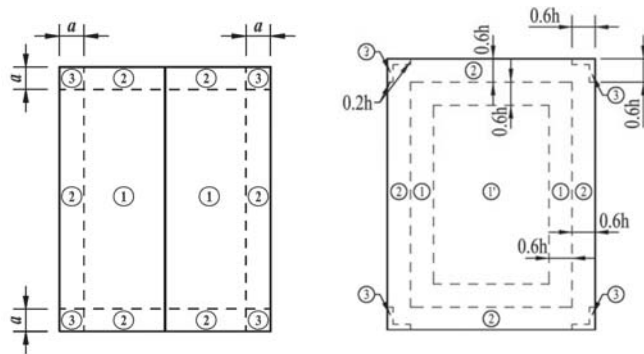
Comparing GC_p pressure coefficients

$h \leq 60$ ft., gable roofs ≤ 7 degrees

Zone	ASCE 7-10	ASCE 7-16	Change
1'	n/a	0.9	-10%
1 (field)	-1.0	-1.7	+70%
2 (perimeter)	-1.8	-2.3	+28%
3 (corners)	-2.8	-3.2	+14%

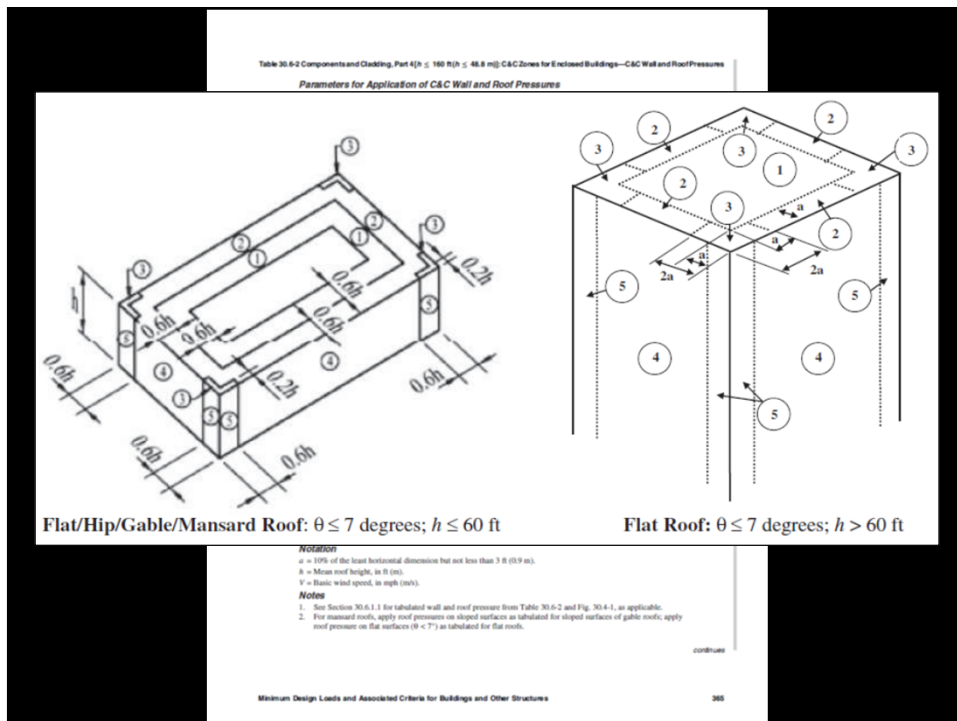
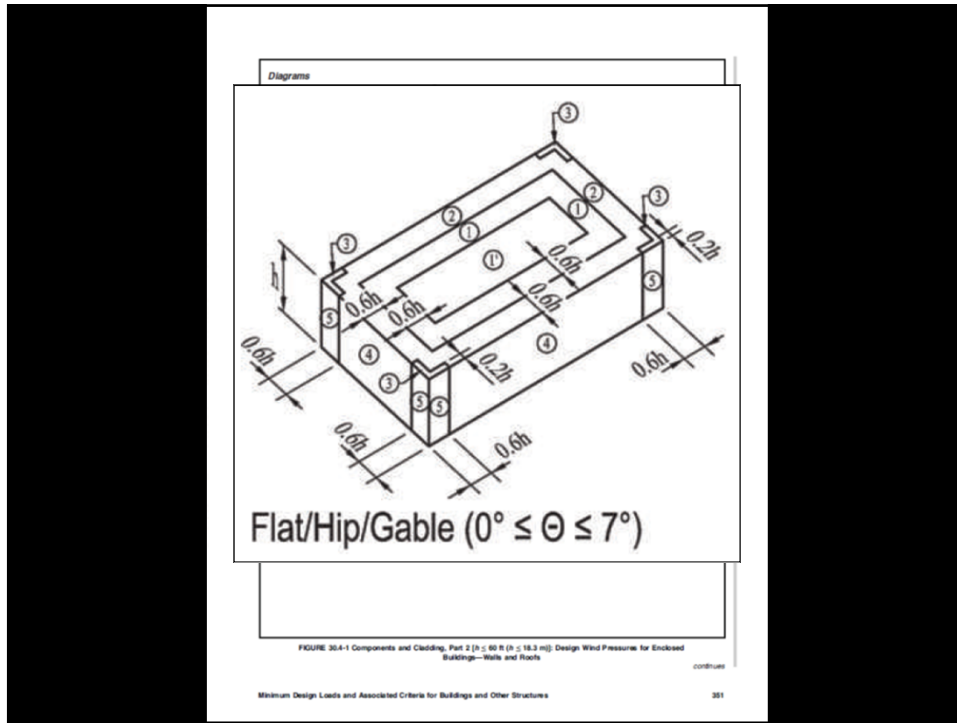
Zones

$h \leq 60$ ft., gable roofs ≤ 7 degrees



ASCE 7-10

ASCE 7-16



Noteworthy changes in ASCE 7-16

Compared to ASCE 7-10

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

While center field pressures may be slightly lower, field, perimeter and corner uplift pressures will generally be greater

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www.asce.org

The screenshot shows the website **roofwinddesigner.com** with a blue header. The text "ASCE 7-05, ASCE 7-10 and ASCE 7-16" is visible, with "ASCE 7-16" circled in red. Below the header, there is a navigation bar with links: Home | Contact Us | FAQ | Welcome: Mark Graham | My Projects | Profile | Logout | Administration. A main text block states: "Roof Wind Designer is intended to provide users with an easy-to-use means for determining roof systems' design wind loads for many commonly encountered building types that are subject to building code compliance." A red-bordered box contains the following text: "Roof Wind Designer has been updated based upon ASCE 7-16:" followed by a bulleted list: "• Part 2: Low-rise Buildings (Simplified) [h ≤ 60 ft.]" and "• Part 4: Buildings with 60 ft. < h ≤ 160 ft. (Simplified)*". Below the list, a note reads: "* Does not include hip and gable roofs h > 60 ft. and all roof slopes over 7 degrees (about 1.5:12)". At the bottom of the page, there is a registration notice: "To register for a new account [click here](#). If you already have an account, [click here](#) to login." and the NRCA logo (National Roofing Contractors Association).

How the roofing industry will adapt to ASCE 7-16 remains to be seen....

FM Global has indicated they will update their FM 1-28 to be based on ASCE 7-16 (with modifications) by the end of the 2018.



Considering the winds

Properly specifying wind design is key to roof system performance
by Mark S. Graham

With increasing frequency, NRCA has been receiving reports of roof system designs that include inadequate provisions for wind loads and resistances. Designs that only specify wind speed, wind direction or depression are high (or low) uplift resistance classifications are still a sign of insufficient design considerations for high winds.

Where it appears
designers have not properly addressed wind design, contractors are encouraged to seek further guidance from designers

Code Requirements
Building codes typically provide minimum requirements for determining and reporting design wind loads on a project-specific basis. For example, in the International Building Code, 2012 Edition,¹ (IBC), design wind loads should be determined according to Chapter 16—Structural Design. This chapter specifically references the 2010 edition of ASCE Standard 7, “Minimum Design Loads for Buildings and Other Structures.” ASCE 7-10 also is referenced in IBC 2012.

With ASCE 7-10, roof systems typically are considered components and cladding elements, and design wind loads are determined using one of two methods: strength design or allowable stress design (ASD). Most roof systems are designed using the ASD method. IBC 2009 and IBC 2006 reference ASCE 7-05, which results in design wind loads that are determined using ASCE 7-10’s ASD method. IBC 2015 Section 1603—Construction Documents indicates a building’s design

loads, including a roof system free load, snow load data, wind design and any special loads be noted in construction documents. Code required wind design data include identifying the ultimate design wind speed, nominal design wind speed, risk category, wind exposure and applicable terrain pressure coefficient. For components and cladding systems not specifically designed for a registered design professional, design wind pressures in terms of pounds per square foot (psf) also are required. Design wind pressures for the field, perimeter and corner regions of roof areas should specifically be noted. A building’s design load must consistently will be identified on the structural drawings in the project drawing set for new construction projects. For remodeling projects without specific structural drawings, design loads must be provided on the architectural drawings or in the project specifications.

IBC 2012 and previous editions include similar construction documents requirements for indicating building design loads.

IBC 2015 also has specific requirements for designing roof systems’ abilities to resist design wind loads. For built-up, polymer-modified bitumen, and adhered and mechanically fastened single-ply membrane roof systems. For example, IBC 2015 Section 1504—Performance Requirements specifies laboratory testing according to one of the following:

- FM 4474, “American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Pressure and/or Negative Pressure”
- UL 580, “Test for Uplift Resistance of Roof Assemblies”
- UL 1897, “Uplift Test for Roof Covering Systems”

These tests provide the basis for FM Approvals and Underwriters Laboratories’ (UL) approval classifications for roof systems.

Roof Wind Designer
NRCA Roof Wind Designer application can help roof system designers properly determine and specify design wind loads on roof systems. Roof Wind Designer allows users to input specific project information and determine design wind loads using ASCE 7-10 or ASCE 7-10’s strength design and ASD methods for many commonly encountered building types. The application also determines minimum recommended tested wind resistance load capacities, taking into consideration a safety factor that allows designers to select appropriate uplift resistance-classified roof systems. Roof Wind Designer generates a project-specific report, which can be used for project documentation and submittal purposes.

Roof Wind Designer is free and can be accessed at www.roofwinddesign.com. To date, the application has been used on more than 17,700 roofing projects.

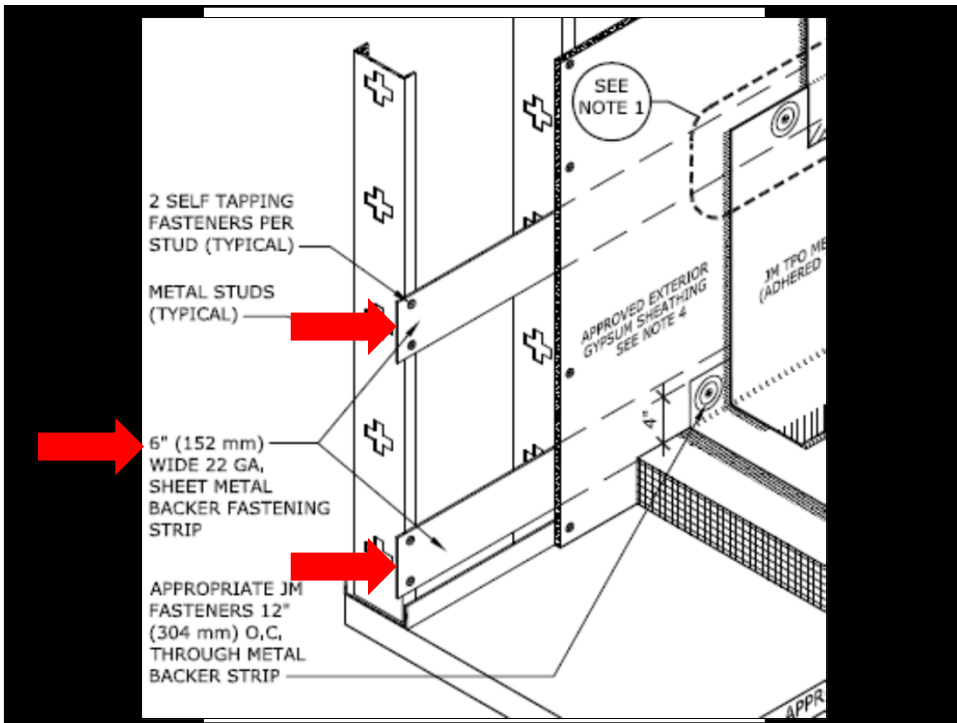
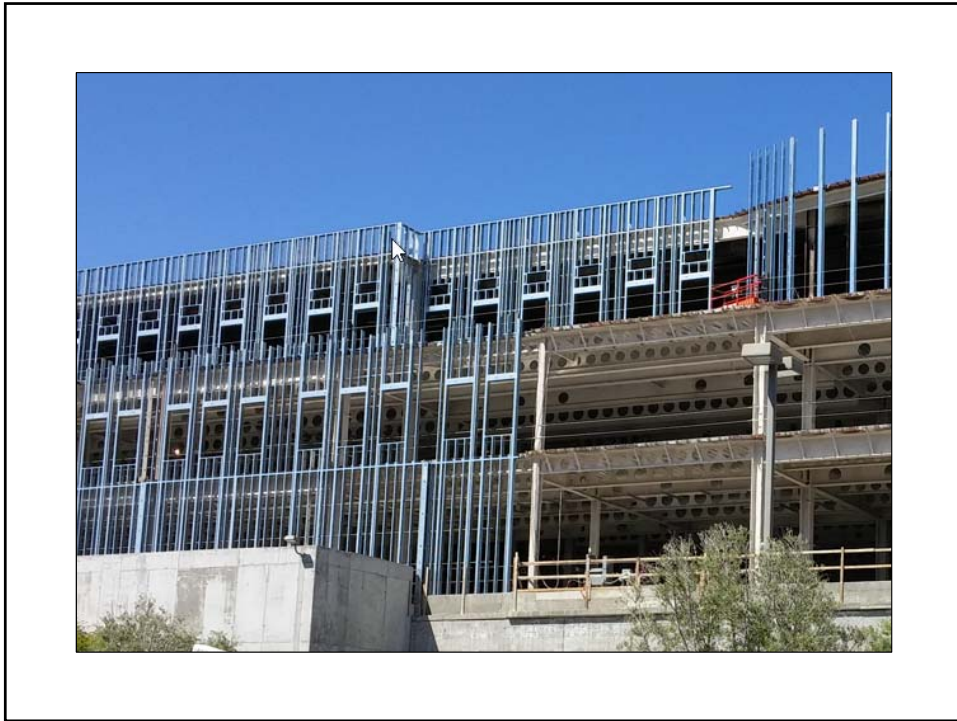
In situations where it appears roof system designers have not properly addressed code-required considerations for wind design, contractors are encouraged to seek further guidance from designers. Referring designers to Roof Wind Designer is one possible approach to helping designers provide complete documentation of design wind loads in contract documents. ■■■

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

Professional Roofing

April 2015

Metal stud-framed parapet walls



***Applicators need more guidance
on base termination/attachment details***



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