Great Lakes Chapter of RCI, Inc.

Spring Technical Session
April 26, 2018 – Troy, MI

NRCA technical issues update

presented by

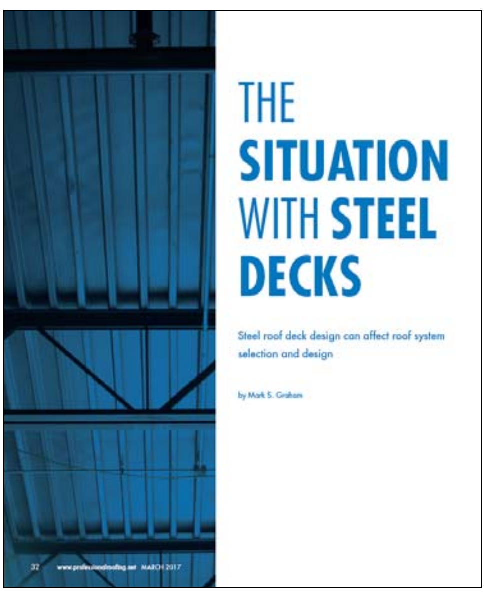
Mark S. Graham
Vice President, Technical Services
National Roofing Contractors Association

NRCA

Topics

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

Steel roof decks


THE SITUATION WITH STEEL DECKS

Steel roof deck design can affect roof system selection and design

by Mark S. Graham

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Professional Roofing
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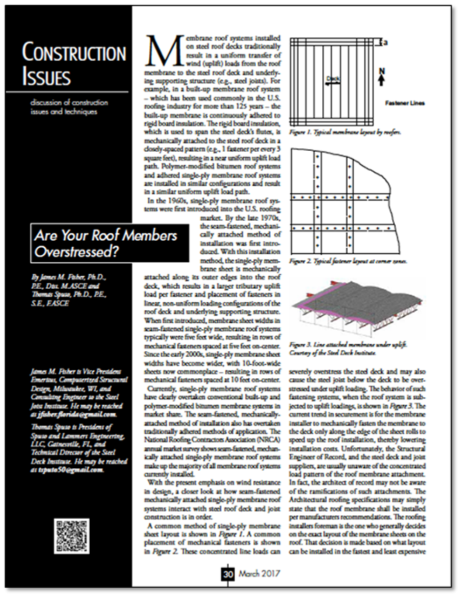


***Structure* magazine**

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)

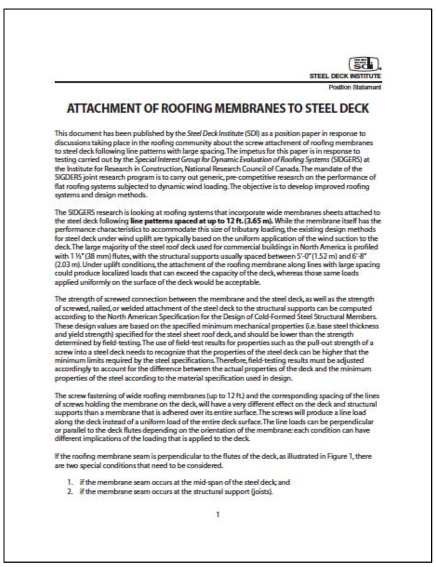
Steel roof deck design

Wind uplift resistance

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

SDI bulletin

2009



STEEL DECK INSTITUTE

Position Statement

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* (SIDGERS) at the Institute for Research in Construction, National Research Council of Canada. The mandate of the SIGDERS 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 SIDGERS research is looking at roofing systems that incorporate wide membranes 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 ½" (38 mm) flutes, with the structural supports usually spaced between 5'-0" (1.52 m) and 6'-8" (2.03 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 computed 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 that 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.

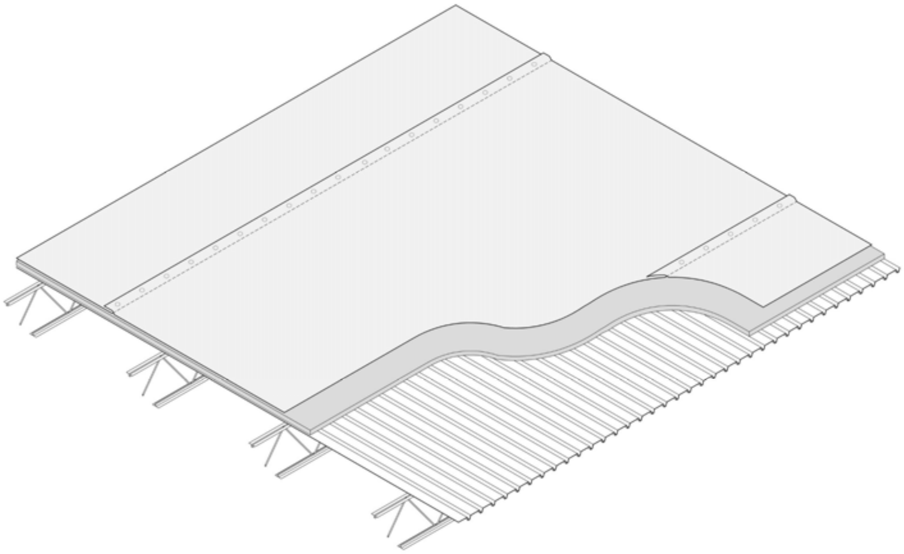
If the roofing membrane seam is perpendicular to the flutes of the deck, as illustrated in Figure 1, there are two special conditions that need to be considered.

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 (joists).

1

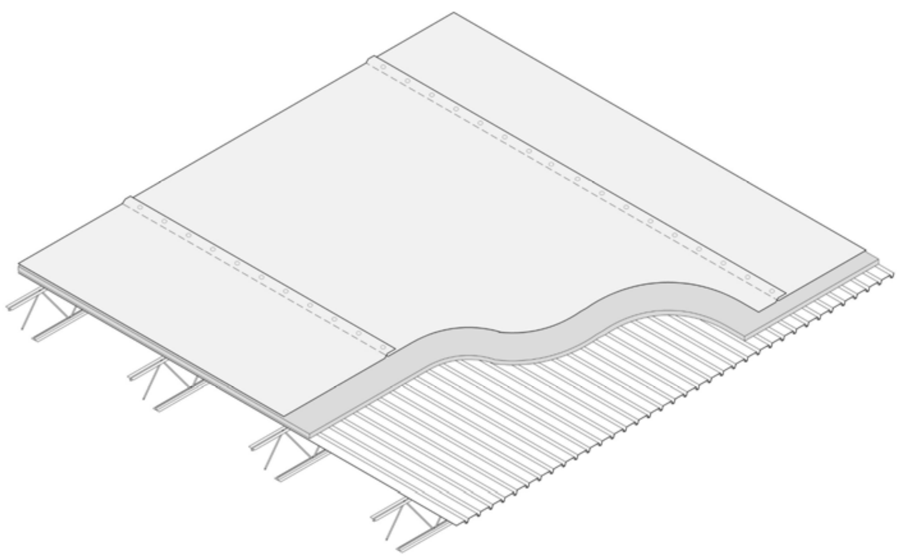
- Decks designed for joist spacing between 5’ and 6’ 8” o.c.
- Decks designed for uniform loading
- Seam-fastened single-ply membranes are a concern

Membrane seams across deck flutes



SDI: 3.8 X moment (deck); 2 X load (joists)

Membrane seams in deck flute direction



SDI: 12 X bending moment and shear (deck)

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)

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FM's guidelines

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- 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

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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.

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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:

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).

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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.

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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
(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
3.5	18	4.5	5.5	5.5	5.5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	4	4	4.5	4.5	4.5	5	5.5	5.5	5.5	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	4	4	4.5	4.5	4.5	5.5	5.5	5.5	6	6	6	6	6	6
4	18	4.5	4.5	5	5	5	6	6	6	6	6	6	6	6	6	6	6		6	6
	20	-	-	-	-	4	4.5	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	4	4.5	5	5	6	6	6	6	6	6	6
4.5	18	-	4	4	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	4	4	5	5	5.5	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6
5	18	-	-	-	4	4	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6	6
	20									4	4.5	5	5.5	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6	6
5.5	18	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5	6	6	6	6
6	18	-	-	-	-	-	-	-	-	4	5	5.5	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6	6
6.5	18	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6
7	18	-	-	-	-	-	-	-	-	-	-	-	4	5.5	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	6	6
7.5	18	-	-	-	-	-	-	-	-	-	-	-	-	4	5.5	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	6	6

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Table 1B. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, Yield Stress ≥ 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, 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
8.5	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	5.5	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6
9.5	18	-	-	-	-	-	-	4	4	4	4.5	5	5.5	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	4	4	4.5	5	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6
10	18	-	-	-	-	-	-	-	4	4	4.5	4.5	5	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	4	4.5	4.5	5.5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	4.5	5.5	6	6
10.5	18	-	-	-	-	-	-	-	4	4	4.5	4.5	5	5.5	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	4	4	4.5	5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6
11	18	-	-	-	-	-	-	-	-	4	4	4.5	5	5	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
11.5	18	-	-	-	-	-	-	-	-	-	4	4	4.5	5	5.5	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
12	18	-	-	-	-	-	-	-	-	-	4	4	4.5	5	5.5	66		6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	5.5	6
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]																		

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

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Table 1B. Maximum Steel Deck Span (ft) for 1 ½ in. (38 mm) Deep, Yield Stress ≥ 60,000 psi (414 MPa) with a mechanically fastened Roof Cover
(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, 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
3.5	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	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
	20	4	4.5	4.5	5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6
6	18	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6
6.5	18	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	4	5	5.5	6	6	6	6	6	6	6
7	18	-	4	4	4.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	4	4	5	5.5	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6
7.5	18	-	-	-	4	4.5	4.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6	6	6	6	6	6
8	18	-	-	-	-	4	4	4.5	5	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	4	5	6	6	6	6	6

FM Global

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 ≤ joist spacing)
  - Use a uniform uplift loading roof system (BUR, MB, adhered single ply)

Fastener pull-out tests…

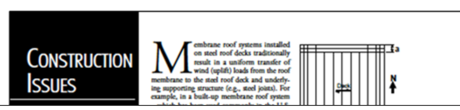
There is little correlation between fastener pull-out resistance and a steel roof deck's yield strength and uplift (bending) strength

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

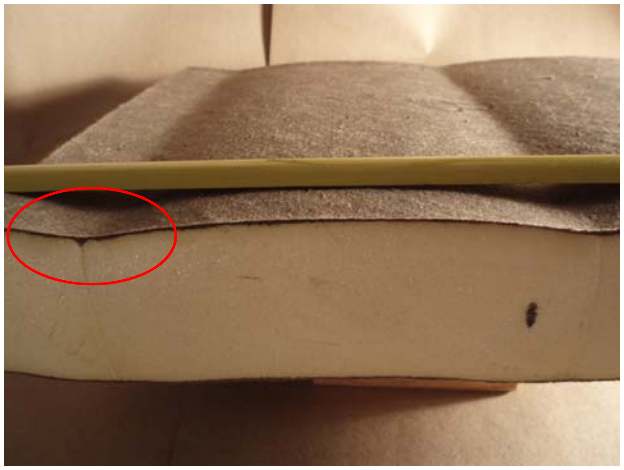
Knit lines -- continued

Photo from manufacturer's product literature

Thickness and knit lines

As delivered by manufacturer.

Knit lines -- continued



After conditioning: 158 ± 4 F and 97 ± 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 limited number of reports of faced, rigid board polyisocyanurate insulation with thicknesses less than what was specified and indicated on the insulation's package labeling 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's recommendations to roofing contractors for monitoring this situation.

Reports

NRCA has received reports of new, uninstalled 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 problems appear to be more common with thicker polyisocyanurate insulation products than thinner ones. For example, NRCA has received multiple reports of 3½-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 ±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

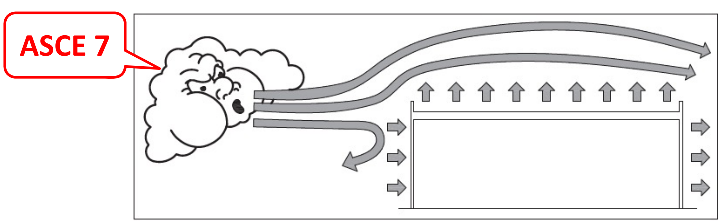
NRCA's recommendations

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

ASCE 7-16
Design wind uplift

The fundamental concept



Wind creates pressures/forces
on building elements

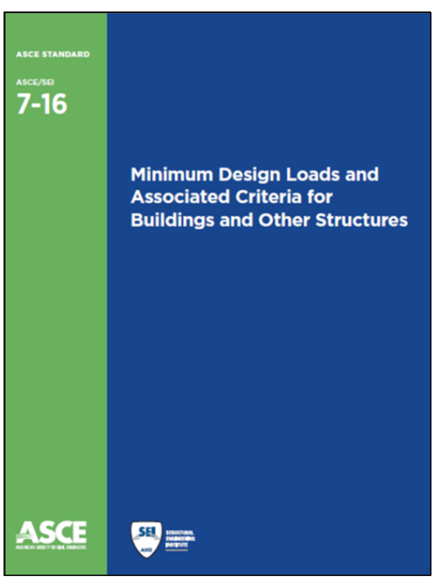
Fundamental concept -- continued

Adhesion or attachment ≥ Uplift pressure

FM rating

UL classification ≥ 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

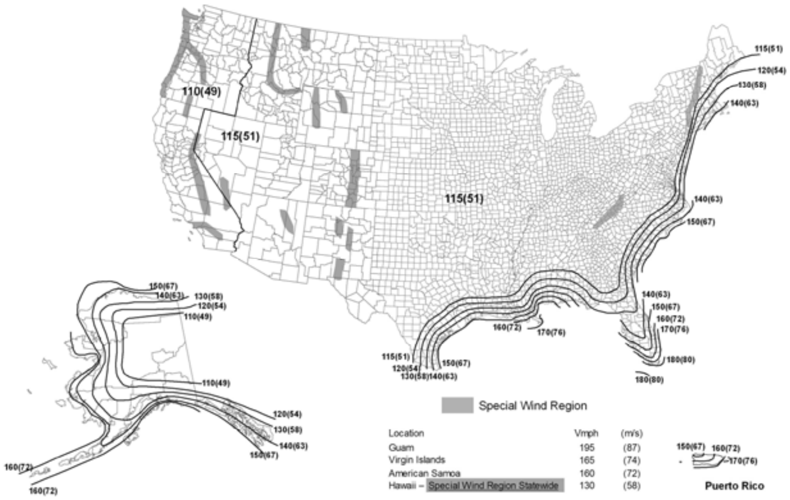
Noteworthy changes in ASCE 7-16

Compared to ASCE 7-10

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

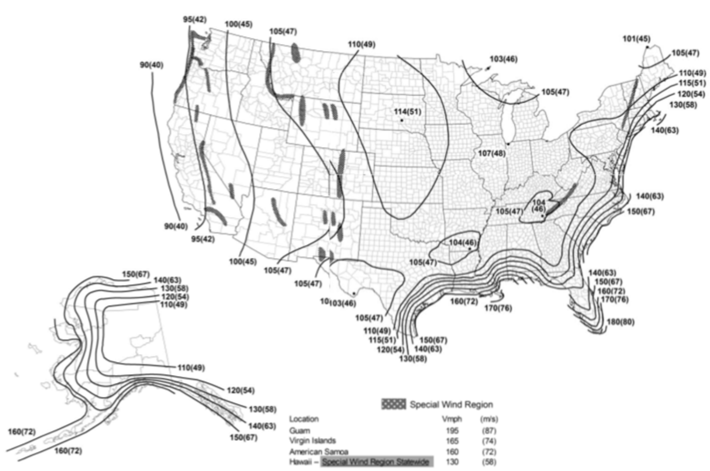
ASCE 7-10 basic wind speed map

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



ASCE 7-16 basic wind speed map

Risk Category II Buildings



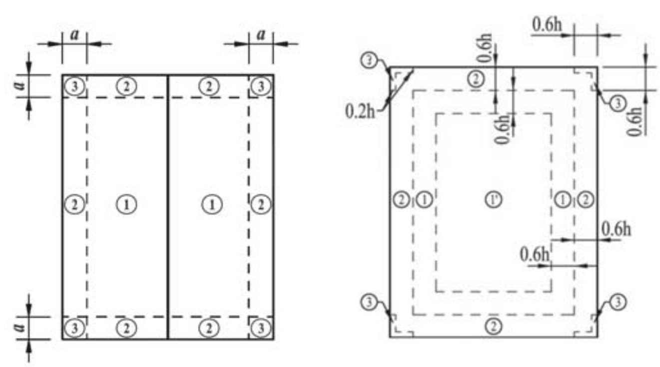
Comparing GC_p pressure coefficients

h ≤ 60 ft., gable roofs ≤ 7 degrees

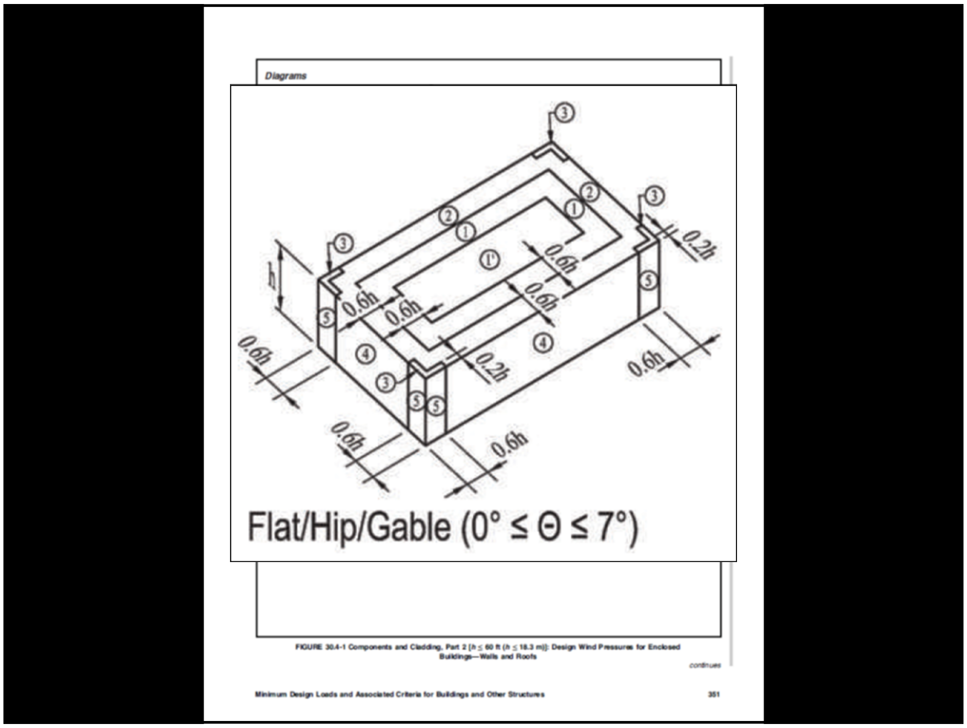
Zone	ASCE 7-10	ASCE 7-16	Change
1’	n/a	0.9	-10%
1 (field)	-1.0	-1.7	+70%
2 (perimeter)	-1.8	-2.3	+28%
3 (corners)	-2.8	-3.2	+14%

Zones

h ≤ 60 ft., gable roofs ≤ 7 degrees



ASCE 7-10 ASCE 7-16


Diagrams
Flat/Hip/Gable (0° ≤ Θ ≤ 7°)
0.6h
0.2h
h
FIGURE 30.4-1 Components and Cladding, Part 2 [h ≤ 60 ft (h ≤ 18.3 m)]: Design Wind Pressures for Enclosed Buildings—Walls and Roofs
continues
Minimum Design Loads and Associated Criteria for Buildings and Other Structures
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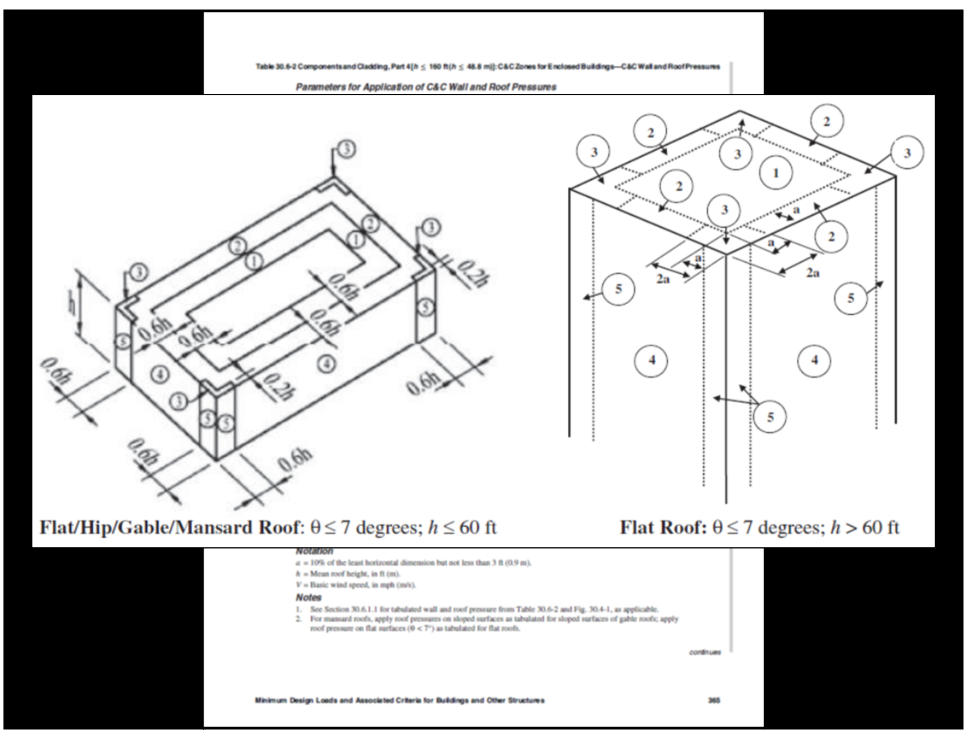


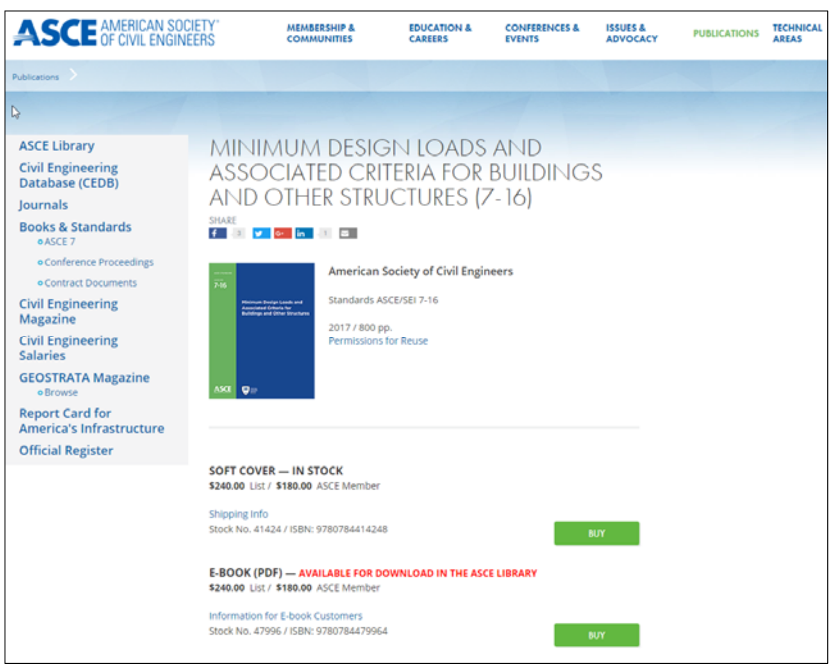
Table 30.6-2 Components and Cladding, Part 4 [h ≤ 160 ft (h ≤ 48.8 m)]: C&C Zones for Enclosed Buildings—C&C Wall and Roof Pressures
Parameters for Application of C&C Wall and Roof Pressures
Flat/Hip/Gable/Mansard Roof: θ ≤ 7 degrees; h ≤ 60 ft
Flat Roof: θ ≤ 7 degrees; h > 60 ft
0.6h
0.2h
h
a
2a
Notation
a = 10% of the least horizontal dimension but not less than 3 ft (0.9 m).
h = Mean roof height, in ft (m).
V = Basic wind speed, in mph (m/s).
Notes
1. See Section 30.6.1.1 for tabulated wall and roof pressure from Table 30.6-2 and Fig. 30.4-1, as applicable.
2. For mansard roofs, apply roof pressures on sloped surfaces as tabulated for sloped surfaces of gable roofs; apply roof pressure on flat surfaces (θ < 7°) as tabulated for flat roofs.
continues
Minimum Design Loads and Associated Criteria for Buildings and Other Structures
365

Noteworthy changes in ASCE 7-16

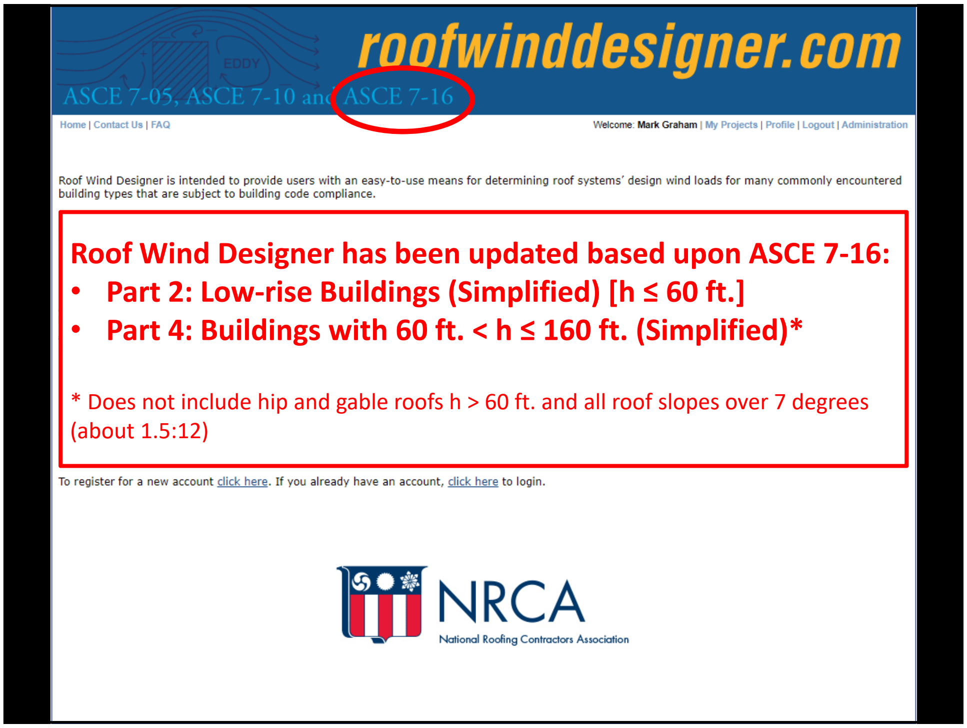
Compared to ASCE 7-10

- 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



www.asce.org



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.

This comparison illustrates why it is important for Designers to include wind design loads in their Construction Documents (per IBC Sec. 1603.1)…

…It also illustrates why specifying a wind warrantee can create an uneven playing field. Unless the Designer indicates the wind design loads, which design method will the manufacturer use (e.g., in a competitive environment)?


RESEARCH+TECH

ASCE 7-16

Increased design wind-uplift loads may present challenges

by Mark S. Graham

In June 2017, the American Society of Civil Engineers (ASCE) published an updated edition of ASCE 7, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures," (ASCE 7-16). Because ASCE 7-16 is referenced in the *International Building Code,® 2018 Edition* (IBC 2018) as the basis for design wind-uplift load determination for all roof assembly types except asphalt shingles and tile, you should be aware of the changes.

ASCE 7-16

ASCE 7-16's design wind-uplift load procedures are described and the basic design wind speed maps are provided in Chapter 26-Wind Loads: General Requirements. Design wind-uplift loads for roof assemblies typically are determined using ASCE 7-16's Chapter 30-Wind Loads: Components and Cladding.

Chapter 30 provides seven methods—referred to as "Parts"—for wind load determination. Part 1 applies to low-rise, enclosed or partially enclosed buildings. Part 2 is a simplified approach applicable to low-rise, enclosed buildings. Part 3 applies to enclosed or partially

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March 2018

TECH TODAY

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 speeds, wind warranties or disproportionately high (or low) uplift-resistance classifications are telltale signs 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, 2015 Edition,* (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 2006 and IBC 2009 reference ASCE 7-05, which results in design wind loads near those derived using ASCE 7-10's ASD method.

IBC 2015's Section 1603—Construction Documents indicates a building's design loads, including a roof system's live 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 internal pressure coefficient. For component and cladding systems not specifically designed by 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 loads most commonly will be identified on the structural drawings in the project drawing set for new construction projects. For reroofing projects without specific structural drawings, design loads may be provided on the architectural drawings or in the project specifications.

IBC 2012 and previous editions include similar construction document 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's 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 Pressures"
- UL 580, "Tests for Uplift Resistance of Roof Assemblies"
- UL 1897, "Uplift Tests for Roof Covering Systems"

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

Roof Wind Designer

NRCA's 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 7-05 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.roofwinddesigner.com. To date, the application has been used on more than 17,750 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 code-required documentation of design wind loads in contract documents.

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

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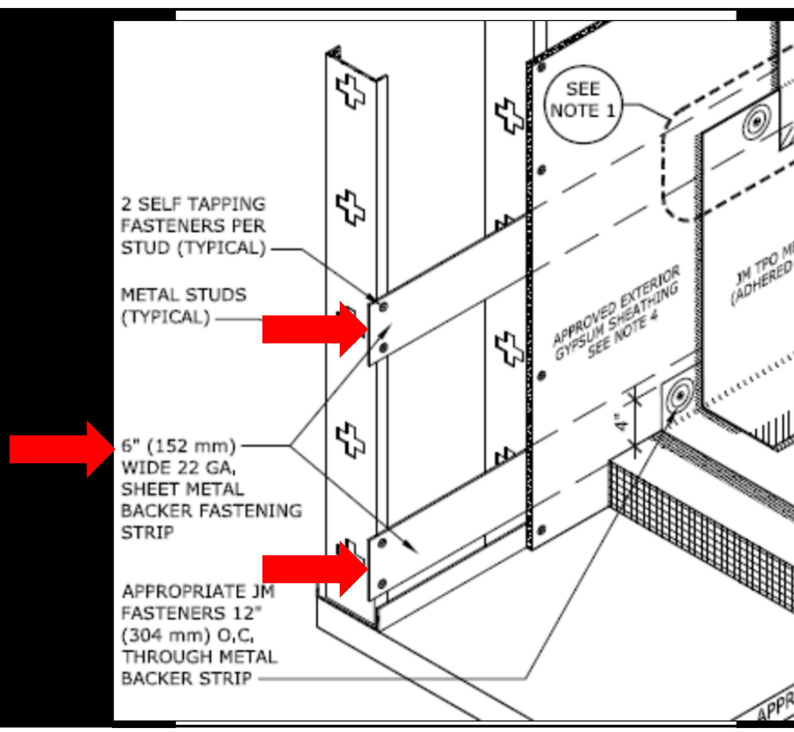
Professional Roofing

April 2015

Metal stud-framed parapet walls


SEE NOTE 1
2 SELF TAPPING FASTENERS PER STUD (TYPICAL)
METAL STUDS (TYPICAL)
6" (152 mm) WIDE 22 GA, SHEET METAL BACKER FASTENING STRIP
APPROPRIATE JM FASTENERS 12" (304 mm) O.C, THROUGH METAL BACKER STRIP
APPROVED EXTERIOR GYPSUM SHEATHING SEE NOTE 4
(ADHERED)

Applicators need more guidance on base termination/attachment details

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