NRCA update on roofing industry technical issues

Wednesday, February 5, 2020

presented by

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Vice President, Technical Services
National Roofing Contractors Association (NRCA)

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Learning objectives:

- Discuss new NRCA technical publications.
- Define current roofing-related technical issues.
- Identify newly-developing roofing-related technical issues.

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Topics

- NRCA technical committees
  - New NRCA technical publications
- Moisture in structural concrete roof decks
- Polymer-modified bitumen sheet testing
- Fastener pull-out testing
- Roof system R-value testing
- FM Global's very severe hail (VSR) classification
- ASCE 7-16 implementation
- SDI bulletin (seam-fastened membrane systems)
- Questions and dialogue

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NRCA Technical Committees

2019-20 NRCA fiscal year (June 1, 2019 – May 31, 2020)

- Technical Operations Committee
- Manual Update Committee
- Waterproofing Task Force
- Roof Tile Task Force
- Roof Coatings Task Force
- Steep-slope Repair Manual Task Force
- Metal Wall Panel Task Force

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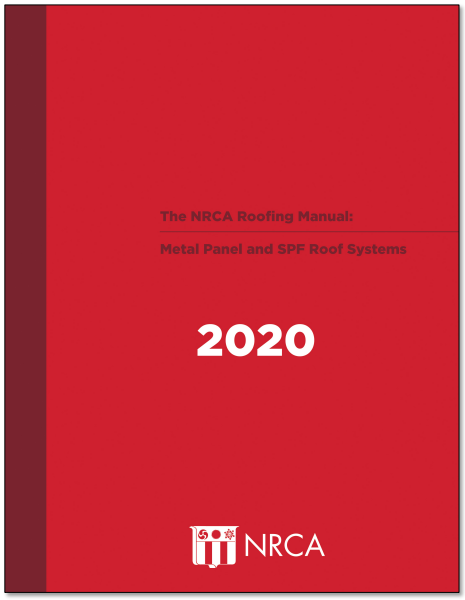

The NRCA Roofing Manual:
Metal Panel and SPF Roof Systems-2020

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The NRCA Roofing Manual

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Spanish version of The NRCA Roofing Manual

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Moisture in concrete roof decks

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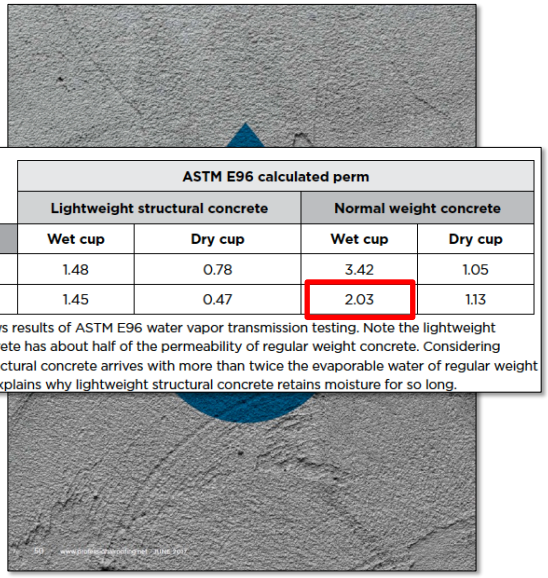

	ASTM E96 calculated perm			
	Lightweight structural concrete		Normal weight concrete	
Age	Wet cup	Dry cup	Wet cup	Dry cup
28 days	1.48	0.78	3.42	1.05
60 days	1.45	0.47	2.03	1.13

The figure shows results of ASTM E96 water vapor transmission testing. Note the lightweight structural concrete has about half of the permeability of regular weight concrete. Considering lightweight structural concrete arrives with more than twice the evaporable water of regular weight concrete, this explains why lightweight structural concrete retains moisture for so long.

Professional Roofing, June 2017

Professional Roofing, December 2018

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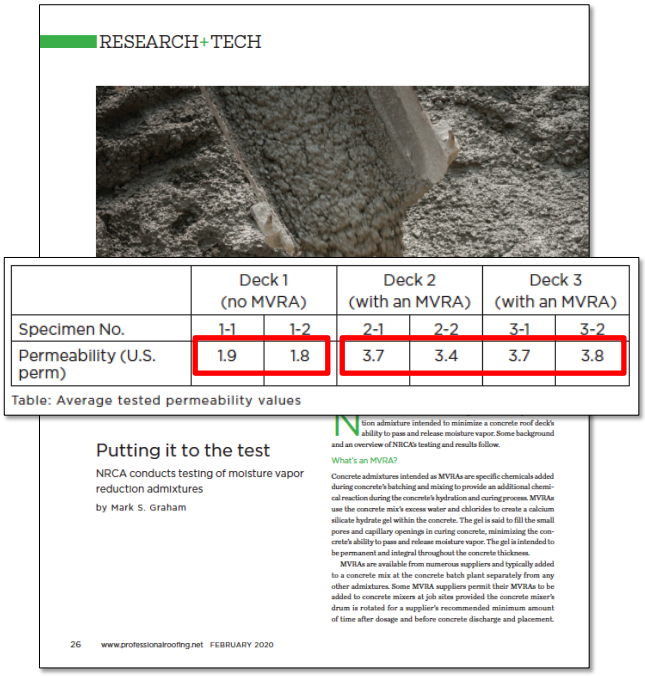

	Deck 1 (no MVRA)		Deck 2 (with an MVRA)		Deck 3 (with an MVRA)	
Specimen No.	1-1	1-2	2-1	2-2	3-1	3-2
Permeability (U.S. perm)	1.9	1.8	3.7	3.4	3.7	3.8

Table: Average tested permeability values

Professional Roofing
February 2020

"…These test results contradict claims an MVRA minimizes concrete's ability to pass and release moisture vapor…"

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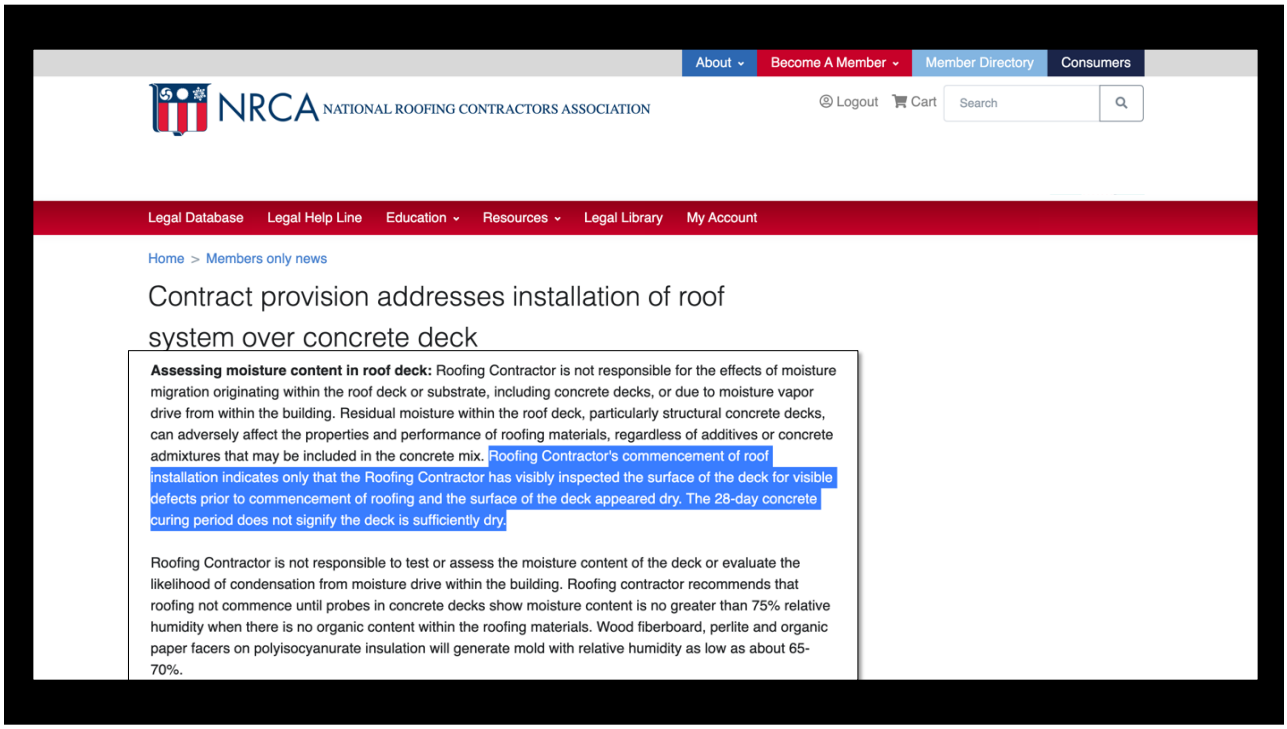

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Coming soon...

- Publication of the final report on SRI's industry-sponsored concrete moisture research
- Research summary article written by Matt Dupuis in the March issue of *Professional Roofing*
- NRCA "Industry Issue update," which will summarize the research to date and provide NRCA latest recommendations

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Polymer-modified bitumen sheet testing

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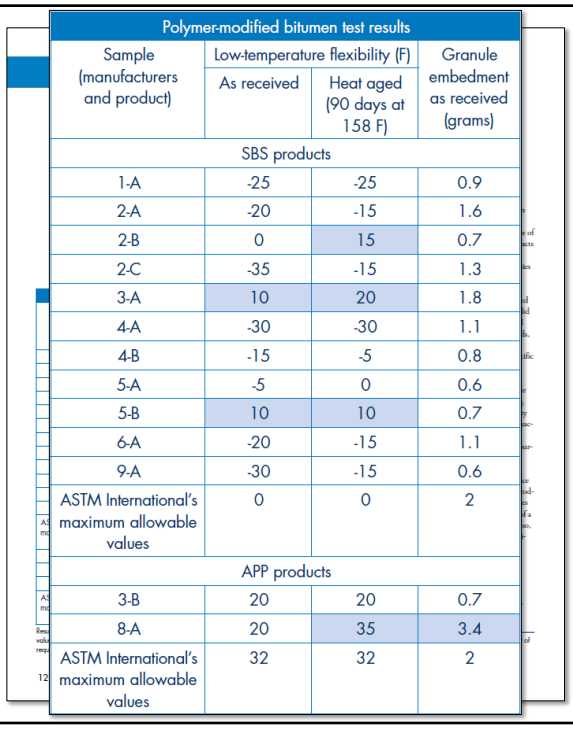

Polymer-modified bitumen test results

Sample (manufacturers and product)	Low-temperature flexibility (F)		Granule embedment as received (grams)
	As received	Heat aged (90 days at 158 F)	
SBS products			
1-A	-25	-25	0.9
2-A	-20	-15	1.6
2-B	0	15	0.7
2-C	-35	-15	1.3
3-A	10	20	1.8
4-A	-30	-30	1.1
4-B	-15	-5	0.8
5-A	-5	0	0.6
5-B	10	10	0.7
6-A	-20	-15	1.1
9-A	-30	-15	0.6
ASTM International's maximum allowable values	0	0	2
APP products			
3-B	20	20	0.7
8-A	20	35	3.4
ASTM International's maximum allowable values	32	32	2

Professional Roofing
February 2016

Nine of 13 products tested complied…

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2011 testing

Only six of the 16 products tested complied….

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2019 MB testing

- ASTM D5147 -- Low-temperature flexibility (as received)
- ASTM D4977 -- Granule embedment (as received)
- ASTM D3461 -- Softening point (as received)

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Products tested

2019 MB testing

- 18 products tested:
  - 7 APP
  - 9 SBS
  - 15 products with granules
  - 3 products without granules (granule embedment doesn't apply)
- Manufacturers:
  - 10 (CertainTeed, Derbigum, Firestone, GAF, Garland, JM, Polyglass, Siplast, Soprema and Tremco)

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Results – SBS products

2019 testing

Sample ID	Modifier	ASTM designation	Low-temp. flex. (F)	Granule loss (g)
1-A	SBS	ASTM D6164, Type I, Grade G	-13	0.56
3-A	SBS	ASTM D6164, Type I, Grade S	-27	NA
3-B	SBS	ASTM D6164, Type II, Grade G	-15	0.48
4-A	SBS	ASTM D6164, Type II, Grade G	-16	1.13
5-A	SBS	ASTM D6162, Type III, Grade G	-15	2.05
6-A	SBS	ASTM D6164, Type I, Grade G	-13	0.34
6-B	SBS	ASTM D6164, Type II, Grade G	-13	0.53
6-C	SBS	ASTM G6164, Type I, Grade G	-9	0.55
8-A	SBS	ASTM D6163, Type I, Grade G	-20	0.09
9-A	SBS	ASTM D6164, Type I, Grade G	-8	0.53
10-A	SBS	ASTM D6163, Type III, Grade G	Less than -40	1.16
		ASTM spec.	0 (max.)	2.0 (max)

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Results – APP products

2019 testing

Sample ID	Modifier	ASTM designation	Low-temp. flex. (F)	Granule loss (g)
2-A	APP	ASTM D6223, Type I, Grade G	21	0.95
2-B	APP	ASTM D6223, Type I, Grade S	10	NA
2-C	APP	D6223, Grade G	14	0.60
2-D	APP	ASTM D6222, Type II, Grade G	10	0.65
2-E	APP	D6223, Grade G	9	NA
7-A	APP	D6222, Grade G	Greater than 41	0.10
7-B	APP	D6222, Type I, Grade G	Greater than 41	0.88
		ASTM spec.	32 (max.)	2.0 (max)

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Summary of results

- 15 of the 18 products tested comply
- Results notably are better than 2015 and 2011
- Still some reason(s) for concern

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Softening point testing

- Tested sheet backside (bottomside) coating material and parting media (sand, film)
- Tested using ASTM D3461 (ring and ball)

APP products: 309 F to 330 F

SBS products: 239 F to 293 F

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Recommendations

2019 MB testing

- Select MB products carefully
- Consider seeking out products with third-party verification of compliance:
  - UL product certification
  - PRI Product Validation
  - Dade County Approval
- As always, call NRCA Technical Services if you see anything unusual

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Fastener pull-out testing

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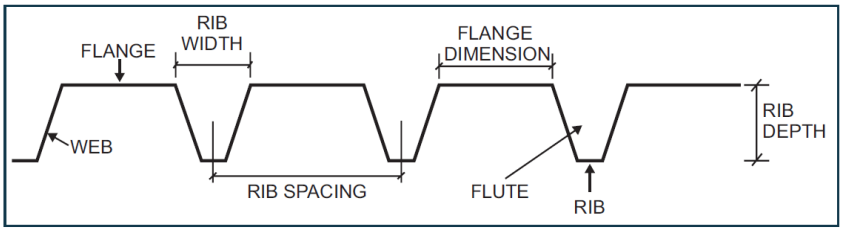
Terminology -- Steel roof decks



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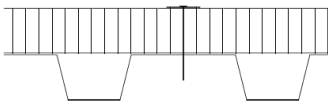
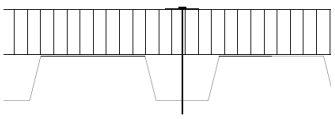
Tested fastener locations

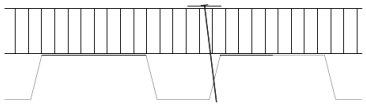
Fastener in flange



Fastener in rib



Fastener in web



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Other test parameters

Steel deck types:

- 22 ga., 1½-in.-thick, Type B-deck
- 20 ga., 3-in.-thick, Type N-deck (Type 3DR)

Fastener types:

- All-purpose fastener (#14)
  - Published pull-out values:
    - 22 ga.: 315 lbf at 33 ksi and 480 lbf at 80 ksi
    - 20 ga.: 420 lbf at 33 ksi and 615 lbf at 80 ksi
- Heavy duty fastener (#15)
  - Published pull-out values:
    - 22 ga.: 595 lbf at 33 ksi and 650 lbf at 80 ksi

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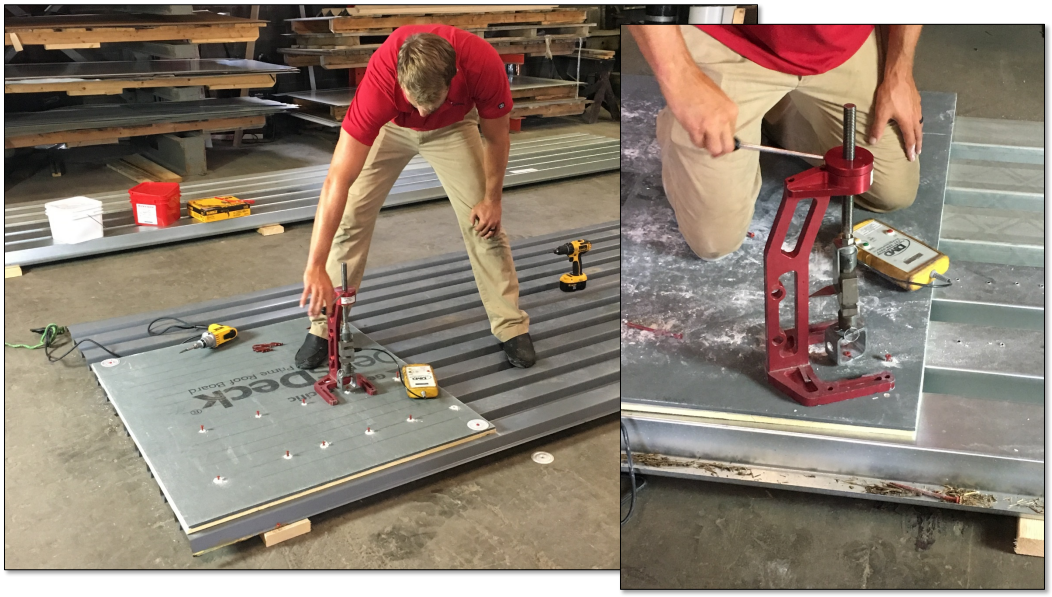
Test set-up and equipment



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Test data

22 ga., 1½-in.-thick, Type B deck
All-purpose Fastener (#14)
Average value 10 pull-out tests

Fastener in flange	Fastener in rib	Fastener in web
637.4 lbf	561.1 lbf	556.2 lbf

Published pull-out value is 315-480 lbf

Tested fastener in rib value is 88 % of fastener in flange value
Tested fastener in web value is 87% of fastener in flange value

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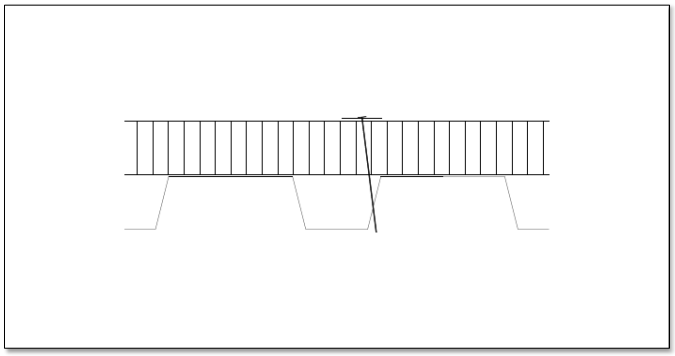
Fastener in web



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Test data

22 ga., 1½-in.-thick, Type B deck
Heavy Duty Fastener (#15)
Average value 10 pull-out tests

Fastener in flange	Fastener in rib	Fastener in web
761 lbf	680.9 lbf	674.8 lbf

Published pull-out value is 595-650 lbf

Tested fastener in rib value is 89 % of fastener in flange value
Tested fastener in web value is 89% of fastener in flange value

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Test data

20 ga., 3-in.-thick, Type3DR deck
All-purpose Fastener (#14)
Average value 10 pull-out tests

Fastener in flange	Fastener in rib	Fastener in web
848.8 lbf	732.8 lbf	733.0 lbf

Published pull-out value is 420-615 lbf

Tested fastener in rib value is 86% of fastener in flange value
Tested fastener in web value is 86% of fastener in flange value

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Test data

20 ga., 3-in.-thick, Type3DR deck
Heavy Duty Fastener (#15)
Average value 10 pull-out tests

Fastener in flange	Fastener in rib	Fastener in web
1,044 lbf	1,037 lbf	978.2 lbf

No published pull-out value

Tested fastener in rib value is 99% of fastener in flange value
Tested fastener in web value is 94% of fastener in flange value

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Conclusions

Fastener pull-out testing

- Tested pull-out values are greater than published values
- "Fastener in web" or "Fastener in rib" placement results in a less than 15% reduction in pull-out load versus "Fastener in flange" placement
- Actual deck gauge, deck yield strength and fastener selection have larger impacts on fastener pull-out values
- A safety factor is typically applied to fastener pull-out loads which more than covers this reduction
- This test data applies to insulation fasteners' performances, not necessarily membrane fasteners' (e.g, fastener "rocking" due to membrane fluttering)

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Roof system R-value testing

R-value testing of compete roof systems

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Why roof system testing?

Takes into account the impact(s) of:

- Board joints (thermal bridge)
- Fasteners and plates (thermal bridges)

Gives us a truer indication of actual roof system thermal performance

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National Research Council Canada | Conseil national de recherches Canada

Canada

Energy Resistance of Commercial Roofs (ERCR)

Project scope

- Evaluate the R-value of individual roof systems components
- Evaluate the impact of fasteners/plates
- Evaluate the impact of board joints
- Development of “compensation factors”

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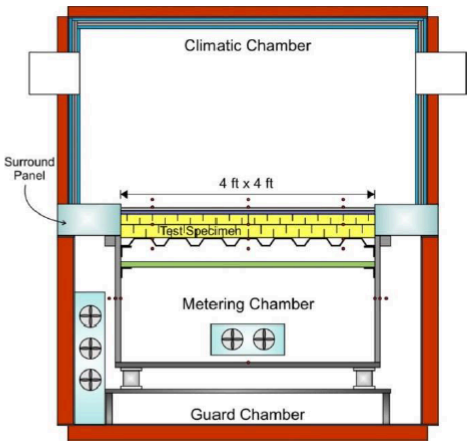

Guarded hot box (4 ft. x 4 ft. specimen)

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Large-scale calibrated hot box (8 ft. x 24 ft. specimens)

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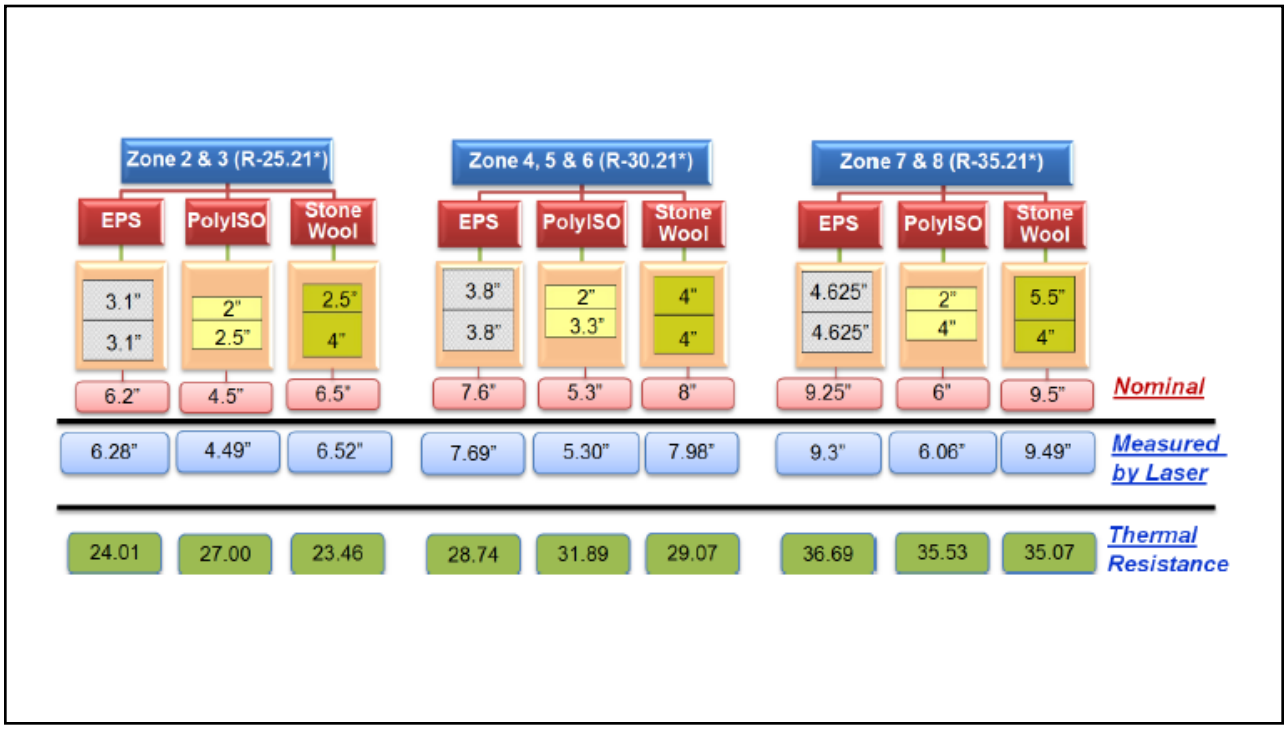

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	New Boards			Stored Boards (in Laboratory conditions)		
	Jul-16	Oct-16	Feb-17	May-19	Feb-19	May-19
	ISO (2" + 2.5")	EPS (3.125" +3.125")	SW (2.5" + 4")	ISO (2" + 2.5")	EPS (3.125" +3.125")	SW (2.5" + 4")
R-25.21	27.00	24.20	23.46	24.76	24.19	23.38
	Mar-17	May-17	May-17	May-19	Feb-19	May-19
	ISO (2" + 3.3")	EPS (3.875" +3.875")	SW (4" + 4")	ISO (2" + 3.3")	EPS (3.875" +3.875")	SW (4" + 4")
R-30.21	31.89	29.60	29.07	29.51	29.61	29.05
	Apr-18	Dec-18	Oct-18	May-19	Feb-19	May-19
	ISO (2" + 4")	EPS (4.625" + 4.625")	SW (5.5" + 4")	ISO (2" + 4")	EPS (4.625" + 4.625")	SW (5.5" + 4")
R-35.21	35.53	36.69	35.07	34.12	36.64	34.83

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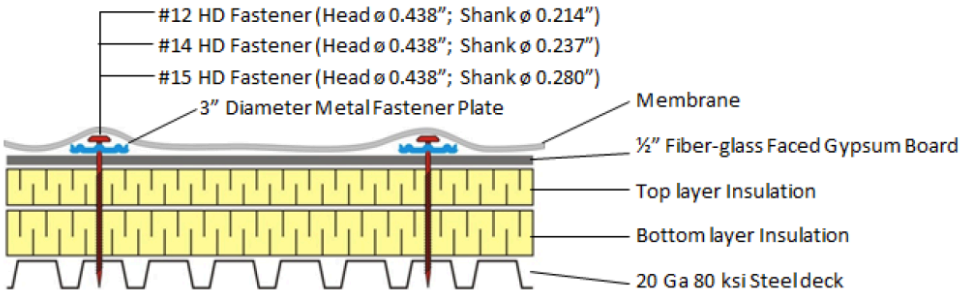

Fastener penetration

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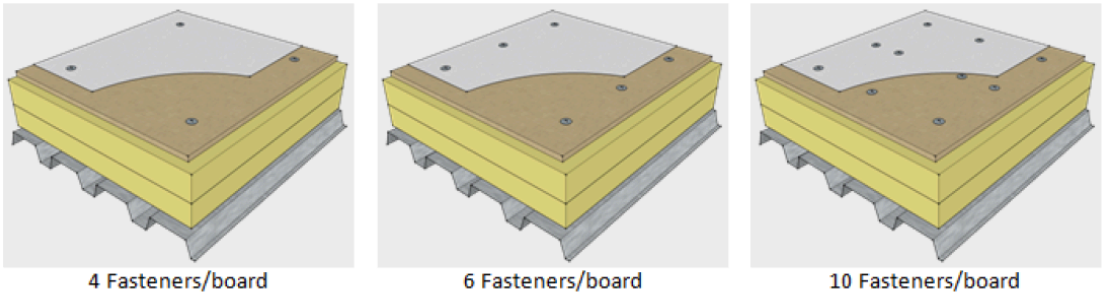

4 Fasteners/board
(2.69 Fast./m²)

6 Fasteners/board
(4.04 Fast./m²)

10 Fasteners/board
(6.73 Fast./m²)

Fastener placement/density

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Test results

Tested R-values and fastener impact

- Polyiso (R = 5.7 nominal): Tested R = 5.9 to 6.0
  - R26 with fasteners: 3 to 11 percent reduction
  - R31 with fasteners: 3 to 10 percent reduction
  - R36 with fasteners: 6 to 14 percent reduction
- EPS (R = 4.0 nominal): Tested R = 3.82 to 3.96
  - R26 with fasteners: 4 to 14 percent reduction
  - R31 with fasteners: 8 to 17 percent reduction
  - R36 with fasteners: 7 to 15 percent reduction
- Stone wool (R = 3.8 nominal): Tested R = 3.61 to 3.69
  - R26 with fasteners: 4 to 14 percent reduction
  - R31 with fasteners: 7 to 16 percent reduction
  - R36 with fasteners: 7 to 14 percent reduction

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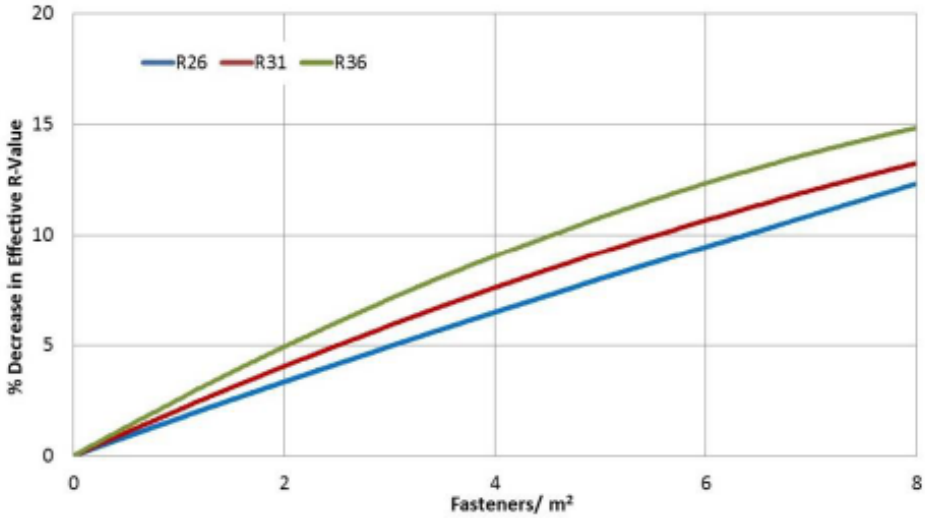

Fastener impact factor

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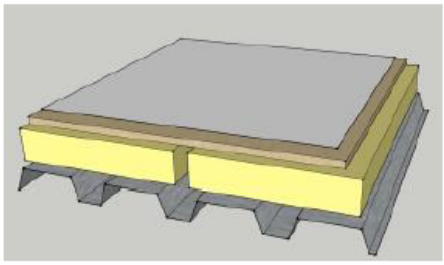
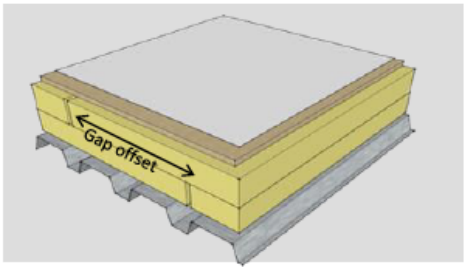


Through Gap (TG):
1. With gap width 0
2. With gap width ¼"
3. With gap width ½"



Staggered Gap (SG):
1. With gap offset 24" (Gap width ¼" and ½")
2. With gap offset 6" (Gap width ½")

Insulation board joints

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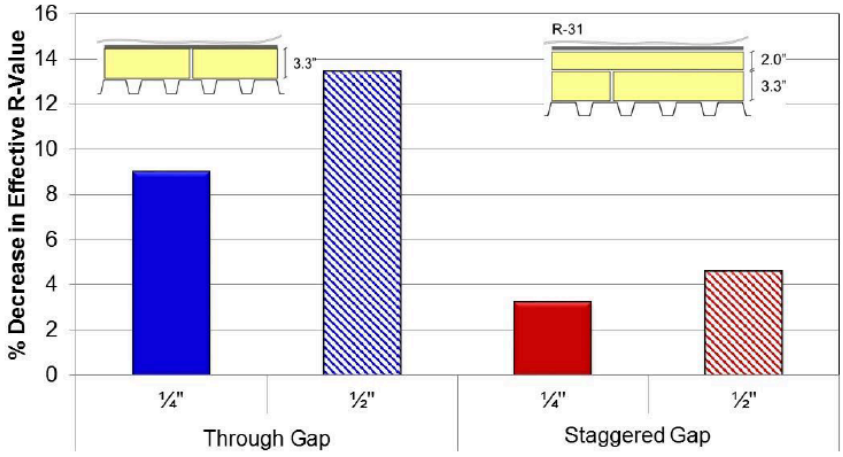

Test results – Insulation board joints

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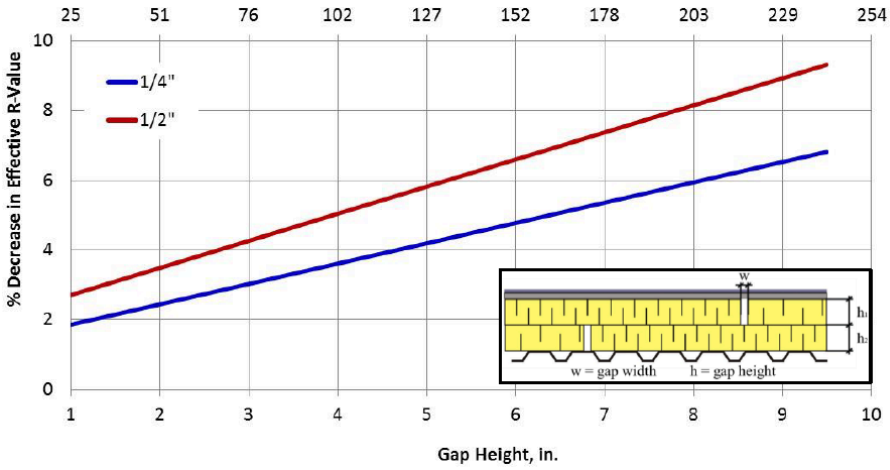

Insulation board joint impact factor

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…the combined effect (fasteners and board joints) has been found to result in an 18-20 percent decrease in a roof assembly's effective R-value…

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FM Global's very severe hail (VSR) classification

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RESEARCH+TECH

Understanding FM VSH

FM has implemented a new impact-resistance classification

by Mark S. Graham

To access FM Global Data Sheets, including FM 1-34—"Hail Damage," go to www.professionalroofing.net.

Commercial and industrial insurer FM Global and its code-approved testing agency subsidiary, FM Approvals, have implemented a Very Severe Hail (VSH) impact-resistance classification that could affect some of the work you do.

FM Global guidelines

FM Global traditionally has recommended its insured building owners use moderate hail- (MH-) and severe hail- (SH-) classified roof systems for buildings located in areas FM Global considers to be susceptible to moderate or severe hail impacts. FM Loss Prevention Data Sheet 1-34 (FM 1-34), "Hail Damage," provides a map identifying those regions.

In recent years, the U.S. insurance industry has experienced increases in losses from hail in terms of the number of claims experienced and costs of those claims. A majority of the hail damage occurs to roof systems and other rooftop components.

In the latest version of FM 1-34, dated October 2014, FM Global has identified a new VSH region, encompassing Oklahoma, Kansas and some northern counties in Texas. FM 1-34's Table 3 identifies the specific northern Texas counties.

22 www.professionalroofing.net DECEMBER 2017

Professional Roofing, December 2017
Link to access this article


RESEARCH+TECH

Designing for hail resistance

Did you know FM Global has updated its hail design guidance?

by Mark S. Graham

In March, property and building loss insurer FM Global updated its Property Loss Prevention Data Sheet 1-34, "Hail Damage" (FM 1-34). If you work on buildings insured by FM Global, you should be aware of its latest hail-resistance guidelines and the effects they may have on roof system selection and design.

FM 1-34

FM 1-34 provides loss-prevention guidelines to minimize the potential for hail damage to buildings, roof-mounted equipment and other outdoor equipment. FM Global intends FM 1-34 and its other Property Loss Prevention Data Sheets to apply to its insured buildings. However, some designers use the Property Loss Prevention Data Sheets as design guidelines for buildings (and roof systems) other than those insured by FM Global.

FM Global contends hailstorms are a widespread hazard affecting many areas of the world that can severely damage buildings' roof systems, rooftop HVAC units and skylights. Cooling towers and exposed glass and plastic components of outdoor equipment also can be

20 www.professionalroofing.net MAY 2018

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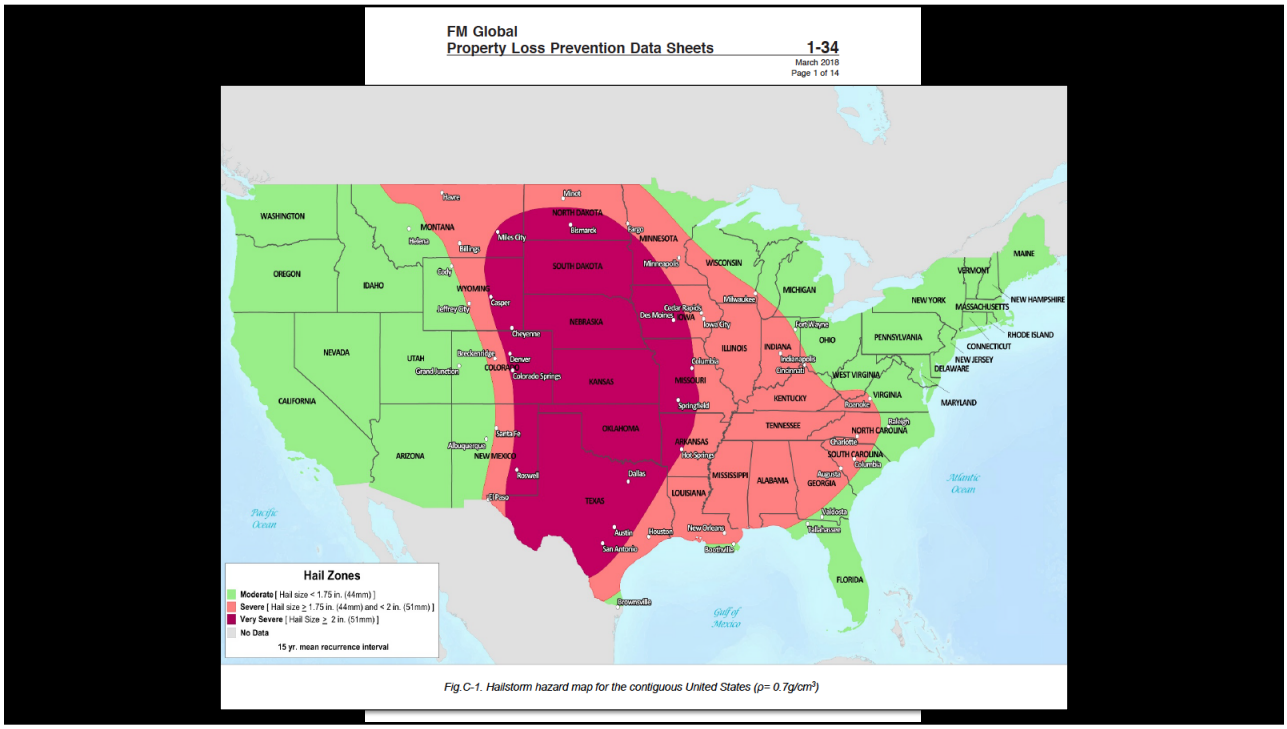

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Of the 951,510 roof assemblies in FM's RoofNav, only 1,745 have a VSH classification

As of February 3, 2020

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ASCE 7-16 implementation

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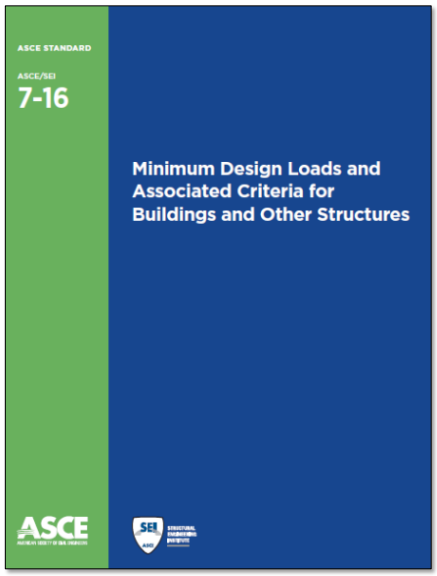

American Society of Civil Engineers Standard 7, "Minimum design loads and associated criteria for buildings and other structures" (ASCE 7-16)

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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

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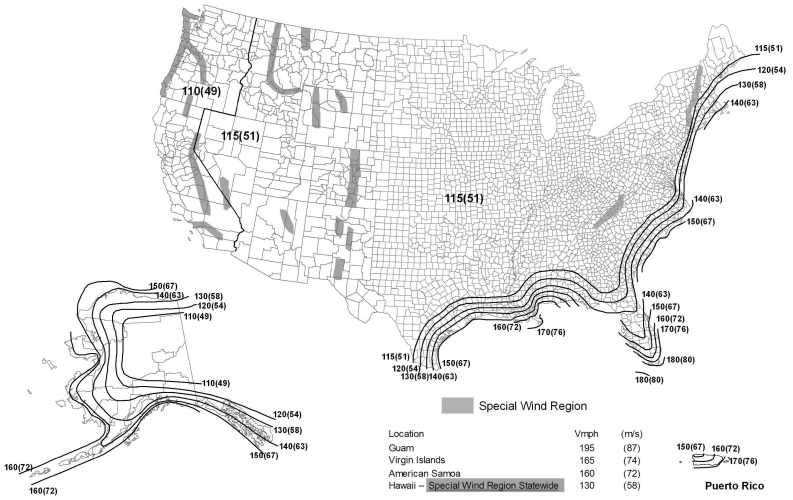
ASCE 7-10 basic wind speed map

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



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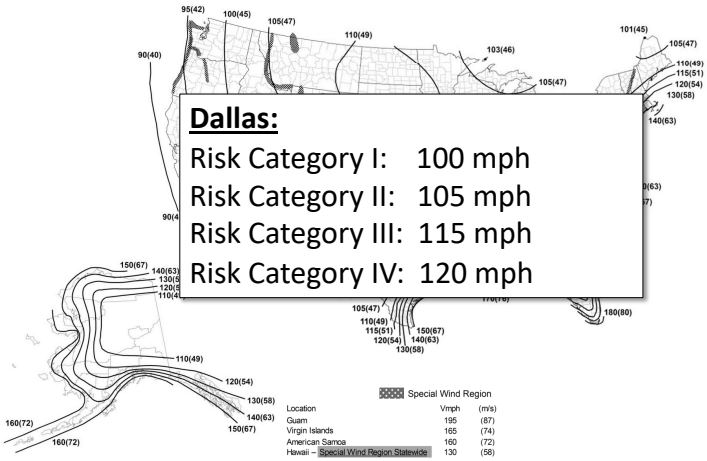
ASCE 7-16 basic wind speed map

Risk Category II Buildings



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Comparing GC_p pressure coefficients

h ≤ 60 ft., gable roofs ≤ 7 degrees

Zone	ASCE 7-10	ASCE 7-16	Change
1' (center field)	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%

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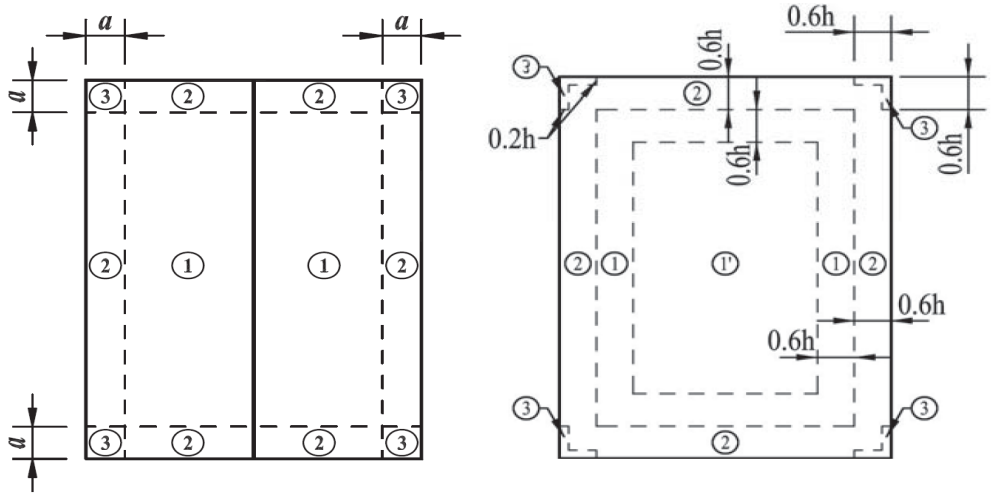
Zones

h ≤ 60 ft., gable roofs ≤ 7 degrees



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

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- 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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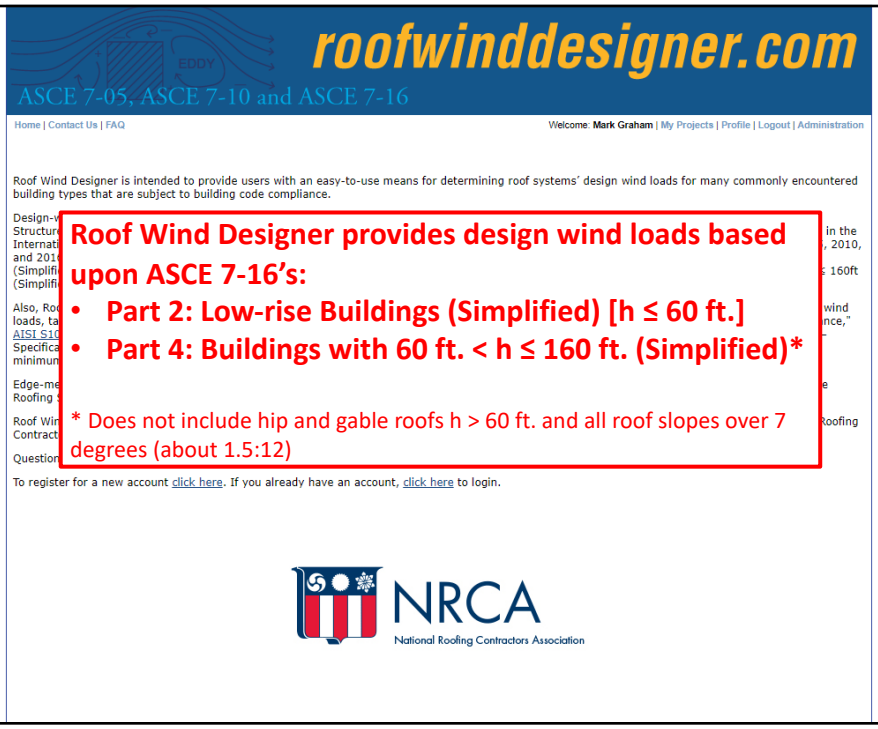

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Comparing ASCE 7-05, ASCE 7-10 and ASCE 7-16

Example: A office building (Risk Category II) is located in Dallas, TX. The building is an enclosed structure with a mean roof height of 60 ft. The building is located in an open terrain area that can be categorized as Exposure Category C. An adhered, membrane roof systems is to be installed.

Document	Basic wind speed (mph)	Design wind pressure (psf)			
		Zone 1' (Center)	Zone 1 (Field)	Zone 2 (Perimeter)	Zone 3 (Corners)
ASCE 7-05	90	--	24	40	60
FM 1-28	90	--	27	46	69
ASCE 7-10 Ult.	115	--	39	65	97
ASCE 7-10 ASD	90	--	23	39	58
ASCE 7-16 Ult.	105	30	51	68	92
ASCE 7-16 ASD	90	18	31	40	55

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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 illustrate 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)?

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FM Global has indicated they will update their Loss Prevention Data Sheet FM 1-28 and RoofNav Ratings Calculator to be based upon ASCE 7-16 (with modifications) in Feb. 2020.

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Steel roof decks/seam-fastened systems

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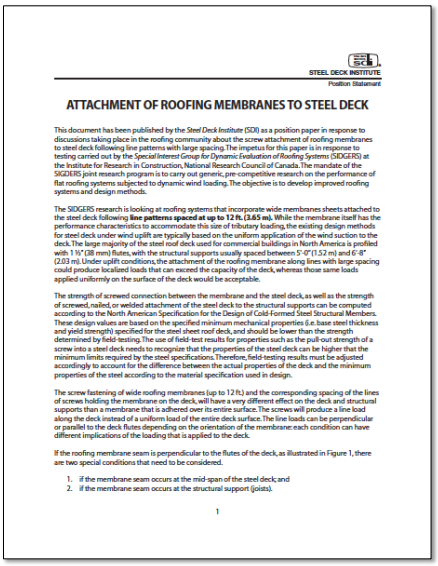
SDI bulletin

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.
- Deck designed for uniform loading
- Seam-fastened single-ply membranes are a concern

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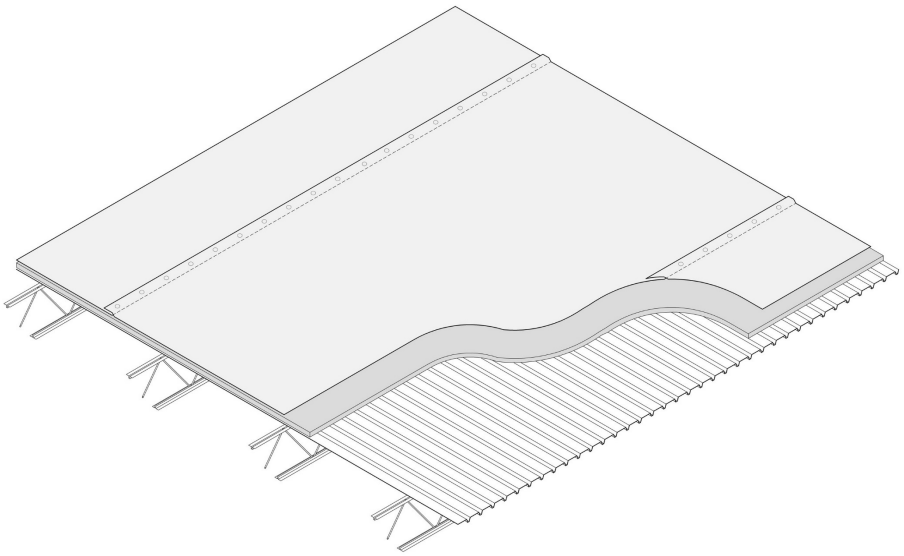
Membrane seams across deck flutes



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

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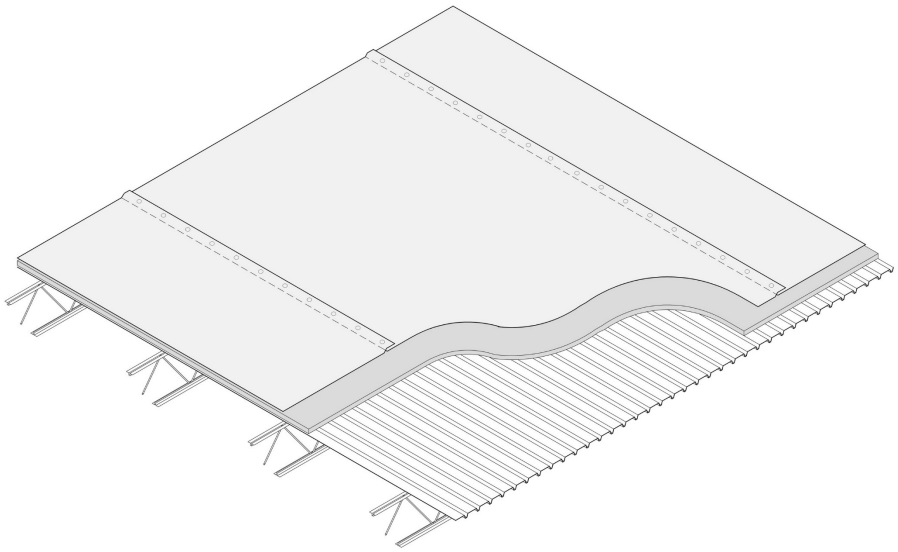
Membrane seams in deck flute direction



SDI: 12 X bending moment and shear (deck)

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SDI bulletin – Conclusion

2009 bulletin

"…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."

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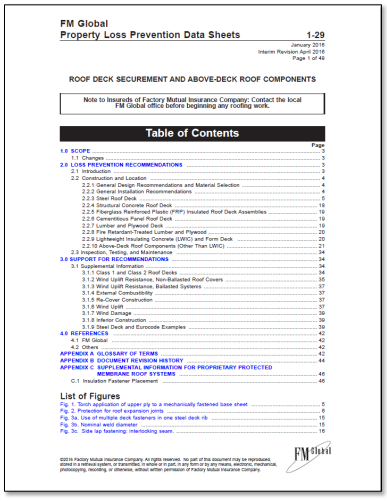
FM Global's Loss Prevention Data Sheet 1-29

April 2016



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.

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

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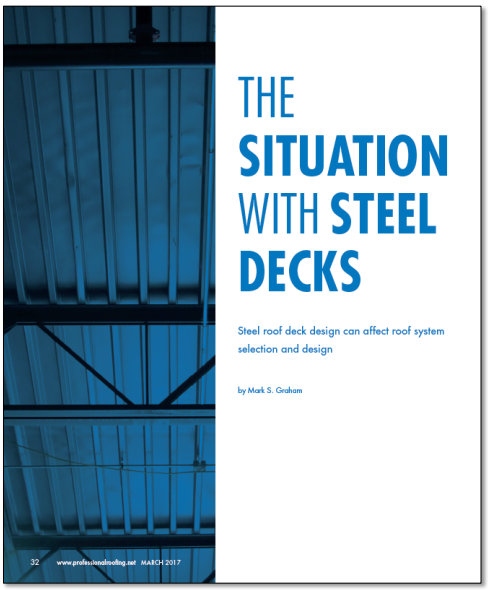

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March 2017
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Fastener pull-out tests…

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

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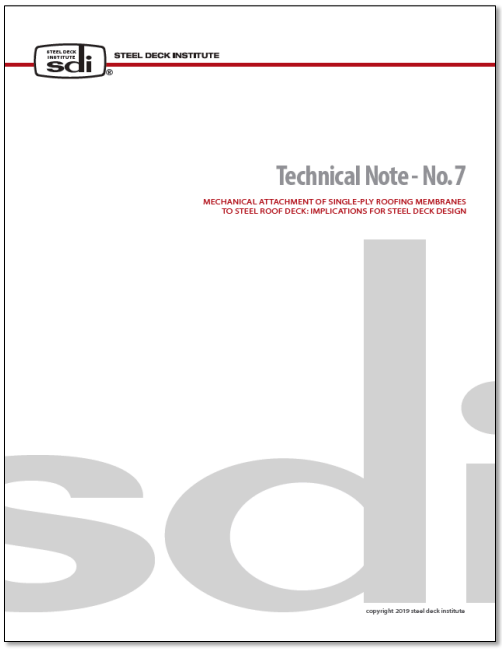

SDI Technical Note-No. 7 (Nov. 2019)

Mechanical attachment of single-ply roofing membranes to steel roof deck: Implications for steel deck design

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Technical Note - No. 7

Analysis of Steel Deck and Supports for Mechanically Attached Membrane Roofs

For both new construction, and recovering or reroofing, the following guidelines reflect generally accepted industry practice:

1. Analyze the deck as a continuous 3-span beam, unless shorter spans are used.
2. Utilize all load combinations required by the applicable building code.
3. For the design spacing of fastener lines, place the first uplift line load at the midspan of the first deck span, then continue to add line loads as applicable. Repeat as necessary to determine the maximum positive and negative bending moments.
4. To determine maximum uplift on deck securement fasteners and support framing, place a line load atop a support.

SDI Recommendations

1. The SDI does not recommend the use of roofing membranes attached to the steel deck using line patterns with large spacing (spacing greater than 1/2 of the deck span) unless a structural engineer has reviewed the adequacy of the steel deck and the structural supports to resist wind uplift loads transmitted along the lines of attachment.
2. When existing buildings with steel roof deck are recovered or reroofed with a mechanically attached membrane, a competent structural engineer should be engaged to determine the limitations imposed by the existing steel deck.
3. The lines of attachment for mechanically attached membranes shall only be perpendicular to the ribs of the deck. Membranes should not be attached with lines of fasteners parallel to the deck ribs.
4. Designers should require pre-construction submittals of membrane layouts to ensure that the lines of fasteners (direction and spacing) comply with structural design assumptions. Determination of membrane layouts should not be left to the option of field crews.

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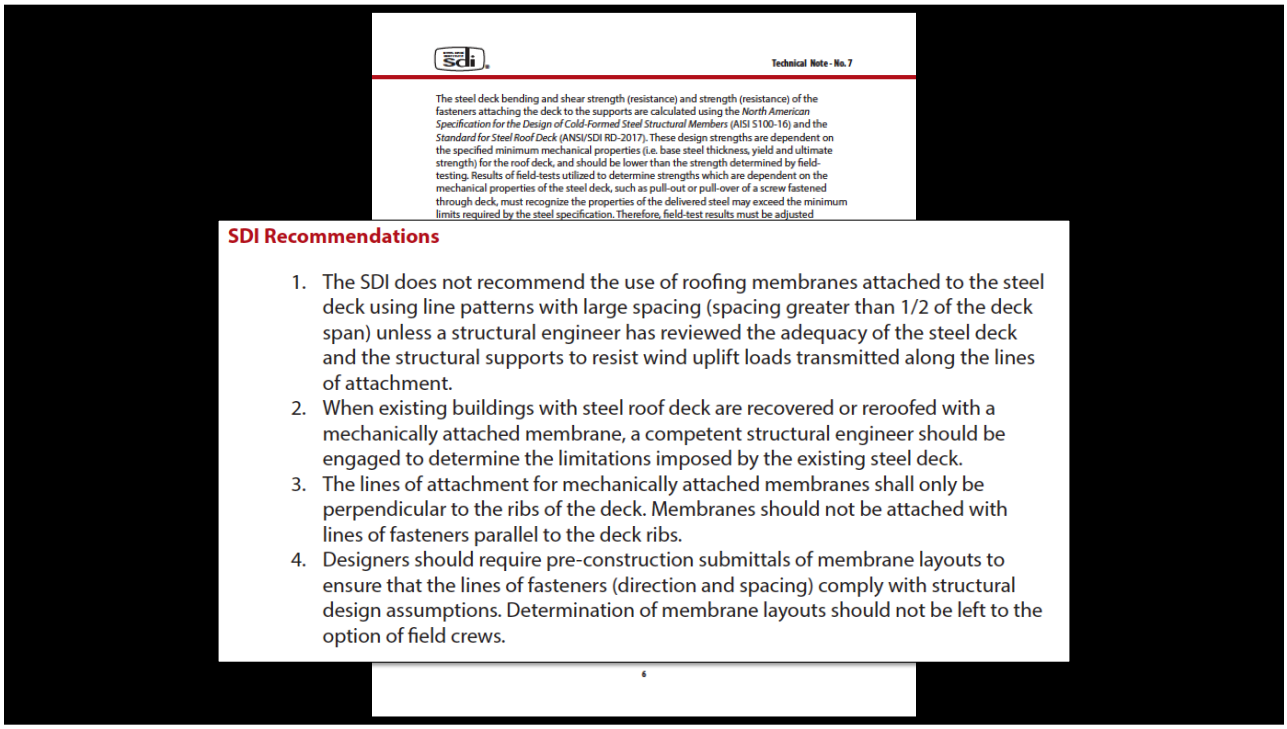

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Expect additional scrutiny of seam-fastened, mechanically-attached, single-ply membrane roof systems

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RESEARCH+TECH

Consider the deck

SDI provides additional guidance for steel roof deck designers

by Mark S. Graham

In November 2019, the Steel Deck Institute issued new guidance for steel roof decks that features seam-fastened, mechanically attached, single-ply membranes. Although this guidance is directed toward roof deck designers, single-ply membrane manufacturers and suppliers, roof system designers and roofing contractors also should be aware of SDI's latest guidelines.

Previous guidance

In May 2009, SDI issued a position statement, "Attachment of Roofing Membranes to Steel Deck," indicating seam-fastened, mechanically attached, single-ply membrane roof systems apply wind-uplift loads to roof decks differently than adhered membrane roof systems. Although adhered membrane roof systems apply uplift loads uniformly across a roof deck, seam-fastened membrane systems result in concentrated line loads along the deck. Such line loads can result in excess bending moment and shear applied to the deck or a doubling of uplift loads on specific structural supports (joists) depending on the orientation of the membrane sheets relative to the deck flutes and joists.

SDI's document goes on to recommend structural engineers should review the adequacy of steel roof decks and their underlying

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January 2020

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Questions… and other topics

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