Midwest Roofing Contractors Association

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Overland Park, Kansas

Update on current roofing industry technical issues

presented by

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National Roofing Contractors Association (NRCA)

NRCA

1

Topics

- MRCA/NRCA-joint research:
  - Fastener pull-out testing
  - MB sheet testing
- Steel roof decks/seam-fastened systems
- Moisture in concrete roof decks
- ASTM and ICC developments
- Questions

2

MRCA/NRCA-joint research:

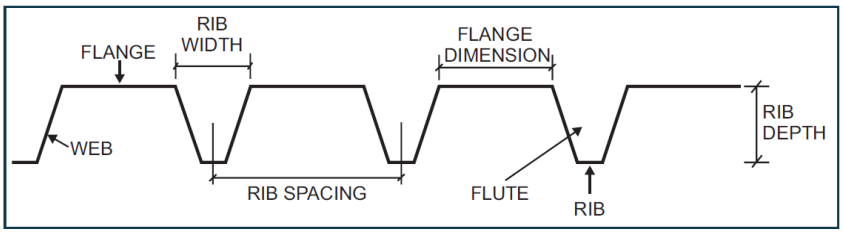
- Fastener pull-out testing
- MB sheet testing

3

Fastener pull-out testing

4

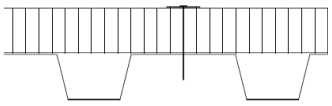
Terminology -- Steel roof decks



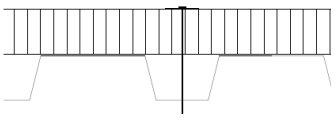
5

Tested fastener locations

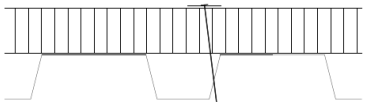
Fastener in flange



Fastener in rib



Fastener in web



6

Other test parameters

Steel deck types:

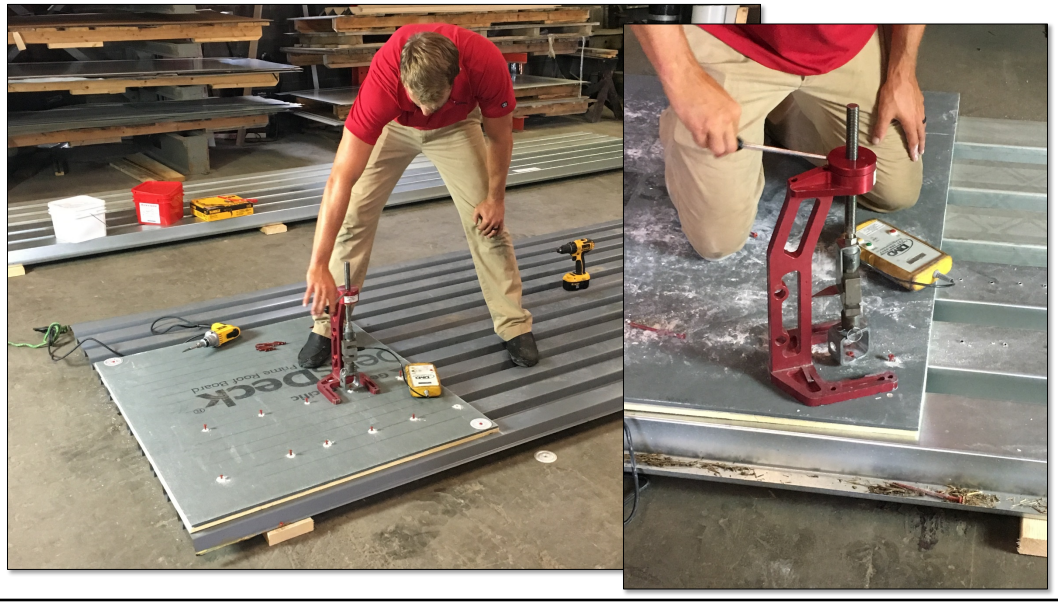
- 22 ga., 1½-in.-thick, Type B-deck
- 20 ga., 3-in.-thick, Type N-deck (Type 3DR)

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

7

Test set-up and equipment



8

Test data

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

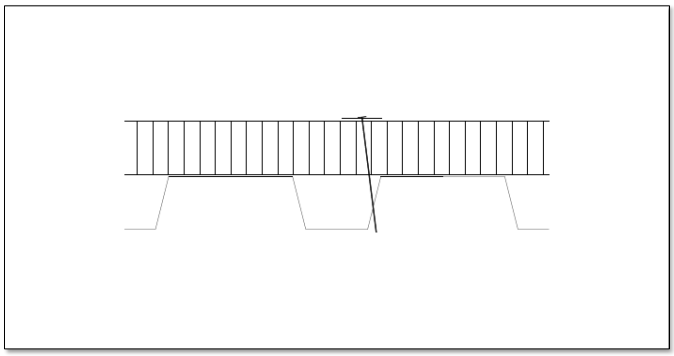
Fastener in flange	Fastener in rib	Fastener in web
637.4 lbf	561.1 lbf	556.2 lbf

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

9

Fastener in flute



10

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

11

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

12

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-outvalue

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

13

Conclusions

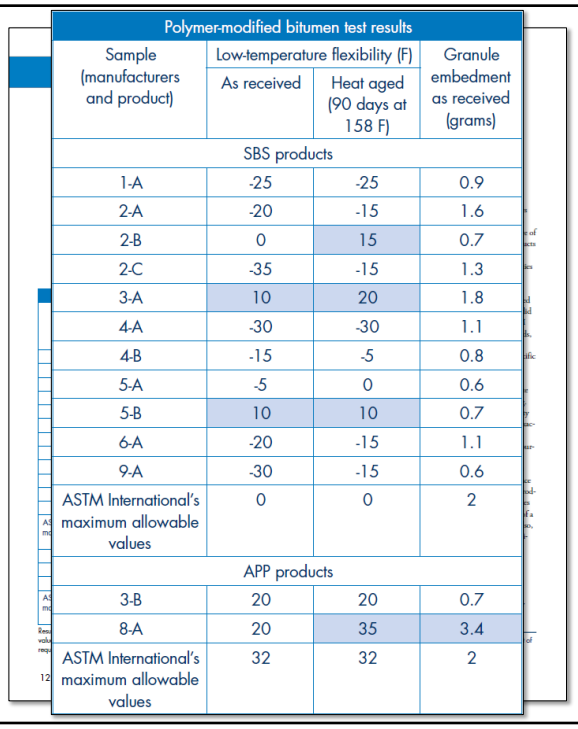
Fastener pull-out testing

- 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)

14

Polymer-modified bitumen sheet testing

15



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…

16

2011 testing

Only six of the 16 products tested complied….

17

2019 MB testing

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

18

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)

19

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)

20

Results – SBS products

2019 testing

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10-A	SBS	ASTM D6163, Type III, Grade G	Less than -40	1.16
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21

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)

22

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)

23

Summary of results

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

24

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

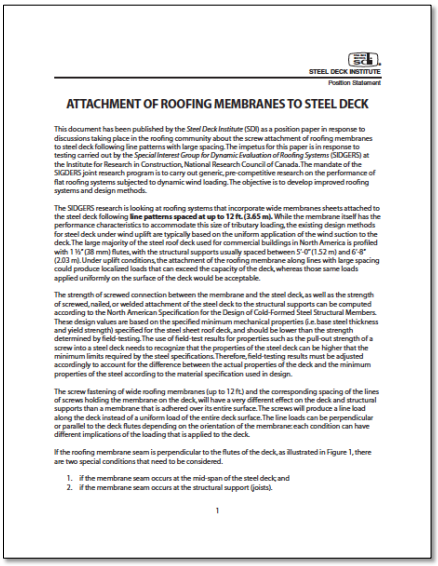
25

Steel roof decks/seam-fastened systems

26

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.

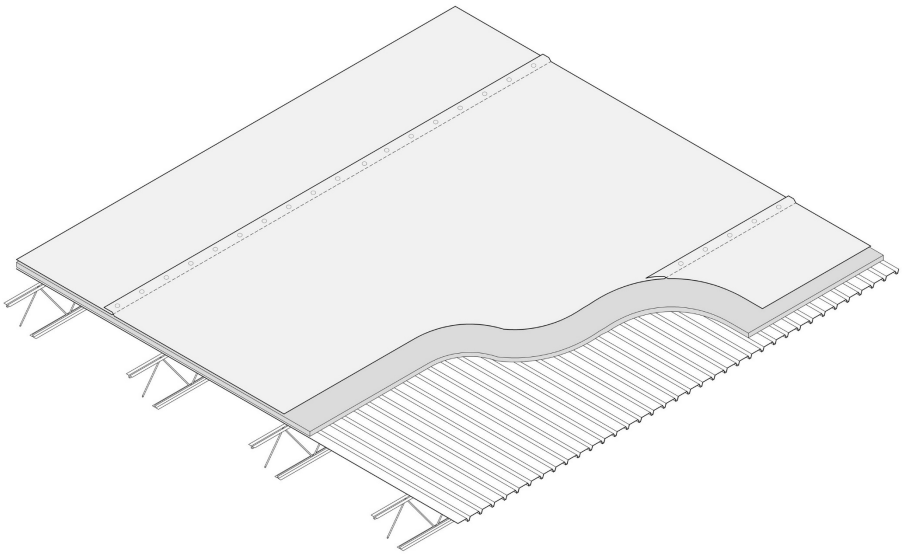
1. if the membrane seam occurs at the mid-span of the steel deck; and
2. if the membrane seam occurs at the structural support (joists).

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

27

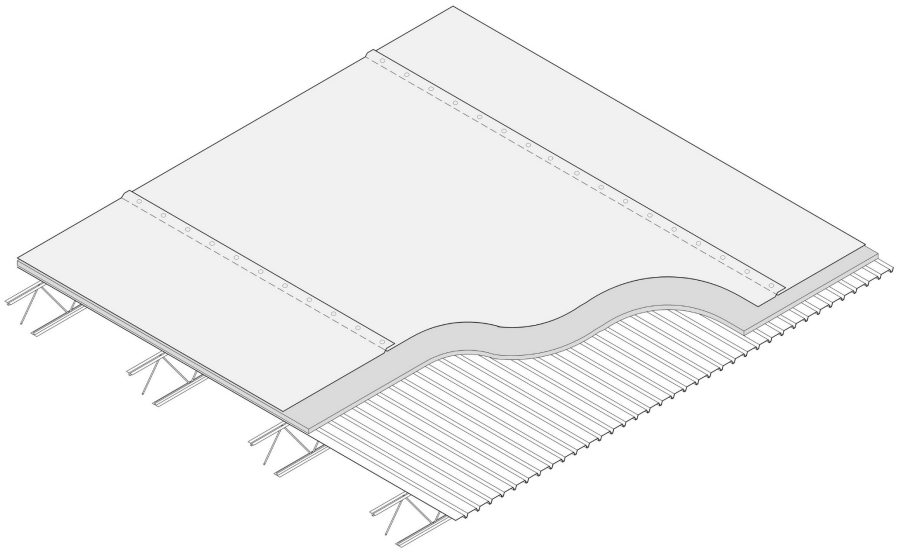
Membrane seams across deck flutes



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

28

Membrane seams in deck flute direction



SDI: 12 X bending moment and shear (deck)

29

SDI bulletin – Conclusion

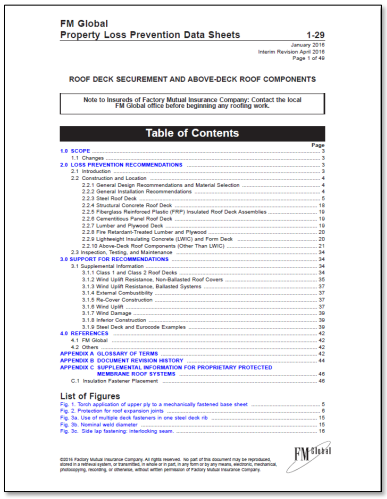
2009 bulletin

"…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."

30

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 46

ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS

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

Table of Contents

Page

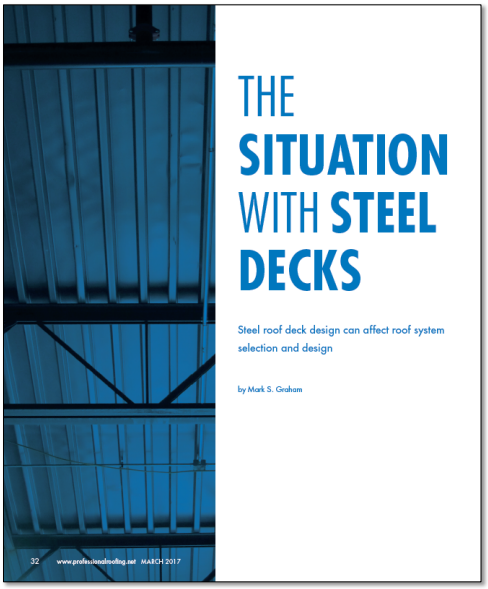
List of Figures

FM Global

Revised/new criteria:

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

31



THE SITUATION WITH STEEL DECKS

Steel roof deck design can affect roof system selection and design

by Mark S. Graham

32 www.professionalroofing.net MARCH 2017

Professional Roofing

March 2017

www.professionalroofing.net

32

Fastener pull-out tests…

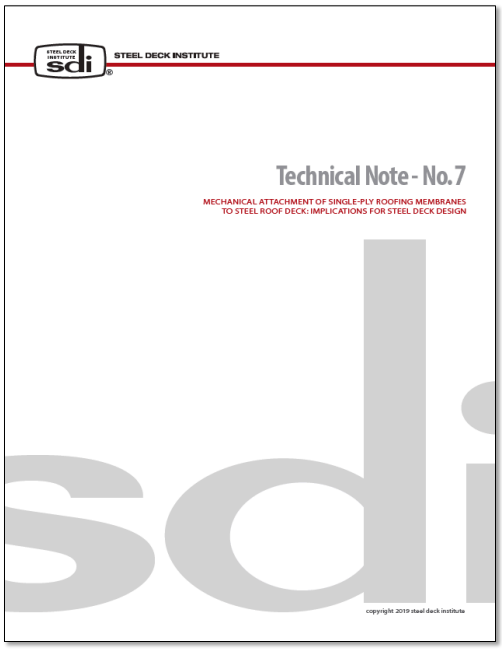
There is little correlation between fastener pull-out resistance and a steel roof deck's yield strength and uplift (bending) strength

33

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.

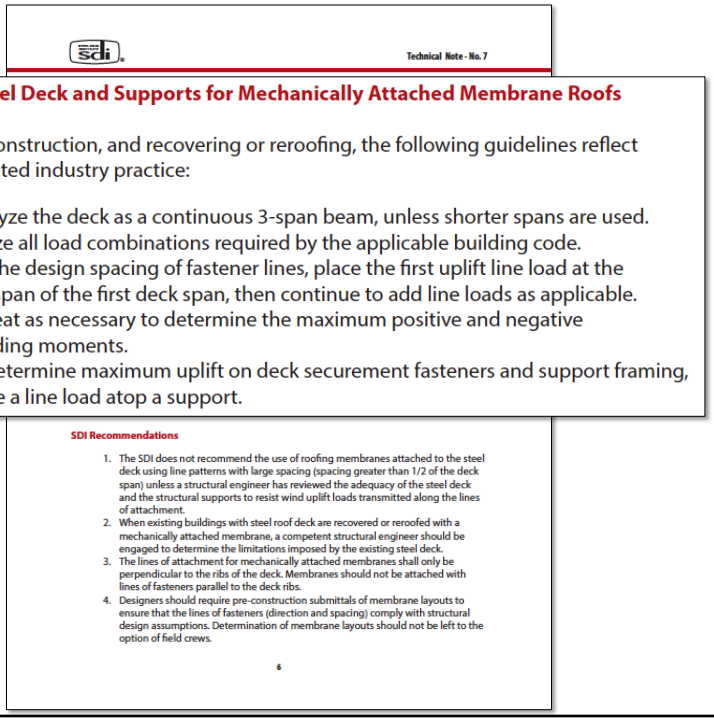
34



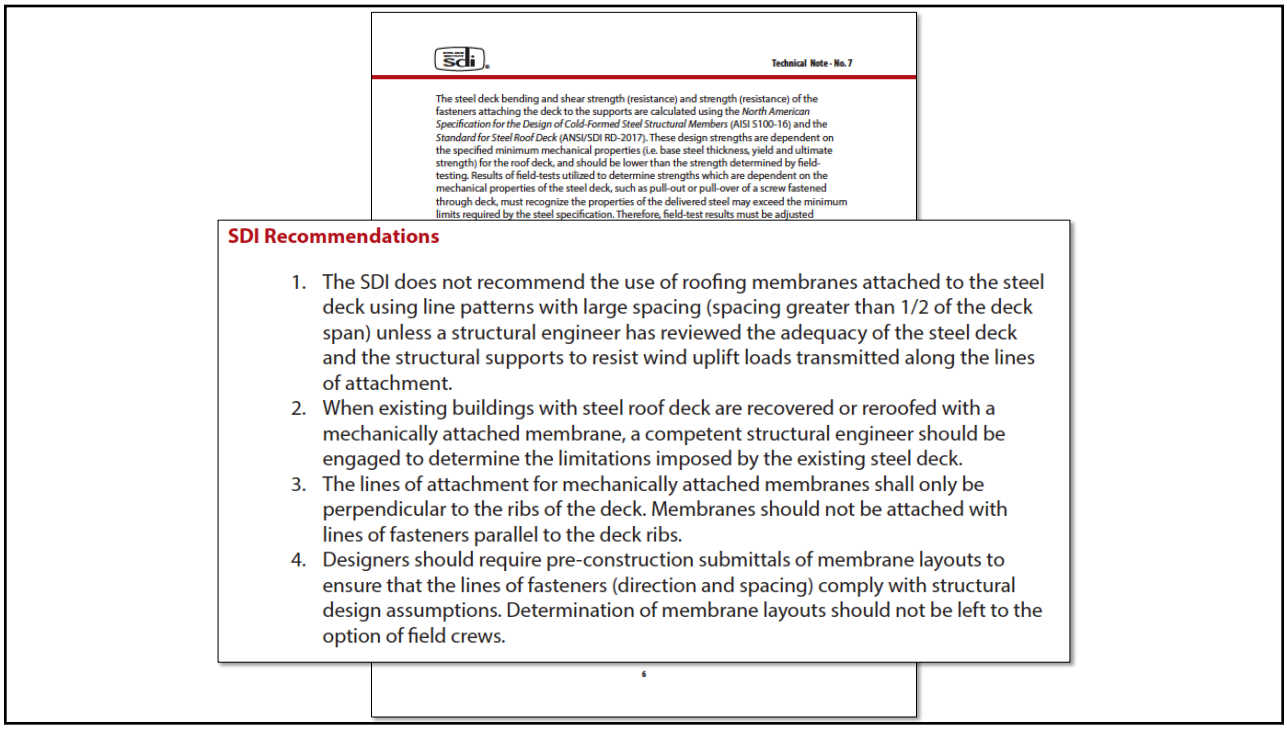
SDI Technical Note-No. 7 (Nov. 2019)

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

35



36



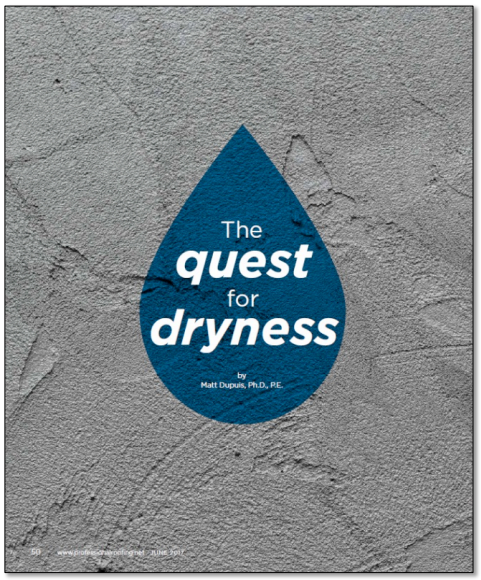
37

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

38

Moisture in concrete roof decks

39



Professional Roofing, June 2017

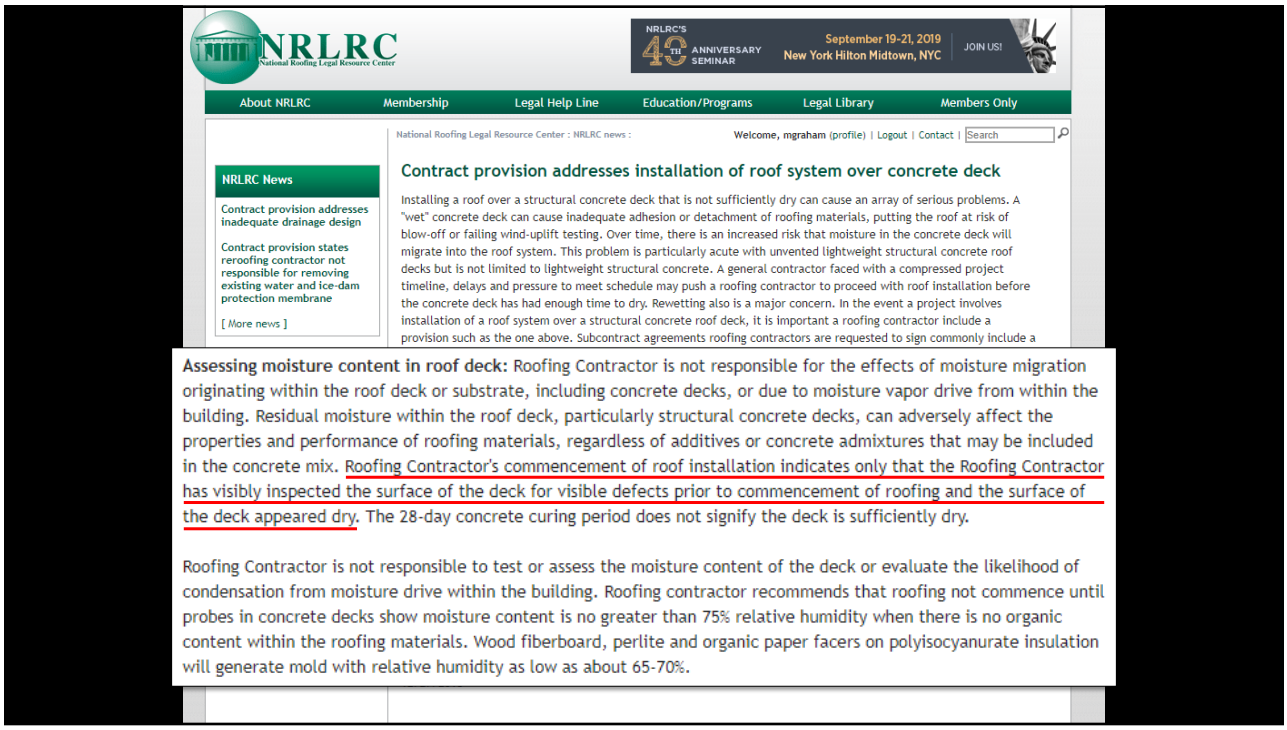
Professional Roofing, December 2018

40

What's next…

- January 2020: Results of MVRA testing
- February 2020: Updated recommendations:
  - Use a "very good" vapor retarder. What is very good?
  - Avoid roof system components with organic content
  - Deck dryness: 75% RH or less using ASTM F2178
  - Limit deck acceptance to visible conditions (e.g, surface moisture, broom clean)
  - Contract language limiting liability

41



42

ASTM and ICC developments

43

Questions…. and other topics

44

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45