Technical Issues in the Roofing Industry

Mark S. Graham, NRCA Vice President of Technical Services

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Material/product/system performance

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GAF Timberline shingle class action

- Manufacture dates:
  - 1999-2007: Mobile, AL plant
  - 1998-2009: All other GAF plants
- Objection/exclusion date:
  - March 16, 2015
- Final approval date:
  - April 23-24, 2015
- Additional information:
  - www.roofsettlement.com

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Hail issues

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Material/product availability concerns

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NRCA's 2014 polyiso. R-value testing

- Repeating similar NRCA testing from 2009
- Newly-manufactured (uninstalled) samples
  - 2.0-inch-thick
  - Permeable-facer-sheet faced
  - Obtained through distribution
- Nationally-recognized testing laboratory
- ASTM C518 tested "as received"
- Tested at 75 F, and 25 F, 40 F and 110 F

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NRCA's 2014 polyiso. R-value testing

Sample	R-value, per inch thickness (2-inch specimens)			
	25 F	40 F	75 F	110 F
1	3.765	4.757	5.774	5.118
2	3.909	4.719	5.444	4.958
3	4.737	5.350	5.371	4.810
4	3.506	4.509	5.828	5.227
5	4.221	5.269	5.522	4.929
6	3.775	4.854	5.889	5.247
7	4.431	4.878	5.058	4.581
Ave. (mean)	4.049	4.905	5.555	4.981
Std. dev.	0.432	0.302	0.297	0.239

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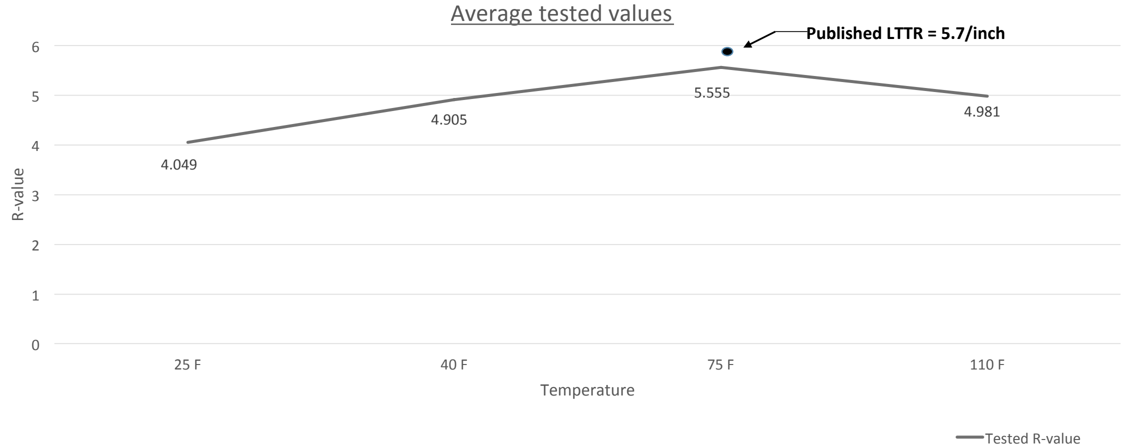
NRCA's 2014 polyiso. R-value testing

Average tested values



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NRCA's recommendations

Polyisocyanurate insulation

Designers should use in-service R-values:

- Heating conditions: R=5.0 per inch thickness
- Cooling conditions: R=5.6 per inch thickness

Specify insulation by its thickness,
not its R-value or LTTR value

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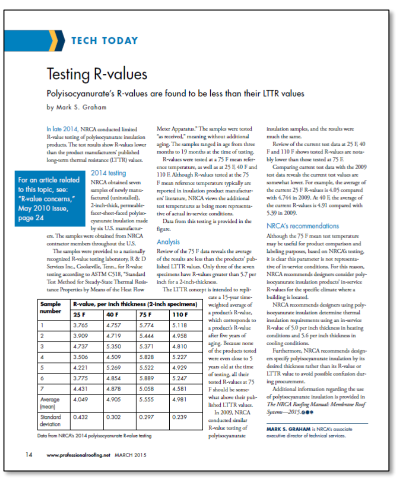

TECH TODAY

Testing R-values

Polyisocyanurate's R-values are found to be less than their LTTR values

by Mark S. Graham

In late 2014, NRCA conducted limited R-value testing of polyisocyanurate insulation products. The test results show R-values lower than the product manufacturers' published long-term thermal resistance (LTTR) values.

For an article related to this topic, see: "R-value concerns," May 2010 issue, page 24

2014 testing

NRCA obtained seven samples of newly manufactured (uninstalled), 2-inch-thick, permeable-facer-sheet-faced polyisocyanurate insulation made by six U.S. manufacturers. The samples were obtained from NRCA contractor members throughout the U.S.

The samples were provided to a nationally recognized R-value testing laboratory, R & D Services Inc., Cookeville, Tenn., for R-value testing according to ASTM C518, "Standard Test Method for Steady-State Thermal Resistance Properties by Means of the Heat Flow Meter Apparatus." The samples were tested "as received," meaning without additional aging. The samples ranged in age from three months to 19 months at the time of testing.

R-values were tested at a 75 F mean reference temperature, as well as at 25 F, 40 F and 110 F. Although R-values tested at the 75 F mean reference temperature typically are reported in insulation product manufacturers' literature, NRCA views the additional test temperatures as being more representative of actual in-service conditions.

Data from this testing is provided in the figure.

Analysis

Review of the 75 F data reveals the average of the results are less than the products' published LTTR values. Only three of the seven specimens have R-values greater than 5.7 per inch for a 2-inch-thickness.

The LTTR concept is intended to replicate a 15-year time-weighted average of a product's R-value, which corresponds to a product's R-value after five years of aging. Because none of the products tested were even close to 5 years old at the time of testing, all their tested R-values at 75 F should be somewhat above their published LTTR values.

In 2009, NRCA conducted similar R-value testing of polyisocyanurate insulation samples, and the results were much the same.

Review of the current test data at 25 F, 40 F and 110 F shows tested R-values are notably lower than those tested at 75 F.

Comparing current test data with the 2009 test data reveals the current test values are somewhat lower. For example, the average of the current 25 F R-values is 4.05 compared with 4.744 in 2009. At 40 F, the average of the current R-values is 4.91 compared with 5.39 in 2009.

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Data from NRCA's 2014 polyisocyanurate R-value testing

NRCA's recommendations

Although the 75 F mean test temperature may be useful for product comparison and labeling purposes, based on NRCA's testing, it is clear this parameter is not representative of in-service conditions. For this reason, NRCA recommends designers consider polyisocyanurate insulation products' in-service R-values for the specific climate where a building is located.

NRCA recommends designers using polyisocyanurate insulation determine thermal insulation requirements using an in-service R-value of 5.0 per inch thickness in heating conditions and 5.6 per inch thickness in cooling conditions.

Furthermore, NRCA recommends designers specify polyisocyanurate insulation by its desired thickness rather than its R-value or LTTR value to avoid possible confusion during procurement.

Additional information regarding the use of polyisocyanurate insulation is provided in *The NRCA Roofing Manual: Membrane Roof Systems—2015.*

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

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Steel deck design

Prior to 2010:

- SDI's *Design Manual for Composite Decks, Form Decks and Roof Decks*
- ANSI/SDI RD1.0-2006, "Standard for Steel Roof Deck" (referenced in IBC 2009)

30-pound-per-square-foot (psf) uplift
and 45-psf uplift at roof overhangs

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Steel deck design

Since 2010:

- ANSI/SDI RD1.0-2010, "Standard for Steel Roof Deck" (referenced in IBC 2012 and IBC 2015)

"… be anchored to resist the required net uplift forces,
<u>but not less than</u>…" 30 psf and 45 psf for eave overhangs

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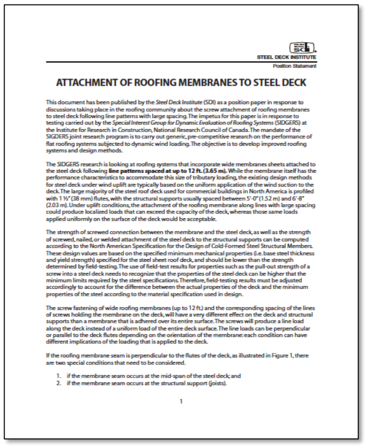
SDI bulletin



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

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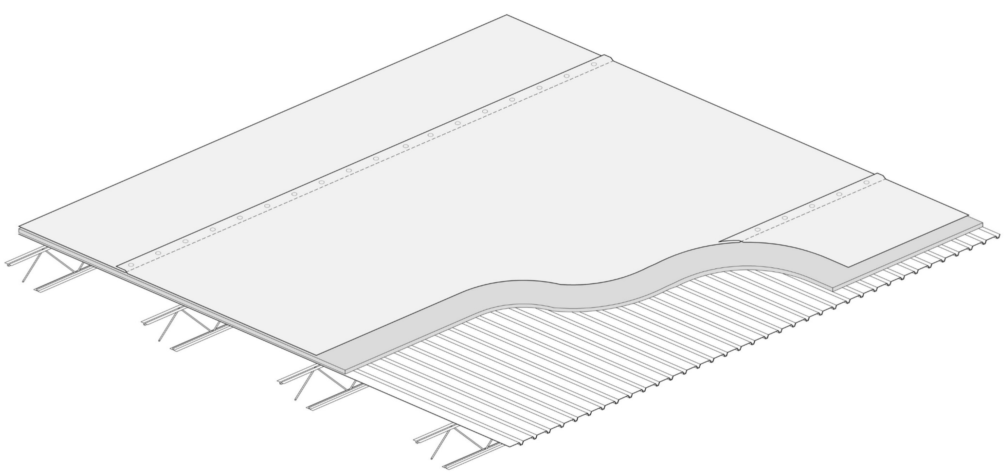
Membrane seams across deck flutes



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

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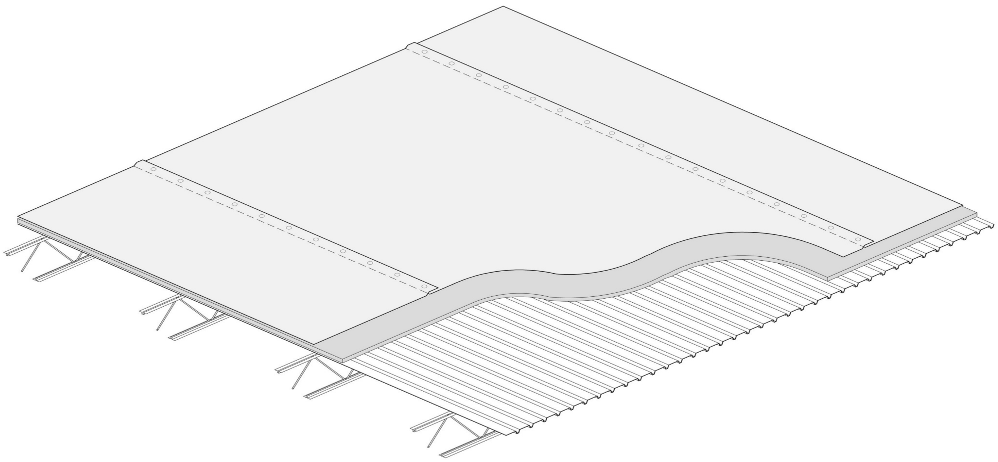
Membrane seams in deck flute direction



SDI: 12 X bending moment and shear (deck)

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SDI bulletin -- Conclusion

"…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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NRCA's recommendations

- Beware of the situation
- Roof system designers should not rely on "excess capacity" in steel roof decks
- Be cautious of "accepting" responsibility for the roof deck; use NRLRC recommended proposal/contract language
- Better communication is needed between roof system designers and roof deck designers

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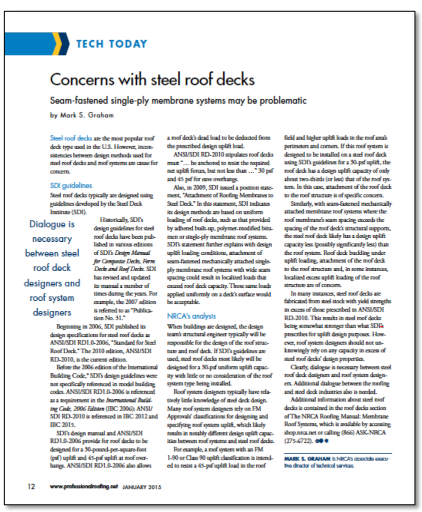

TECH TODAY

Concerns with steel roof decks

Seam-fastened single-ply membrane systems may be problematic

by Mark S. Graham

Steel roof decks are the most popular roof deck type used in the U.S. However, inconsistencies between design methods used for steel roof decks and roof systems are cause for concern.

SDI guidelines

Steel roof decks typically are designed using guidelines developed by the Steel Deck Institute (SDI).

Dialogue is necessary between steel roof deck designers and roof system designers

Historically, SDI's design guidelines for steel roof decks have been published in various editions of SDI's *Design Manual for Composite Decks, Form Decks and Roof Decks*. SDI has revised and updated its manual a number of times during the years. For example, the 2007 edition is referred to as "Publication No. 31."

Beginning in 2006, SDI published its design specifications for steel roof decks as ANSI/SDI RD1.0-2006, "Standard for Steel Roof Deck." The 2010 edition, ANSI/SDI RD-2010, is the current edition.

Before the 2006 edition of the International Building Code," SDI's design guidelines were not specifically referenced in model building codes. ANSI/SDI RD1.0-2006 is referenced as a requirement in the *International Building Code, 2006 Edition* (IBC 2006); ANSI/SDI RD-2010 is referenced in IBC 2012 and IBC 2015.

SDI's design manual and ANSI/SDI RD1.0-2006 provide for roof decks to be designed for a 30-pound-per-square-foot (psf) uplift and 45-psf uplift at roof overhangs. ANSI/SDI RD1.0-2006 also allows a roof deck's dead load to be deducted from the prescribed design uplift load.

ANSI/SDI RD-2010 stipulates roof decks must "... be anchored to resist the required net uplift forces, but not less than ..." 30 psf and 45 psf for eave overhangs.

Also, in 2009, SDI issued a position statement, "Attachment of Roofing Membranes to Steel Deck." In this statement, SDI indicates its design methods are based on uniform loading of roof decks, such as that provided by adhered built-up, polymer-modified bitumen or single-ply membrane roof systems. SDI's statement further explains with design uplift loading conditions, attachment of seam-fastened mechanically attached single-ply membrane roof systems with wide seam spacing could result in localized loads that exceed roof deck capacity. Those same loads applied uniformly on a deck's surface would be acceptable.

NRCA's analysis

When buildings are designed, the design team's structural engineer typically will be responsible for the design of the roof structure and roof deck. If SDI's guidelines are used, steel roof decks most likely will be designed for a 30-psf uniform uplift capacity with little or no consideration of the roof system type being installed.

Roof system designers typically have relatively little knowledge of steel deck design. Many roof system designers rely on FM Approvals' classifications for designing and specifying roof system uplift, which likely results in notably different design uplift capacities between roof systems and steel roof decks.

For example, a roof system with an FM 1-90 or Class 90 uplift classification is intended to resist a 45-psf uplift load in the roof field and higher uplift loads in the roof area's perimeters and corners. If this roof system is designed to be installed on a steel roof deck using SDI's guidelines for a 30-psf uplift, the roof deck has a design uplift capacity of only about two-thirds (or less) that of the roof system. In this case, attachment of the roof deck to the roof structure is of specific concern.

Similarly, with seam-fastened mechanically attached membrane roof systems where the roof membrane's seam spacing exceeds the spacing of the roof deck's structural supports, the steel roof deck likely has a design uplift capacity less (possibly significantly less) than the roof system. Roof deck buckling under uplift loading, attachment of the roof deck to the roof structure and, in some instances, localized excess uplift loading of the roof structure are of concern.

In many instances, steel roof decks are fabricated from steel stock with yield strengths in excess of those prescribed in ANSI/SDI RD-2010. This results in steel roof decks being somewhat stronger than what SDI's prescribes for uplift design purposes. However, roof system designers should not unknowingly rely on any capacity in excess of steel roof decks' design properties.

Clearly, dialogue is necessary between steel roof deck designers and roof system designers. Additional dialogue between the roofing and steel deck industries also is needed.

Additional information about steel roof decks is contained in the roof decks section of The NRCA Roofing Manual: Membrane Roof Systems, which is available by accessing shop.nrca.net or calling (866) ASK-NRCA (275-6722).

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

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Consider adding contract provisions

"Roofing Contractor's commencement of the roof installation indicates only that the Roofing Contractor has visually inspected the surface of the roof deck for visible defects and has accepted the surface of the roof deck. Roofing Contractor is not responsible for the construction, structural sufficiency, durability, fastening, moisture content, suitability, or physical properties of the roof deck or other trades' work or design. Roofing Contractor is not responsible to test or assess moisture content of the deck or substrate."

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Additional topics

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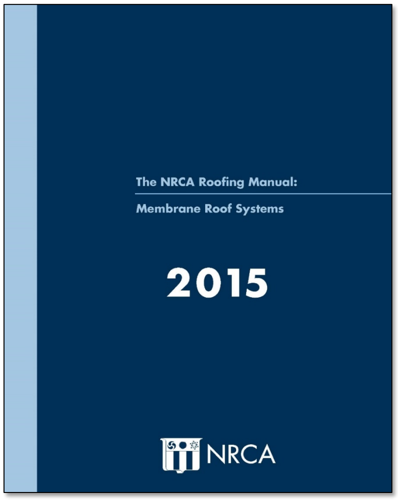
The NRCA Roofing Manual



NRCA's best practice guidelines

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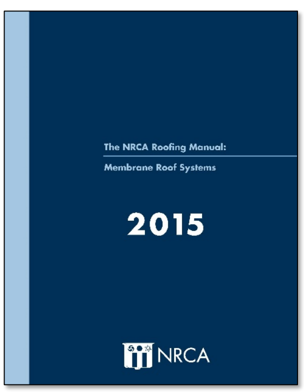
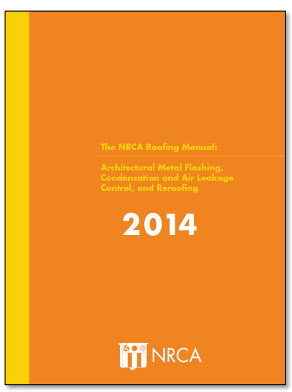
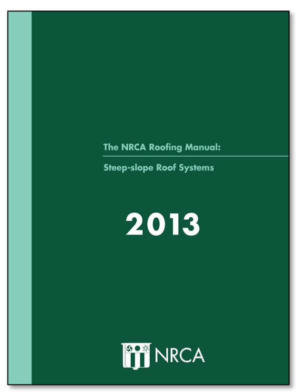
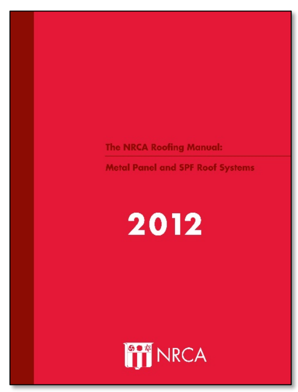
The NRCA Roofing Manual









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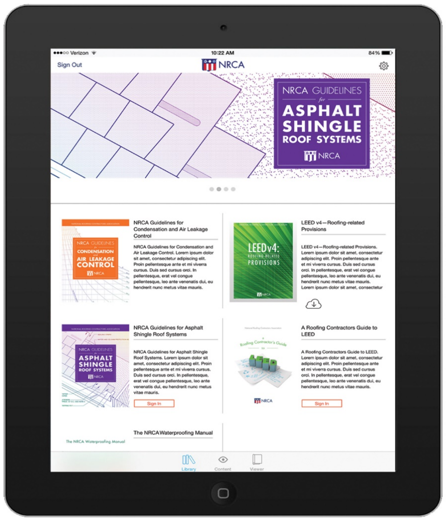

- NRCA App available on the Apple Store and Google Play Store for tablets
- iPhone App available in Summer
- Register within App as being an NRCA member
- The NRCA Roofing Manual is viewable to NRCA members
- Favorite and send pages features

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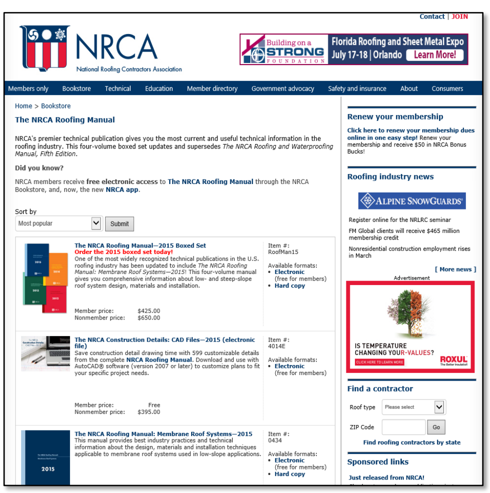
Manual online

www.nrca.net



- Available to all NRCA member registered users (multiple users per member company)
- “Members only” section, click on “My account”, the “Electronic file”
- View, download and print

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NRCA

Testing R-values

Polyisocyanurate's R-values are found to be less than their LTTR values

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Seam-fastened single-ply membrane systems may be problematic

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Dialogue is necessary between steel roof deck designers and roof system designers

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