NRCA Roofing Industry Regional Summit
Wednesday, April 29, 2015 – Pampano Beach, FL

Technical issues & update

Mark S. Graham
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National Roofing Contractors Association (NRCA)

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Topics

- FBC 2014
- Polyiso. R-value testing
- Deck issues:
  - Normal- and lightweight structural concrete
  - Steel
- Asphalt
- Asphalt shingles

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Florida Building Code 2014

- 2014 Edition
- Based upon IBC 2012 with FL-specific amendments (including HVHZ)
- 6/30/15 effective date

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In a cooling climate

10,000 sq. ft. single-story building in Miami, FL

R-value increase	Annual Btu savings	Payback time
R-10 to R-15	14,094,020 Btu	10.8 years
R-15 to R-20	7,870,571 Btu	22.1 years
R-20 to R-25	4,561,644 Btu	35.4 years
R-25 to R-30	3,232,756 Btu	76.7 years

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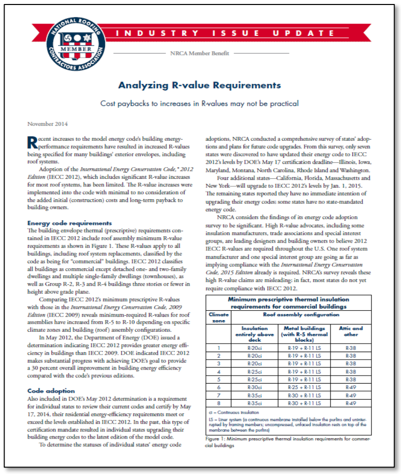
Is there a realistic payback?


INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Analyzing R-value Requirements

Cost paybacks to increases in R-values may not be practical

November 2014

NRCA "Industry Issue Update," Nov. 2014:

- R-15 to R-20: 14 to 24 yrs.
- R-20 to R-25: 26 to 63 yrs.
- R-25 to R-30: 48 to 133 yrs.

Average roof life is 17.4 yrs.

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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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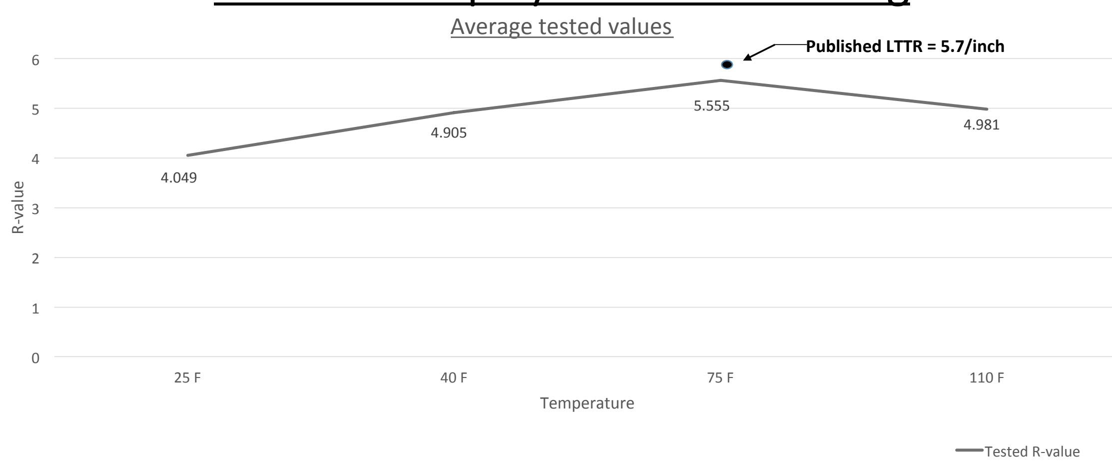
NRCA's 2014 polyiso. R-value testing



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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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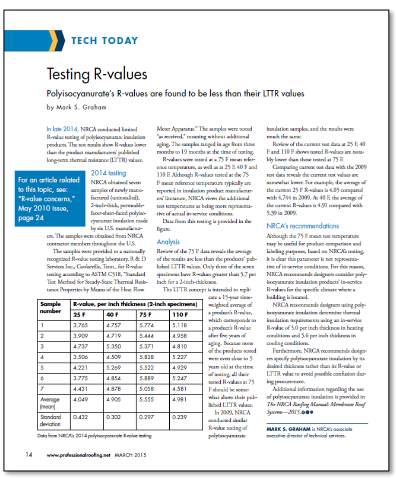

TECH TODAY

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.

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.*

Sample number	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
Average (mean)	4.049	4.905	5.555	4.981
Standard deviation	0.432	0.302	0.297	0.239

Data from NRCA's 2014 polyisocyanurate R-value testing

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

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March 2015

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Concrete roof decks

Roofing-related reported problems

- Moisture within the roof system
- Loss of adhesion
- Insulation facer delamination
- Adhesive curing issues
- Mold growth
- Fastener/metal corrosion
- R-value loss

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Concrete drying rates[1]

- Normal-weight structural concrete:
  - Less than 90 days
- Light-weight structural concrete:
  - Almost 6 months

[1] Howard Kanare, "Concrete Floors and Moisture, Second Edition," 75 percent internal RH, controlled laboratory conditions

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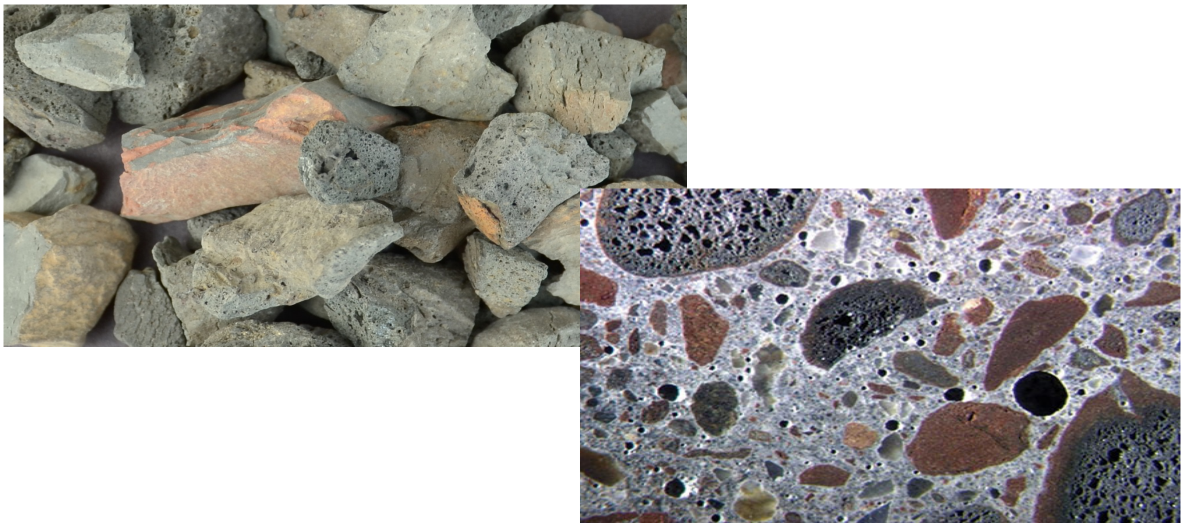
An up-close look



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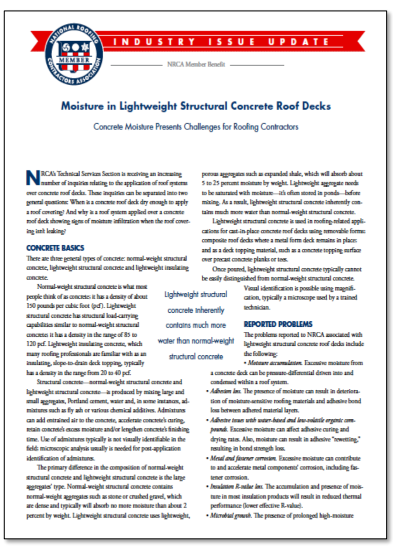
Industry Issue Update, August 2013



INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Moisture in Lightweight Structural Concrete Roof Decks

Concrete Moisture Presents Challenges for Roofing Contractors

NRCA's Technical Services Section is receiving an increasing number of inquiries relating to the application of roof systems over concrete roof decks. These inquiries can be separated into two general questions: When is a concrete roof deck dry enough to apply a roof covering? And why is a roof system applied over a concrete roof deck showing signs of moisture infiltration when the roof covering isn't leaking?

CONCRETE BASICS

There are three general types of concrete: normal-weight structural concrete, lightweight structural concrete and lightweight insulating concrete.

Normal-weight structural concrete is what most people think of as concrete; it has a density of about 150 pounds per cubic foot (pcf). Lightweight structural concrete has structural load-carrying capabilities similar to normal-weight structural concrete; it has a density in the range of 85 to 120 pcf. Lightweight insulating concrete, which many roofing professionals are familiar with as an insulating, slope-to-drain deck topping, typically has a density in the range from 20 to 40 pcf.

Structural concrete—normal-weight structural concrete and lightweight structural concrete—is produced by mixing large and small aggregates, Portland cement, water and, in some instances, admixtures such as fly ash or various chemical additives. Admixtures can add entrained air to the concrete, accelerate concrete's curing, retain concrete's excess moisture and/or lengthen concrete's finishing time. Use of admixtures typically is not visually identifiable in the field; microscopic analysis usually is needed for post-application identification of admixtures.

The primary difference in the composition of normal-weight structural concrete and lightweight structural concrete is the large aggregates' type. Normal-weight structural concrete contains normal-weight aggregates such as stone or crushed gravel, which are dense and typically will absorb no more moisture than about 2 percent by weight. Lightweight structural concrete uses lightweight, porous aggregates such as expanded shale, which will absorb about 5 to 25 percent moisture by weight. Lightweight aggregate needs to be saturated with moisture—it's often stored in ponds—before mixing. As a result, lightweight structural concrete inherently contains much more water than normal-weight structural concrete.

Lightweight structural concrete is used in roofing-related applications for cast-in-place concrete roof decks using removable forms; composite roof decks where a metal form deck remains in place; and as a deck topping material, such as a concrete topping surface over precast concrete planks or tees.

Once poured, lightweight structural concrete typically cannot be easily distinguished from normal-weight structural concrete. Visual identification is possible using magnification, typically a microscope used by a trained technician.

Lightweight structural concrete inherently contains much more water than normal-weight structural concrete

REPORTED PROBLEMS

The problems reported to NRCA associated with lightweight structural concrete roof decks include the following:

- *Moisture accumulation.* Excessive moisture from a concrete deck can be pressure-differential driven into and condensed within a roof system.
- *Adhesion loss.* The presence of moisture can result in deterioration of moisture-sensitive roofing materials and adhesive bond loss between adhered material layers.
- *Adhesive issues with water-based and low-volatile organic compounds.* Excessive moisture can affect adhesive curing and drying rates. Also, moisture can result in adhesive "rewetting," resulting in bond strength loss.
- *Metal and fastener corrosion.* Excessive moisture can contribute to and accelerate metal components' corrosion, including fastener corrosion.
- *Insulation R-value loss.* The accumulation and presence of moisture in most insulation products will result in reduced thermal performance (lower effective R-value).
- *Microbial growth.* The presence of prolonged high-moisture

NRCA's recommendations:

- Designers should avoid using light-weight structural concrete for roof decks
- Remedial system configurations for retrofit applications

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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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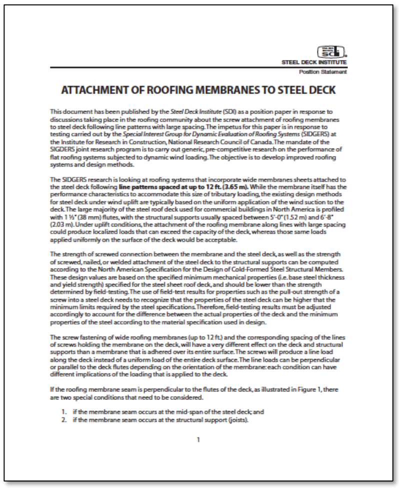
SDI bulletin



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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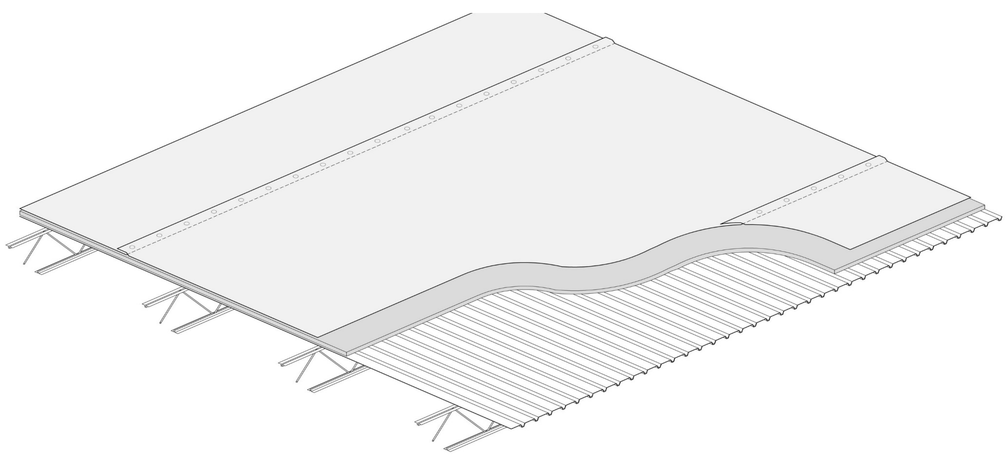
Membrane seams across deck flutes



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

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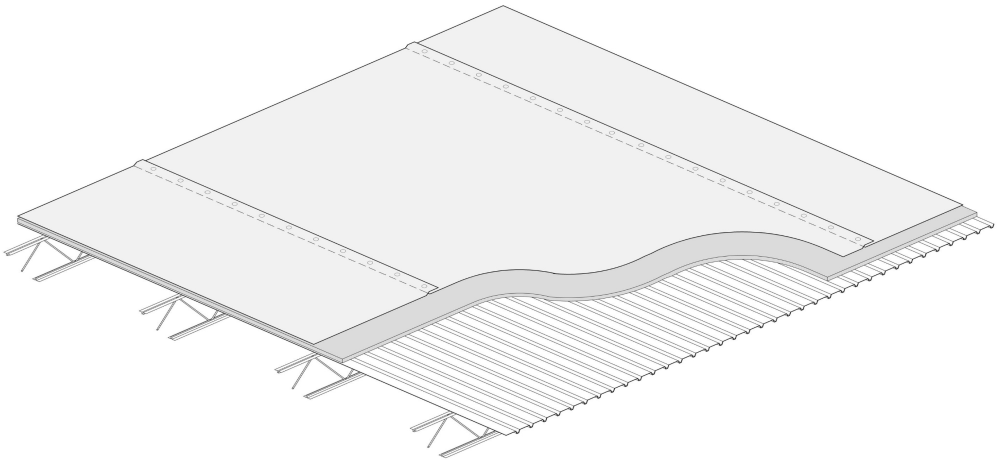
Membrane seams in deck flute direction



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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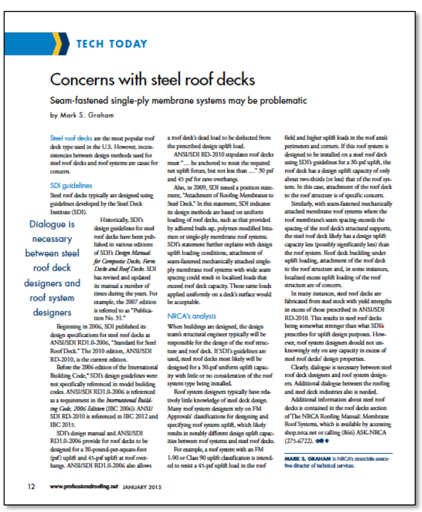

TECH TODAY

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 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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January 2015

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Consider adding contract provisions

NRLRC
National Roofing Legal Resource Center

"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."

NRLRC Member Benefit

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Revision to ASTM D312

Published as ASTM D312-15

- Maximum heating temp.: 550 F (575 F min. FP)
- Maximum EVTs:
  - Type III (mop) 430 F
  - Type III (spreader) 455 F
  - Type IV (mop) 470 F
  - Type IV (spreader) 485 F
- Lot-specific package labeling of EVT

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NRCA's recommendations

Mopping asphalt

- Seek out asphalt complying with ASTM D312-15
- Consider asking for certificates of compliance
- Do not overheat asphalt
  - 550 F maximum kettle/tanker temperature
- Apply at EVT (BUR application)
- Make field crews aware
- Contact NRCA with any questions or issues

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TECH TODAY

An updated standard

ASTM International revises its product standard for asphalt

by Mark S. Graham

In December 2014, ASTM International revised and updated its product standard applicable to oxidized roofing asphalt, ASTM D312, "Standard Specification for Asphalt Used in Roofing."

Earlier editions

ASTM D312 originally was developed, approved and published in 1929. In 1978, ASTM D312-78 was updated from its 1971 edition and reformatted into its current format. The softening point ranges for ASTM D312-78's Type III and Type IV asphalts increased by 5 degrees Fahrenheit from the 1971 edition's to 185 F to 205 F for Type III asphalt and 210 F to 225 F for Type IV asphalt; these ranges still apply in ASTM D312's current edition.

Did you KNOW? NRCA maintains past editions of ASTM D312 dating to 1971. If you have editions of ASTM D312 from 1929 to 1964, please contact Mark Graham, NRCA's associate executive director of technical services, at (800) 323-9545, ext. 7511 or mgraham@nrca.net.

ASTM D312's 1971 and 1978 editions established asphalt's minimum flash point temperature as 437 F.

With ASTM D312-84, asphalt's minimum flash point temperature increased to 475 F. Other physical properties (softening point, penetration, ductility and solubility) remained unchanged.

In 1989, ASTM International added a nonmandatory application guide to ASTM D312-89 indicating: "Asphalt should be applied within the EVT range. …" At this point, ASTM D312 did not require asphalt suppliers to test for nor provide labeling of an asphalt's equiviscous temperature (EVT).

ON the WEB: For a link to NRCA's Industry Issue Update, log on to www.professionalroofing.net.

In 1995, a statement was added to ASTM D312-95's packaging and marking requirements indicating asphalt's flash point temperature and EVT for mop and mechanical spreader application need to be provided by asphalt suppliers on package labeling or bills of lading. ASTM D312-95 did not specify a test method for determining EVT.

In 2000, ASTM International increased asphalt's minimum flash point temperature to 500 F. Also, the organization deleted nonmandatory slope guidelines contained in ASTM D312's previous editions; these were moved to ASTM D6510, "Standard Guide for Selection of Asphalt Used in Built-Up Roofing Systems."

ASTM D312-00 was reapproved in 2006 and remained in place until its December 2014 revision.

ASTM D312-15

The December 2014 revision of ASTM D312 is published as ASTM D312-15. This latest edition includes the following revisions and additions:

- A maximum asphalt kettle temperature of 550 F
- A change in asphalt's minimum flash point temperature to 575 F
- Establishment of ASTM D4402, "Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer," as the basis for determining EVT
- Establishment of maximum EVT values for Type III asphalt of 430 F (mop application) and 470 F (mechanical spreader application) and Type IV asphalt of 455 F (mop application) and 485 F (mechanical spreader application)
- A requirement that asphalt suppliers provide lot-specific EVTs for mop and mechanical spreader application on asphalt package labeling or bills of lading for bulk shipments

The establishment of a 550 F maximum kettle temperature and maximum EVT values should result in lowering asphalts' kettle (and tanker) heating temperatures.

These revisions were developed by NRCA and the Asphalt Roofing Manufacturers Association in recognition of current crude source availability, refining practices and NRCA's best-practice application guidelines while considering current safety and health practices. Additional background information is provided in the NRCA members-only publication Industry Issue Update, "Asphalt Health and Safety," May 2014.

Implementation

If you specify, supply or install mop-applied asphalt roofing materials, NRCA encourages you to use asphalt that complies with ASTM D312-15.

Furthermore, NRCA now recommends consideration be given to specifying and using asphalt suppliers' proprietary "low-fuming" asphalt formulations. Asphalts' low-fuming additives are not currently addressed (or excluded) within ASTM D312-15 and, therefore, need to be specifically requested in addition to specifying ASTM D312-15.

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

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Professional Roofing, February 2015

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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
- Additional information:
  - www.roofsettlement.com

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