NRCA University Webinar
December 8, 2016

Roofing Industry Technical Update

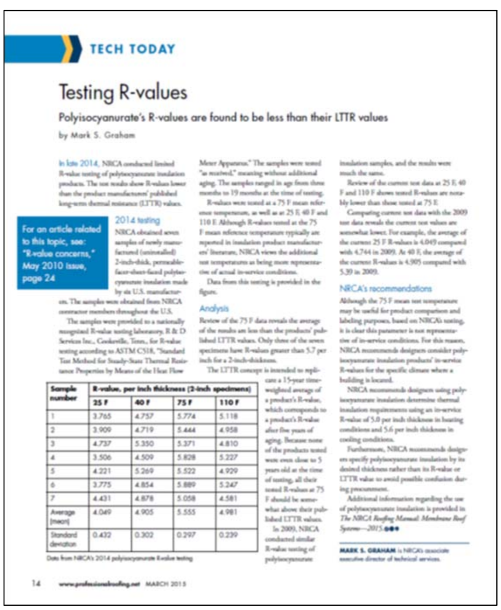
presented by

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

Topics

- Polyiso. insulation update
- IEBC 2015
- ASCE 7-16 in IBC 2018
- Other topics

<u>Update on polyisocyanurate insulation issues</u>


TECH TODAY

Testing R-values

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

by Mark S. Graham

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

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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 4.049 compared with 4.744 in 2009. At 40 F, the average of the current R-values is 4.905 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
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Average (mean)	4.049	4.905	5.555	4.981
Standard deviation	0.432	0.302	0.297	0.239

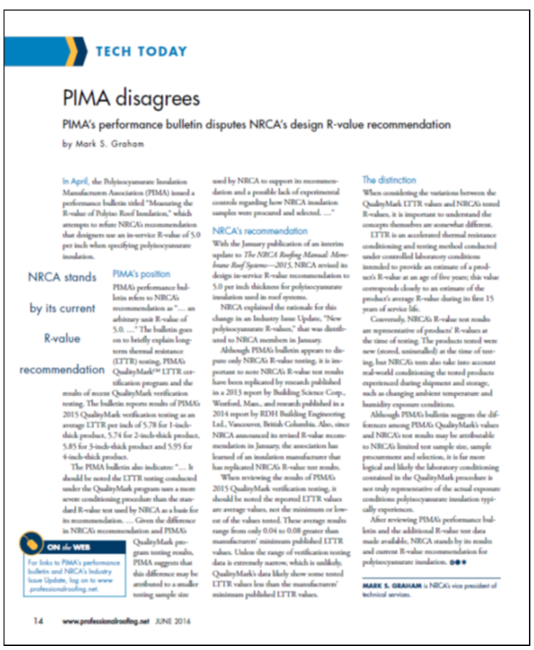
Data from NRCA's 2014 polyisocyanurate R-value testing

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

14 www.professionalroofing.net MARCH 2015

Professional Roofing, March 2015

Professional Roofing,
February 2016



TECH TODAY

PIMA disagrees

PIMA's performance bulletin disputes NRCA's design R-value recommendation

by Mark S. Graham

In April, the Polyisocyanurate Insulation Manufacturers Association (PIMA) issued a performance bulletin titled "Measuring the R-value of Polyiso Roof Insulation," which attempts to refute NRCA's recommendation that designers use an in-service R-value of 5.0 per inch when specifying polyisocyanurate insulation.

NRCA stands by its current R-value recommendation

PIMA's position

PIMA's performance bulletin refers to NRCA's recommendation as "… an arbitrary unit R-value of 5.0. …" The bulletin goes on to briefly explain long-term thermal resistance (LTTR) testing, PIMA's QualityMark℠ LTTR certification program and the results of recent QualityMark verification testing. The bulletin reports results of PIMA's 2015 QualityMark verification testing as an average LTTR per inch of 5.78 for 1-inch-thick product, 5.74 for 2-inch-thick product, 5.85 for 3-inch-thick product and 5.95 for 4-inch-thick product.

The PIMA bulletin also indicates: "… It should be noted the LTTR testing conducted under the QualityMark program uses a more severe conditioning procedure than the standard R-value test used by NRCA as a basis for its recommendation. … Given the difference in NRCA's recommendation and PIMA's QualityMark program testing results, PIMA suggests that this difference may be attributed to a smaller testing sample size used by NRCA to support its recommendation and a possible lack of experimental controls regarding how NRCA insulation samples were procured and selected. …"

ON the WEB

For links to PIMA's performance bulletin and NRCA's Industry Issue Update, log on to www.professionalroofing.net.

NRCA's recommendation

With the January publication of an interim update to *The NRCA Roofing Manual: Membrane Roof Systems—2015*, NRCA revised its design in-service R-value recommendation to 5.0 per inch thickness for polyisocyanurate insulation used in roof systems.

NRCA explained the rationale for this change in an Industry Issue Update, "New polyisocyanurate R-values," that was distributed to NRCA members in January.

Although PIMA's bulletin appears to dispute only NRCA's R-value testing, it is important to note NRCA's R-value test results have been replicated by research published in a 2013 report by Building Science Corp., Westford, Mass., and research published in a 2014 report by RDH Building Engineering Ltd., Vancouver, British Columbia. Also, since NRCA announced its revised R-value recommendation in January, the association has learned of an insulation manufacturer that has replicated NRCA's R-value test results.

When reviewing the results of PIMA's 2015 QualityMark verification testing, it should be noted the reported LTTR values are average values, not the minimum or lowest of the values tested. These average results range from only 0.04 to 0.08 greater than manufacturers' minimum published LTTR values. Unless the range of verification testing data is extremely narrow, which is unlikely, QualityMark's data likely show some tested LTTR values less than the manufacturers' minimum published LTTR values.

The distinction

When considering the variations between the QualityMark LTTR values and NRCA's tested R-values, it is important to understand the concepts themselves are somewhat different.

LTTR is an accelerated thermal resistance conditioning and testing method conducted under controlled laboratory conditions intended to provide an estimate of a product's R-value at an age of five years; this value corresponds closely to an estimate of the product's average R-value during its first 15 years of service life.

Conversely, NRCA's R-value test results are representative of products' R-values at the time of testing. The products tested were new (stored, uninstalled) at the time of testing, but NRCA's tests also take into account real-world conditioning the tested products experienced during shipment and storage, such as changing ambient temperature and humidity exposure conditions.

Although PIMA's bulletin suggests the differences among PIMA's QualityMark's values and NRCA's test results may be attributable to NRCA's limited test sample size, sample procurement and selection, it is far more logical and likely the laboratory conditioning contained in the QualityMark procedure is not truly representative of the actual exposure conditions polyisocyanurate insulation typically experiences.

After reviewing PIMA's performance bulletin and the additional R-value test data made available, NRCA stands by its results and current R-value recommendation for polyisocyanurate insulation.

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

14 www.professionalroofing.net JUNE 2016

Professional Roofing,
June 2016

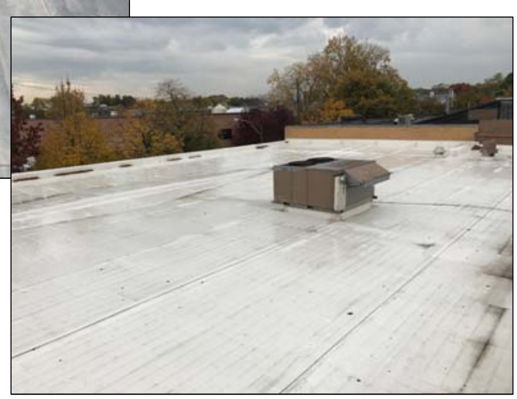
PIMA/NRCA TOC meeting

July 12, 2016

Outcomes:

- PIMA R-value research
  - Results to NRCA by the end of the year
- Facer sheet descriptions
- Knit line criteria
- Review storage/covering criteria

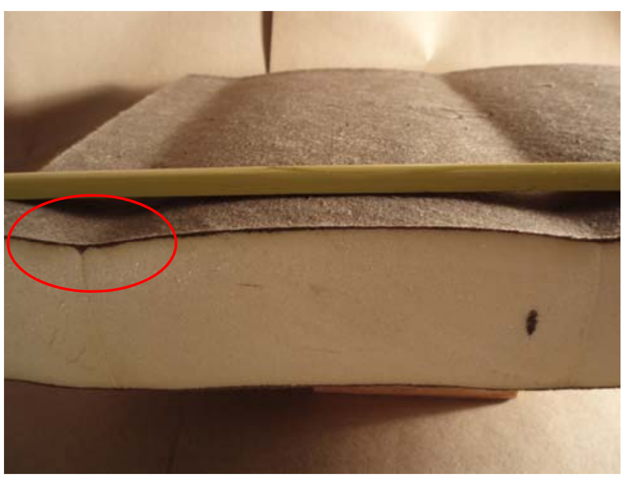
Knit lines



Knit lines -- continued

As delivered by manufacturer.

Knit lines -- continued



After conditioning

Knit lines -- continued

Knit line and V-groove close-up (after conditioning)

NRCA's interim recommendations

Knit line, thickness and dimensional stability concerns

- Measure polyiso. thickness upon delivery
- Look for knit lines and board unevenness
- Contact manufacturer and NRCA if you see any issues

International Existing Building Code, 2015 Edition

International Code Council (ICC)

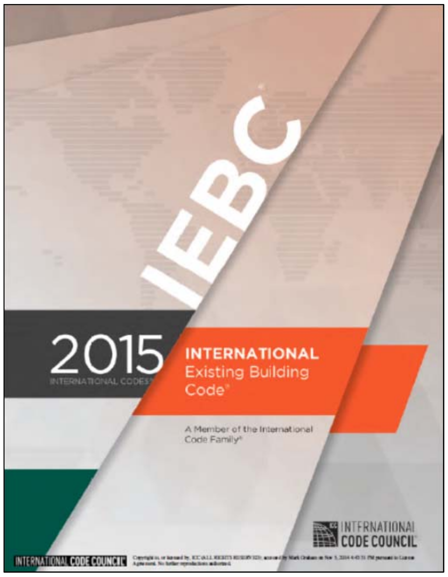
Beginning in 2000 and currently

INTERNATIONAL CODE COUNCIL®

People Helping People Build a Safer World™

THE I-CODES

ICC Performance Code (ICCPC)
International Building Code (IBC)
International Energy Conservation Code (IECC)
International Existing Building Code (IEBC)
International Fire Code (IFC)
International Fuel Gas Code (IFGC)
International Green Construction Code (IgCC)
International Mechanical Code (IMC)
International Plumbing Code (IPC)
International Private Sewage Disposal Code (IPSDC)
International Property Maintenance Code (IPMC)
International Residential Code (IRC)
International Swimming Pool and Spa Code (ISPSC)
International Wildland-Urban Interface Code (IWUIC)
International Zoning Code (IZC)



International Existing Building Code, 2015 Edition

IEBC 2015

Scope:

"…shall apply to the *repair, alteration, change of occupancy, addition* to and relocation of *existing buildings*."

Classifications:

- Level 1: Removal and replacement of materials
- Level 2: Reconfiguration or extension
- Level 3: Exceeds 50 percent of *building area*

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

SECTION 706
REROOFING

[BS] 706.1 General. Materials and methods of application used for recovering or replacing an existing roof covering shall comply with the requirements of Chapter 15 of the *International Building Code.*

Exception: Reroofing shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section 1507 of the *International Building Code* for roofs that provide positive roof drainage.

[BS] 706.2 Structural and construction loads. Structural roof components shall be capable of supporting the roof-covering system and the material and equipment loads that will be encountered during installation of the system.

[Continued…]

IBC 2012, Section 1510-Reroofing

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

SECTION 707
STRUCTURAL

[BS] 707.1 General. Where *alteration* work includes replacement of equipment that is supported by the building or where a reroofing permit is required, the provisions of this section shall apply.

[BS] 707.2 Addition or replacement of roofing or replacement of equipment. Where addition or replacement of roofing or replacement of equipment results in additional dead loads, structural components supporting such reroofing or equipment shall comply with the gravity load requirements of the *International Building Code.*

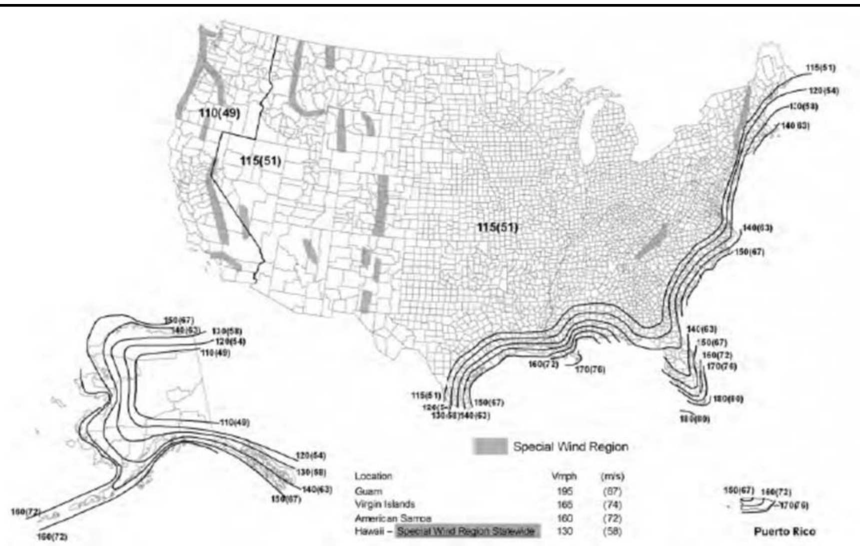
Exceptions:

1. Structural elements where the additional dead load from the roofing or equipment does not increase the force in the element by more than 5 percent.
2. Buildings constructed in accordance with the *International Residential Code* or the conventional light-frame construction methods of the *International Building Code* and where the dead load from the roofing or equipment is not increased by more than 5 percent.
3. Addition of a second layer of roof covering weighing 3 pounds per square foot (0.1437 kN/m2) or less over an existing, single layer of roof covering.

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

[BS] 707.3.2 Roof diaphragms resisting wind loads in high-wind regions. Where roofing materials are removed from more than 50 percent of the roof diaphragm or section of a building located where the ultimate design wind speed, V_{ult}, determined in accordance with Figure 1609.3(1) of the *International Building Code,* is greater than 115 mph (51 m/s) or in a special wind region, as defined in Section 1609 of the *International Building Code*, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the *International Building Code*, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the *International Building Code.*



Notes:
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

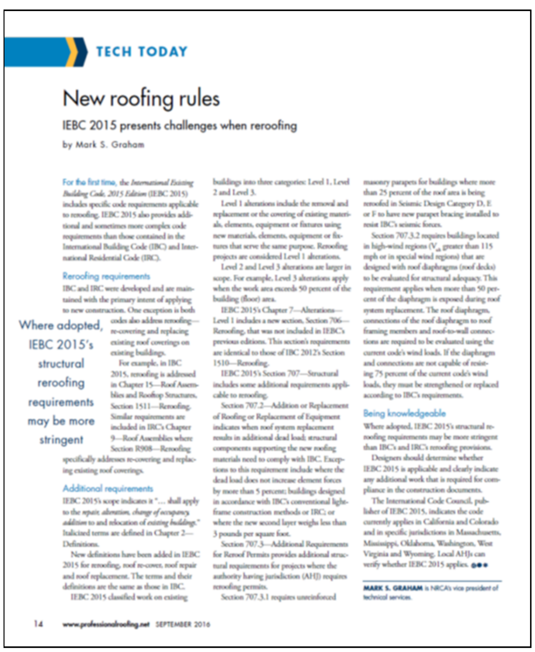
FIGURE 1609.3(1)
ULTIMATE DESIGN WIND SPEEDS, V_{ult}, FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES

International Existing Building Code, 2015 Edition

Chapter 7-Alterations-Level I

SECTION 708
ENERGY CONSERVATION

708.1 Minimum requirements. Level 1 *alterations* to *existing buildings* or structures are permitted without requiring the entire building or structure to comply with the energy requirements of the *International Energy Conservation Code* or *International Residential Code*. The *alterations* shall conform to the energy requirements of the *International Energy Conservation Code* or *International Residential Code* as they relate to new construction only.



TECH TODAY

New roofing rules

IEBC 2015 presents challenges when reroofing

by Mark S. Graham

For the first time, the *International Existing Building Code, 2015 Edition* (IEBC 2015) includes specific code requirements applicable to reroofing. IEBC 2015 also provides additional and sometimes more complex code requirements than those contained in the International Building Code (IBC) and International Residential Code (IRC).

Reroofing requirements

IBC and IRC were developed and are maintained with the primary intent of applying to new construction. One exception is both codes also address reroofing—re-covering and replacing existing roof coverings on existing buildings.

Where adopted, IEBC 2015's structural reroofing requirements may be more stringent

For example, in IBC 2015, reroofing is addressed in Chapter 15—Roof Assemblies and Rooftop Structures, Section 1511—Reroofing. Similar requirements are included in IRC's Chapter 9—Roof Assemblies where Section R908—Reroofing specifically addresses re-covering and replacing existing roof coverings.

Additional requirements

IEBC 2015's scope indicates it "… shall apply to the *repair, alteration, change of occupancy, addition* to and relocation of *existing buildings*." Italicized terms are defined in Chapter 2—Definitions.

New definitions have been added in IEBC 2015 for reroofing, roof re-cover, roof repair and roof replacement. The terms and their definitions are the same as those in IBC.

IEBC 2015 classified work on existing buildings into three categories: Level 1, Level 2 and Level 3.

Level 1 alterations include the removal and replacement or the covering of existing materials, elements, equipment or fixtures using new materials, elements, equipment or fixtures that serve the same purpose. Reroofing projects are considered Level 1 alterations.

Level 2 and Level 3 alterations are larger in scope. For example, Level 3 alterations apply when the work area exceeds 50 percent of the building (floor) area.

IEBC 2015's Chapter 7—Alterations—Level 1 includes a new section, Section 706—Reroofing, that was not included in IEBC's previous editions. This section's requirements are identical to those of IBC 2012's Section 1510—Reroofing.

IEBC 2015's Section 707—Structural includes some additional requirements applicable to reroofing.

Section 707.2—Addition or Replacement of Roofing or Replacement of Equipment indicates when roof system replacement results in additional dead load; structural components supporting the new roofing materials need to comply with IBC. Exceptions to this requirement include where the dead load does not increase element forces by more than 5 percent; buildings designed in accordance with IBC's conventional light-frame construction methods or IRC; or where the new second layer weighs less than 3 pounds per square foot.

Section 707.3—Additional Requirements for Reroof Permits provides additional structural requirements for projects where the authority having jurisdiction (AHJ) requires reroofing permits.

Section 707.3.1 requires unreinforced masonry parapets for buildings where more than 25 percent of the roof area is being reroofed in Seismic Design Category D, E or F to have new parapet bracing installed to resist IBC's seismic forces.

Section 707.3.2 requires buildings located in high-wind regions (V_{ult} greater than 115 mph or in special wind regions) that are designed with roof diaphragms (roof decks) to be evaluated for structural adequacy. This requirement applies when more than 50 percent of the diaphragm is exposed during roof system replacement. The roof diaphragm, connections of the roof diaphragm to roof framing members and roof-to-wall connections are required to be evaluated using the current code's wind loads. If the diaphragm and connections are not capable of resisting 75 percent of the current code's wind loads, they must be strengthened or replaced according to IBC's requirements.

Being knowledgeable

Where adopted, IEBC 2015's structural reroofing requirements may be more stringent than IBC's and IRC's reroofing provisions.

Designers should determine whether IEBC 2015 is applicable and clearly indicate any additional work that is required for compliance in the construction documents.

The International Code Council, publisher of IEBC 2015, indicates the code currently applies in California and Colorado and in specific jurisdictions in Massachusetts, Mississippi, Oklahoma, Washington, West Virginia and Wyoming. Local AHJs can verify whether IEBC 2015 applies.

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

14 www.professionalroofing.net SEPTEMBER 2016

Professional Roofing, September 2016

ASCE 7-16 adoption into IBC 2018

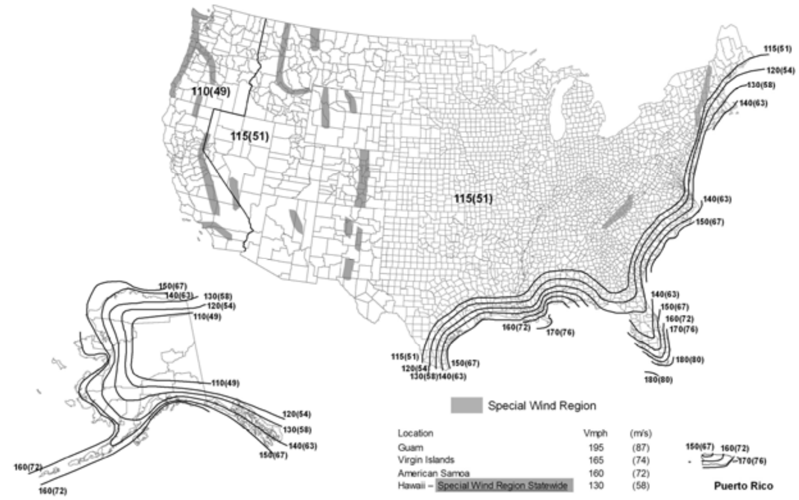
ASCE 7-16 (public review draft)

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

Expect higher field, perimeter and corner uplift pressures

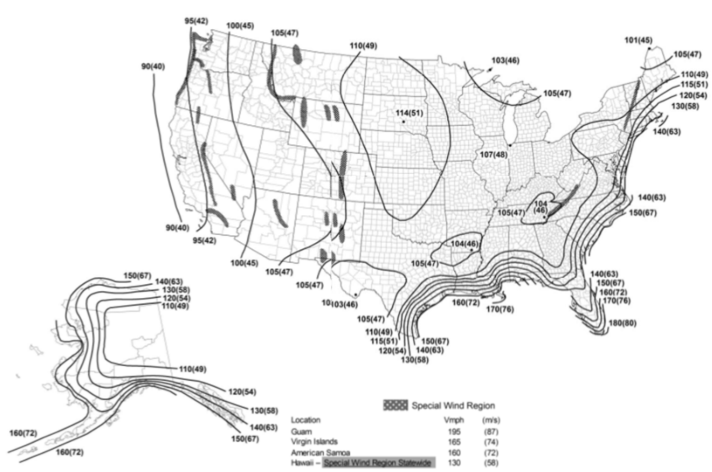
ASCE 7-10 basic wind speed map

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



ASCE 7-16 (draft) basic wind speed map

Risk Category II Buildings



GC_p pressure coefficients

h ≤ 60 ft., gable roofs ≤ 7 degrees

Zone	ASCE 7-10	ASCE 7-16 (draft)
1 (field)	-1.0	-1.7
1’	--	-0.9
2 (perimeter)	-1.8	-2.3
3 (corners)	-2.8	-3.2

Zones

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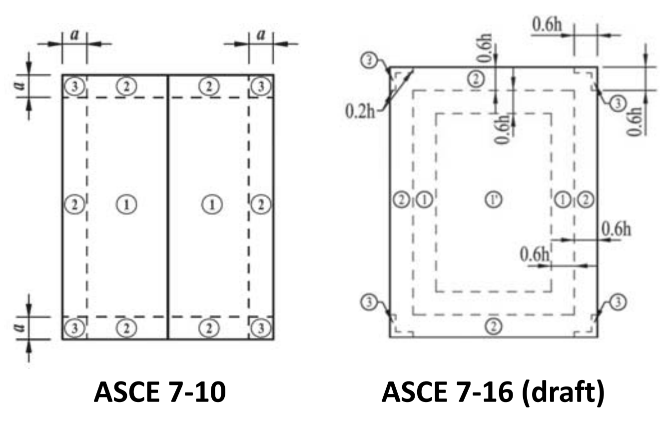
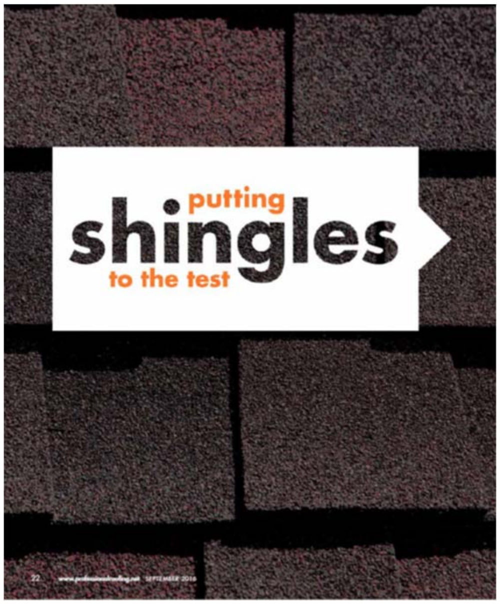
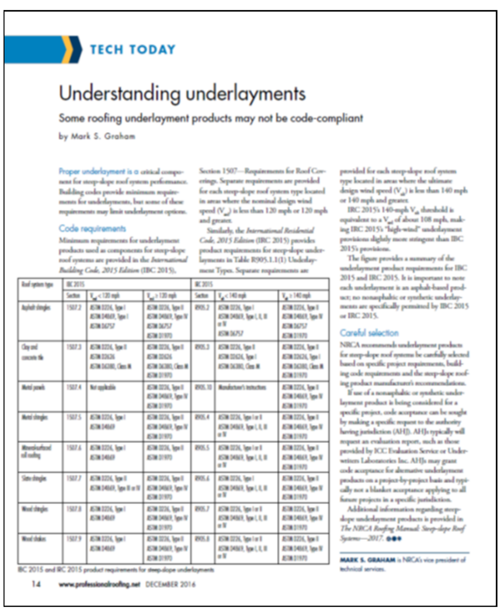


Proper wind design (which is oftentimes avoided) is getting even more complicated…

Other topics…



Professional Roofing,
September 2015


TECH TODAY

Understanding underlayments

Some roofing underlayment products may not be code-compliant

by Mark S. Graham

Code requirements

Careful selection

Professional Roofing,
December 2015

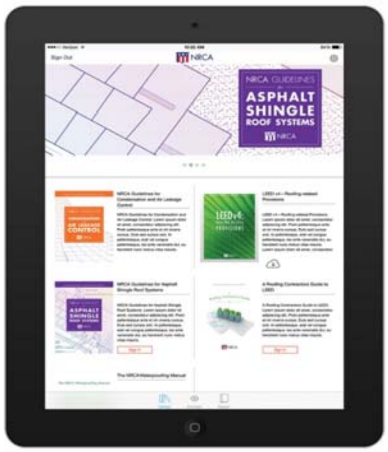
The NRCA Roofing Manual

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

NRCA App



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

NRCA

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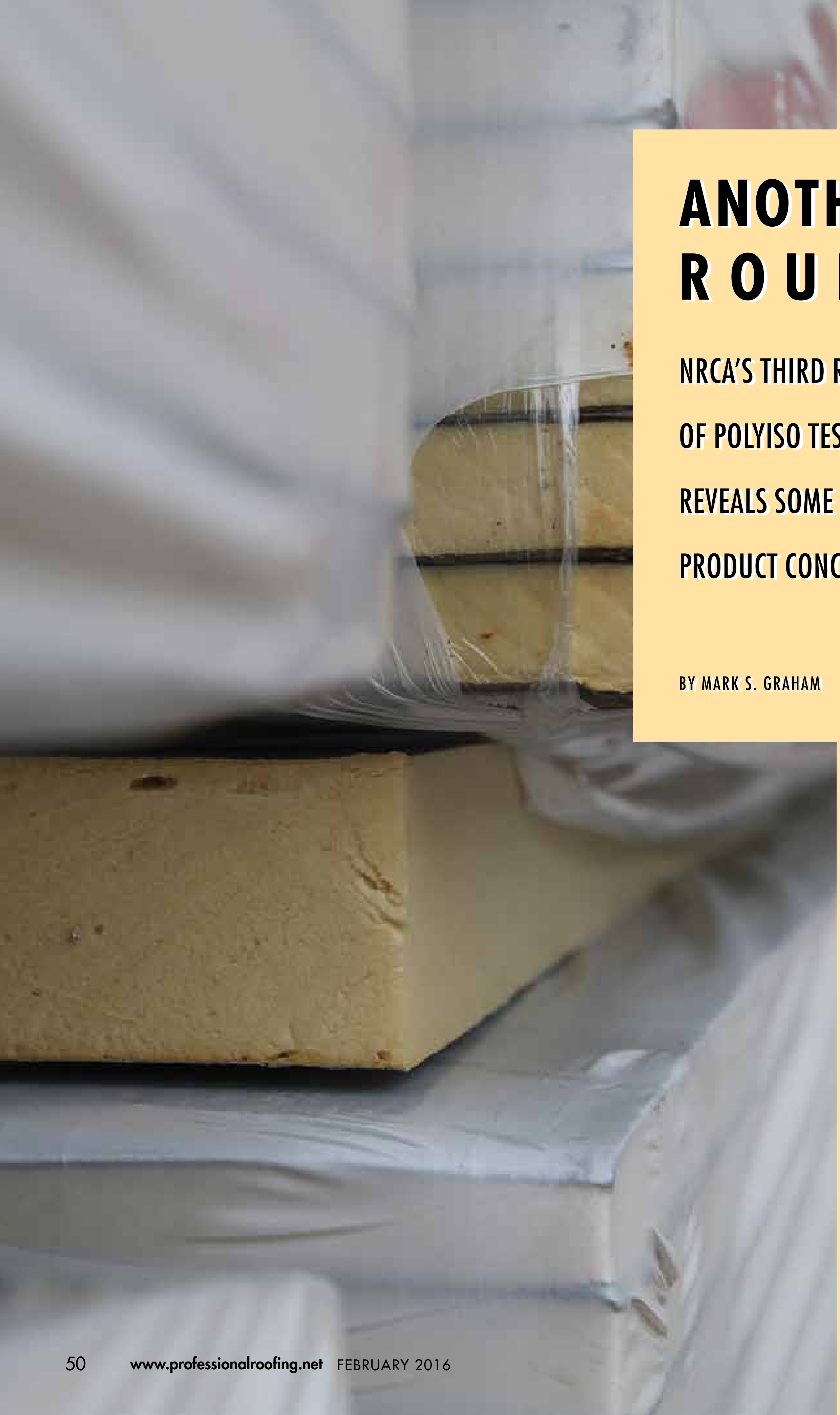

ANOTHER ROUND

NRCA'S THIRD ROUND OF POLYISO TESTS REVEALS SOME PRODUCT CONCERNS

BY MARK S. GRAHAM

In late 2015, NRCA conducted physical property testing on a limited number of samples of new (uninstalled) faced, rigid board polyisocyanurate insulation used as components of low-slope roof systems.

The purpose was to determine the samples' compliances with the U.S. product standard for polyisocyanurate insulation, ASTM C1289, "Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation." The results also provide a basis for comparison with previous testing conducted by NRCA in 2002 and 2009.

ASTM C1289

ASTM C1289 describes methods for testing faced polyisocyanurate insulation's physical properties and R-values and provides consensus–based minimum or maximum values for the properties tested. For example, ASTM C1289's Section 11—Test Methods indicates dimensional stability testing shall be conducted using ASTM D2126, "Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging," except each test specimen shall be 12 inches by 12 inches by the full-faced board thickness. ASTM C1289's Table 1-Physical Properties prescribes maximum dimensional stability values of 2 percent linear change in a board's length and width and 4 percent linear change in a board's thickness.

ASTM C1289 also provides prescriptive requirements addressing polyisocyanurate insulation's dimensional tolerances, face trueness and package marking.

PREVIOUS NRCA TESTING

NRCA previously conducted similar physical property test programs on faced, rigid board polyisocyanurate insulation in 2002 and 2009. Data from these test programs provide a basis for comparing results from NRCA's current test program with its previous test programs.

Results from NRCA's 2002 test program are characterized by relatively high compressive strength and dimensional stability values in a board's thickness though only one sample exceeded ASTM C1289's 4 percent allowable linear change limit in a board's thickness.

Some products included in NRCA's 2002 test program are now known to have been manufactured using the then-common HCFC-141b blowing agent while other products were manufactured using the next generation hydrocarbon- (pentane-) based blowing agents. Because Dec. 31, 2002, marked a federally mandated deadline for ceasing production of HCFC-141b, polyisocyanurate insulation manufacturers were in a period of transitioning blowing agents during the time NRCA collected polyisocyanurate insulation board samples for its 2002 test program.

All the products included in NRCA's 2009 test program are believed to have been manufactured using hydrocarbon-based blowing agents, the same general class of blowing agent currently used for products.

Results from NRCA's 2009 test program are characterized by relatively high compressive strength values and a range of dimensional stability values. One sample tested exceeded ASTM C1289's 2 percent allowable linear change limit in the cross-machine direction, and two samples exhibited shrinkage in board thickness.

2015 TESTING AND RESULTS

NRCA obtained seven multiple-board 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. from their stored stocks.

Samples 1-A and 1-B were manufactured by the same manufacturer. Sample 1-A is faced with Class 1 fiberglass-reinforced cellulosic felt facers, and Sample 1-B is faced with Class 2 coated polymer-bonded fiberglass mat facers. Samples 2, 3, 4 and 6 were manufactured from four manufacturers using Class 1 facers. Sample 5 was manufactured by a different manufacturer using Class 2 facers. All U.S. manufacturers of rigid board polyisocyanurate insulation are represented in the sampling.

The samples were provided to a nationally recognized testing laboratory, Structural Research Inc. (SRI), Middleton, Wis., for testing and analysis. A minimum of five specimens per sample were subjected to testing for the samples' compressive strength, dimensional stability, flexural strength and tensile strength properties using the methods defined in ASTM C1289.

The samples' densities also were determined; density measurement is not part of ASTM C1289.

Measured apparent overall density (including the facer sheets) and apparent foam core density values for each of the samples are shown in Figure 1. The values reported in the figures are the per sample averages for the multiple specimens tested.

Sample	Facer type	Density (lb/ft³)	
		Apparent overall density	Apparent foam core density
1-A	Cellulosic (Class 1)	2.16	1.57
1-B	Coated fiberglass (Class 2)	3.80	1.68
2	Cellulosic (Class 1)	2.25	1.56
3	Cellulosic (Class 1)	2.26	1.65
4	Cellulosic (Class 1)	2.25	1.64
5	Coated fiberglass (Class 2)	3.16	1.79
6	Cellulosic (Class 1)	2.39	1.68

Figure 1: Density

The difference between a sample's apparent overall density and apparent foam core density is an indication of the relative mass of the foam's facers (top and bottom facers). Although Samples 1B and 5 (the samples with coated fiberglass facers) have notably higher apparent densities than other samples, their apparent foam core densities are similar to the cellulosic felt-faced samples.

Apparent foam core density values in NRCA's 2015 test program are similar to those from its 2009 testing and slightly lower than those in the 2002 testing.

Tested compressive strength values for each of the samples are shown in Figure 2. All the samples tested comply with ASTM C1289's Grade 2 designation, meaning they have a 20-psi minimum compressive strength. Sample 1-B also complies with ASTM C1289's Grade 3 designation (25-psi minimum compressive strength).

Compressive strength values with facers in the 2015 test program are notably lower than those from NRCA's 2002 and 2009 testing.

Tested dimensional stability values for each of the samples are shown in Figure 3. Only Samples 1-A and 5 comply with the maximum percent linear change allowable limit in ASTM C1289. Samples 2, 3, 4 and 6 exceed the allowable limit in the machine direction (MD); Samples 2 and 4 also exceed the allowable limit in the cross-machine direction (XMD). Sample 1-B exceeds the allowable limit in the sample's thickness.

Sample	Compressive strength (psi)		
	With facers	Machine direction	Cross-machine direction
1-A	22.3	16.1	26.5
1-B	28.4	21.2	29.8
2	24.4	16.7	22.0
3	24.5	17.5	19.4
4	23.5	18.5	21.0
5	24.4	20.6	19.8
6	24.5	18.9	21.1
ASTM C1289, Type II requirement	Grade 1: 16 (minimum) Grade 2: 20 (minimum) Grade 3: 25 (minimum)	No requirement	

Figure 2: Compressive strength

Dimensional stability values in the 2015 test program are notably higher than those in NRCA's 2002 and 2009 testing. From NRCA's 2002 and 2009 testing, only one sample failed to comply with ASTM C1289's dimensional stability limits. In the 2015 test program, five of the seven did not comply.

Tested flexural strength, modulus of rupture, break load and tensile strength perpendicular to the surface for each of the samples are shown in Figure 4. All the samples have tested values well in excess of ASTM C1289's minimum requirements. Samples 1B and 5 (the samples with coated fiberglass facers) have somewhat higher modulus of rupture and break strength values than the samples with cellulosic felt facers.

Modulus of rupture and break strength values in NRCA's 2015 test program are slightly lower than those from the 2002 and 2009 testing. Tensile strength values are similar in all three test programs.

KNIT LINE ASSESSMENT

Linear surface depressions, or rutting, sometimes is associated with smooth-surfaced membrane roof systems, particularly single-ply membrane roof systems applied directly over faced, rigid board polyisocyanurate insulation. An example of this condition is shown in the photo.

Field investigations and test cuts reveal such rutting typically correlates to linear depressions occurring on the flat surfaces of polyisocyanurate insulation. These depressions align with knit lines that occur through the foam's cross-sectional thickness. Multiple knit lines occur in the foam's machine direction as a result of streams of liquid foam spreading and rising between mix heads during

Sample	Dimensional stability (Percent linear change after seven days at 158 F and 97 percent relative humidity)		
	Machine direction	Cross-machine direction	Thickness
1-A	1.22	1.27	1.77
1-B	0.54	1.31	5.88
2	3.35	2.91	-1.11
3	2.42	1.53	3.19
4	2.14	2.24	1.21
5	0.56	0.75	3.74
6	2.52	1.96	1.68
ASTM C1289, Type II requirement	2.0 (maximum)		4.0 (maximum)

Figure 3: Dimensional stability (The shaded values denote those values exceeding ASTM C1289's maximum allowable requirement.)

Example of rutting in polyisocyanurate insulation in an adhered EPDM membrane roof system

manufacturing. The number and spacing of knit lines per polyisocyanurate insulation board may vary by manufacturer and plants based on the number of mix heads and liquid streams used in a particular manufacturing line.

To assess the surface depressions associated with faced, rigid board polyisocyanurate insulation's knit lines, NRCA asked SRI to record the number of knit lines and measure knit line depths on each of the samples included in NRCA's 2015 test program (see Figure 5).

ASTM C1289 neither specifically addresses knit line depressions in polyisocyanurate insulation nor provides allowable maximum knit line depression tolerances. Relating to surface variability, ASTM C1289's Section 8.1—Dimensional Tolerances indicates "… the thickness tolerance shall not exceed ⅛ in. (3.2 mm), and the thickness of any two boards shall not differ more than ⅛ in. (3.2 mm). …" Section 8.5—Face Thickness indicates "… boards shall not depart from absolute flatness more than ⅛ in./ft. (10 mm/m) of length and width." Section 8.7—Crushings and Depressions indicates "… boards shall have no crushed or depressed areas on any surface exceeding ⅛ in (3.2 mm) in depth on more than 10% of the total surface area."

Sample	Flexural strength		Tensile strength perpendicular to surface (lbf/ft^3)
	Modulus of rupture (psi)	Break strength (lbf)	
1-A	MD: 79.6 XMD: 61.2	MD: 64.8 XMD: 49.3	3259
1-B	MD: 127.9 XMD: 135.5	MD: 102.4 XMD: 108.2	2590
2	MD: 93.0 XMD: 64.1	MD: 75.4 XMD: 51.1	3080
3	MD: 98.4 XMD: 59.5	MD: 75.8 XMD: 47.2	3083
4	MD: 73.0 XMD: 52.6	MD: 58.1 XMD: 42.2	2904
5	MD: 121.1 XMD: 93.6	MD: 92.9 XMD: 76.9	3668
6	MD: 96.3 XMD: 55.8	MD: 71.3 XMD: 41.7	2657
ASTM C1289, Type II requirement	40	17	500

Figure 4: Flexural strength and tensile strength

Sample	Board side indication	Knit line depth (inch)							
		Line 1	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7	Line 8
1-A	None	-0.084	-0.078	-0.068	—	—	—	—	—
	"This side down"	-0.061	-0.137	-0.110					
1-B	None	-0.038	-0.030	-0.048	—	—	—	—	—
	None	-0.049	-0.085	-0.041					
2	None	-0.015	-0.059	-0.060	-0.028	-0.020	-0.028	-0.010	-0.005
	"This side down"	-0.130	-0.167	-0.161	-0.193	-0.210	-0.166	-0.171	-0.143
3	None	-0.023	-0.049	-0.046	-0.051	-0.047	—	—	—
	None	-0.015	-0.031	-0.045	-0.036	-0.021			
4	None	-0.035	-0.038	-0.068	-0.055	-0.062	—	—	—
	"This side down"	-0.091	-0.112	-0.122	-0.114	-0.072			
5	None	-0.023	-0.036	-0.045	-0.040	-0.025	—	—	—
	None	-0.013	-0.016	-0.013	-0.013	-0.012			
6	None	-0.136	-0.169	-0.189	-0.170	-0.171	-0.173	-0.165	-0.146
	None	-0.035	-0.015	-0.017	-0.007	-0.005	-0.018	-0.036	-0.037

Figure 5: Knit line depth assessment (The shaded values denote those exceeding ⅛-inch in depth.)

In Figure 5, measured values in excess of ⅛ of an inch (0.125 in.) are highlighted. NRCA considers this value to be excessive, particularly for adhered, single-ply membrane roof systems. Possible pooling of adhesives in these depressions during application, bridging of the membrane over the depressions and the rutted finished membrane surface appearance are among NRCA's concerns.

CLOSING THOUGHTS

NRCA's Technical Operations Committee has overseen and reviewed the results of NRCA's 2015 testing of faced, rigid board polyisocyanurate insulation.

The results show some variability in faced, rigid board polyisocyanurate insulation products; instances where specific physical property values do not fall within ASTM C1289's allowable limits; and instances where values have noticeably changed from NRCA's previous testing in 2002 and 2009. NRCA acknowledges the sampling used in this program may not be statistically representative of all polyisocyanurate insulation currently being manufactured.

The test program's findings regarding dimensional stability are of specific concern. NRCA first raised this issue specific to faced, rigid board polyisocyanurate insulation during the mid-1990s. The 2002 and 2009 testing showed some improvements in polyisocyanurate insulation's dimensional stabilities, but NRCA's 2015 testing shows dimensional stability issues are recurring with newly manufactured products and the magnitude of the issues is equal to or greater than in the 1990s. This finding also is consistent with field reports NRCA's Technical Services Section is receiving.

In addition, the issue of surface depressions associated with knit lines in faced, rigid board polyisocyanurate insulation is of particular concern. Although this problem was previously seen only in isolated instances, it now appears to be more pronounced and widespread with the current generation of polyisocyanurate insulation blowing agents and manufacturing processes. Polyisocyanurate insulation manufacturers need to improve the flatness of their roofing-specific products, and appropriate evaluation criteria need to be developed and included in ASTM C1289.

Until these issues are adequately addressed, NRCA maintains its longstanding recommendation to roof system designers for use of a suitable cover board over faced, rigid board polyisocyanurate insulation. Additional information regarding polyisocyanurate insulation and NRCA's cover board recommendations are provided in *The NRCA Roofing Manual: Membrane Roof Systems—2015.*

NRCA looks forward to working constructively with polyisocyanurate insulation manufacturers at ASTM International and elsewhere in the roofing industry to address these issues.

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

PIMA disagrees

PIMA's performance bulletin disputes NRCA's design R-value recommendation

by Mark S. Graham

In April, the Polyisocyanurate Insulation Manufacturers Association (PIMA) issued a performance bulletin titled "Measuring the R-value of Polyiso Roof Insulation," which attempts to refute NRCA's recommendation that designers use an in-service R-value of 5.0 per inch when specifying polyisocyanurate insulation.

NRCA stands by its current R-value recommendation

PIMA's position

PIMA's performance bulletin refers to NRCA's recommendation as "… an arbitrary unit R-value of 5.0. …" The bulletin goes on to briefly explain long-term thermal resistance (LTTR) testing, PIMA's QualityMark[CM] LTTR certification program and the results of recent QualityMark verification testing. The bulletin reports results of PIMA's 2015 QualityMark verification testing as an average LTTR per inch of 5.78 for 1-inch-thick product, 5.74 for 2-inch-thick product, 5.85 for 3-inch-thick product and 5.95 for 4-inch-thick product.

The PIMA bulletin also indicates: "… It should be noted the LTTR testing conducted under the QualityMark program uses a more severe conditioning procedure than the standard R-value test used by NRCA as a basis for its recommendation. … Given the difference in NRCA's recommendation and PIMA's QualityMark program testing results, PIMA suggests that this difference may be attributed to a smaller testing sample size used by NRCA to support its recommendation and a possible lack of experimental controls regarding how NRCA insulation samples were procured and selected. …"

ON *the* WEB

For links to PIMA's performance bulletin and NRCA's Industry Issue Update, log on to www.professionalroofing.net.

NRCA's recommendation

With the January publication of an interim update to *The NRCA Roofing Manual: Membrane Roof Systems—2015*, NRCA revised its design in-service R-value recommendation to 5.0 per inch thickness for polyisocyanurate insulation used in roof systems.

NRCA explained the rationale for this change in an Industry Issue Update, "New polyisocyanurate R-values," that was distributed to NRCA members in January.

Although PIMA's bulletin appears to dispute only NRCA's R-value testing, it is important to note NRCA's R-value test results have been replicated by research published in a 2013 report by Building Science Corp., Westford, Mass., and research published in a 2014 report by RDH Building Engineering Ltd., Vancouver, British Columbia. Also, since NRCA announced its revised R-value recommendation in January, the association has learned of an insulation manufacturer that has replicated NRCA's R-value test results.

When reviewing the results of PIMA's 2015 QualityMark verification testing, it should be noted the reported LTTR values are average values, not the minimum or lowest of the values tested. These average results range from only 0.04 to 0.08 greater than manufacturers' minimum published LTTR values. Unless the range of verification testing data is extremely narrow, which is unlikely, QualityMark's data likely show some tested LTTR values less than the manufacturers' minimum published LTTR values.

The distinction

When considering the variations between the QualityMark LTTR values and NRCA's tested R-values, it is important to understand the concepts themselves are somewhat different.

LTTR is an accelerated thermal resistance conditioning and testing method conducted under controlled laboratory conditions intended to provide an estimate of a product's R-value at an age of five years; this value corresponds closely to an estimate of the product's average R-value during its first 15 years of service life.

Conversely, NRCA's R-value test results are representative of products' R-values at the time of testing. The products tested were new (stored, uninstalled) at the time of testing, but NRCA's tests also take into account real-world conditioning the tested products experienced during shipment and storage, such as changing ambient temperature and humidity exposure conditions.

Although PIMA's bulletin suggests the differences among PIMA's QualityMark's values and NRCA's test results may be attributable to NRCA's limited test sample size, sample procurement and selection, it is far more logical and likely the laboratory conditioning contained in the QualityMark procedure is not truly representative of the actual exposure conditions polyisocyanurate insulation typically experiences.

After reviewing PIMA's performance bulletin and the additional R-value test data made available, NRCA stands by its results and current R-value recommendation for polyisocyanurate insulation.

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

New roofing rules

IEBC 2015 presents challenges when reroofing

by Mark S. Graham

For the first time, the *International Existing Building Code, 2015 Edition* (IEBC 2015) includes specific code requirements applicable to reroofing. IEBC 2015 also provides additional and sometimes more complex code requirements than those contained in the International Building Code (IBC) and International Residential Code (IRC).

Reroofing requirements

IBC and IRC were developed and are maintained with the primary intent of applying to new construction. One exception is both codes also address reroofing—re-covering and replacing existing roof coverings on existing buildings.

Where adopted, IEBC 2015's structural reroofing requirements may be more stringent

For example, in IBC 2015, reroofing is addressed in Chapter 15—Roof Assemblies and Rooftop Structures, Section 1511—Reroofing. Similar requirements are included in IRC's Chapter 9—Roof Assemblies where Section R908—Reroofing specifically addresses re-covering and replacing existing roof coverings.

Additional requirements

IEBC 2015's scope indicates it "… shall apply to the *repair, alteration, change of occupancy, addition* to and relocation of *existing buildings*." Italicized terms are defined in Chapter 2—Definitions.

New definitions have been added in IEBC 2015 for reroofing, roof re-cover, roof repair and roof replacement. The terms and their definitions are the same as those in IBC.

IEBC 2015 classified work on existing buildings into three categories: Level 1, Level 2 and Level 3.

Level 1 alterations include the removal and replacement or the covering of existing materials, elements, equipment or fixtures using new materials, elements, equipment or fixtures that serve the same purpose. Reroofing projects are considered Level 1 alterations.

Level 2 and Level 3 alterations are larger in scope. For example, Level 3 alterations apply when the work area exceeds 50 percent of the building (floor) area.

IEBC 2015's Chapter 7—Alterations—Level 1 includes a new section, Section 706—Reroofing, that was not included in IEBC's previous editions. This section's requirements are identical to those of IBC 2012's Section 1510—Reroofing.

IEBC 2015's Section 707—Structural includes some additional requirements applicable to reroofing.

Section 707.2—Addition or Replacement of Roofing or Replacement of Equipment indicates when roof system replacement results in additional dead load; structural components supporting the new roofing materials need to comply with IBC. Exceptions to this requirement include where the dead load does not increase element forces by more than 5 percent; buildings designed in accordance with IBC's conventional light-frame construction methods or IRC; or where the new second layer weighs less than 3 pounds per square foot.

Section 707.3—Additional Requirements for Reroof Permits provides additional structural requirements for projects where the authority having jurisdiction (AHJ) requires reroofing permits.

Section 707.3.1 requires unreinforced masonry parapets for buildings where more than 25 percent of the roof area is being reroofed in Seismic Design Category D, E or F to have new parapet bracing installed to resist IBC's seismic forces.

Section 707.3.2 requires buildings located in high-wind regions (V_{ult} greater than 115 mph or in special wind regions) that are designed with roof diaphragms (roof decks) to be evaluated for structural adequacy. This requirement applies when more than 50 percent of the diaphragm is exposed during roof system replacement. The roof diaphragm, connections of the roof diaphragm to roof framing members and roof-to-wall connections are required to be evaluated using the current code's wind loads. If the diaphragm and connections are not capable of resisting 75 percent of the current code's wind loads, they must be strengthened or replaced according to IBC's requirements.

Being knowledgeable

Where adopted, IEBC 2015's structural reroofing requirements may be more stringent than IBC's and IRC's reroofing provisions.

Designers should determine whether IEBC 2015 is applicable and clearly indicate any additional work that is required for compliance in the construction documents.

The International Code Council, publisher of IEBC 2015, indicates the code currently applies in California and Colorado and in specific jurisdictions in Massachusetts, Mississippi, Oklahoma, Washington, West Virginia and Wyoming. Local AHJs can verify whether IEBC 2015 applies.

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

putting shingles to the test

NRCA product testing reveals some concerns with asphalt shingles

by Mark S. Graham

NRCA conducted limited physical property testing during 2016 on a number of samples of new (uninstalled) asphalt shingle products. The testing's goal was to determine the samples' compliance with ASTM D3462, "Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules." The results also provide a basis for comparison with previous NRCA testing.

ASTM D3462

ASTM D3462 describes methods for testing and evaluating fiberglass-reinforced asphalt shingles. It addresses materials and manufacture; physical requirements; dimensions, masses and permissible variations; workmanship, finish and appearance; sampling and test methods; inspection; rejection and resubmission; and packaging, marking and shipping.

ASTM D3462's Table 1—Physical Requirements of Asphalt Shingles Made from Glass Felt and Table 2—Masses of Asphalt Shingles Made from Glass Felt provide consensus-based minimum or maximum values for the physical requirements and masses tested.

For example, ASTM D3462's minimum tear strength value is established as 1,700 grams (g). The maximum allowable weight of displaced granules is 1.0 g. The minimum average fastener pull-through resistance is 20 pounds force (lbf) for single-layer specimens and 30 lbf for multilayer specimens when tested at 73 F ± 4 F and 23 lbf for single-layer specimens and 40 lbf for multilayer specimens when tested at 32 F ± 4 F. A minimum of four out of five specimens tested must pass the pliability test at 73 F ± 4 F in the weather-side up (top side) machine (MD) and cross machine (XMD) directions and weather-side down (bottom side) MD and XMD.

Compliance with ASTM D3462 is referenced in the International Building Code and International Residential Code as a minimum requirement for fiberglass-reinforced asphalt shingles.

The current edition of ASTM D3462 was published this year and is designated ASTM D3462-16.

Previous NRCA testing

In 2001, NRCA also conducted tests on fiberglass-reinforced asphalt shingles. Since then, other fiberglass-reinforced asphalt shingle products have been tested. Data from these test programs provide a basis for comparing results from NRCA's current test program with its previous testing.

For more about this topic, see "Asphalt shingles' tear strengths revisited," October 2006 issue, page 32.

NRCA's 2001 testing program resulted in only five of the 15 fiberglass-reinforced asphalt shingle products being found to comply with ASTM D3462's then-current requirements. Nine of the 15 shingle products tested were found to have tear strength values less than ASTM D3462's minimum requirement. Also, six of the 15 products tested failed ASTM D3462's pliability test requirement. All 15 products tested in 2001 complied with ASTM D3462's granule displacement and fastener pull-though criteria.

NRCA's latest testing

This year, NRCA obtained 17 samples of new fiberglass-reinforced asphalt shingle products. Eight product samples were three-tab strip shingles; nine products were multilayer, architectural laminated shingles.

Product samples were procured by NRCA technical committee members from throughout the U.S. through normal distribution sources. Product samples consisted of a minimum of five bundles of asphalt shingles in their original packaging. Each product was labeled as complying with ASTM D3462.

Test results for three-tab asphalt strip shingles

Sample	Tear strength (g)	Weight of displaced granules (g)	Fastener pull-through resistance (lbf)		Pliability	
			73 F	32 F	Top	Bottom
T-1	797	0.71	24.6	30.2	Pass	Pass
T-2	855	0.40	28.1	31.3	Pass	Pass
T-3	1,654	0.31	33.4	44.2	Pass	Pass
T-4	958	0.63	35.5	40.4	Pass	Pass
T-5	1,755	0.08	37.0	51.4	Pass	Pass
T-6	1,682	0.25	36.7	44.4	Pass	Pass
T-7	1,488	0.29	30.0	41.3	Pass	Pass
T-8	1,502	0.73	30.1	41.1	Pass	Pass
ASTM D3462 requirement	1,700 (minimum)	1.0 (maximum)	20 (minimum)	23 (minimum)	4 of 5 pass (minimum)	

Figure 1: Test results for three-tab asphalt strip shingles

Every U.S. manufacturer of fiberglass-reinforced asphalt shingles was represented in the NRCA testing with a minimum of two products (different brand names). One manufacturer was represented with three products.

NRCA acknowledges the sampling procedure used in the 2016 and 2001 test programs does not strictly comply with ASTM D3462's sampling requirements. Additional information regarding ASTM D3462's sampling requirements and the timing of testing of asphalt shingles is provided in "Product sampling and '… as manufactured …'" (see facing page).

Samples were provided to a nationally recognized testing laboratory for test specimen preparation, laboratory testing and analysis. A minimum of five specimens per sample (one specimen from each asphalt shingle bundle) were subjected to testing for tear strength, fastener pull-through resistance and pliability. Weight of displaced granules (granule loss) testing also was conducted on three-tab strip shingle samples.

Results of NRCA's 2016 testing on the three-tab strip shingles samples are shown in Figure 1; architectural laminated shingle results are shown in Figure 2.

ASTM D3462 also includes test methods that were not specifically conducted in NRCA's current testing, such as loss of volatile matter, sliding of granule surfacing, wind resistance, fire resistance, asphalt penetration and asphalt softening point testing. Asphalt penetration and asphalt softening point testing are intended to be conducted before shingle manufacturing and cannot be accurately conducted on finished asphalt shingle products. Wind- and fire-resistance testing are conducted on constructed test roof deck assemblies, not individual asphalt shingles.

NRCA considers the limited ASTM D3462 testing conducted in its 2016 test program adequate to show some degree of differentiation among uninstalled fiberglass-reinforced asphalt shingle products.

Analyzing the results

Review of the test results shows only one of the eight three-tab strip shingle samples (Sample T-5) and one of the nine architectural laminated shingles (Sample L-9) exceeded ASTM D3462's minimum 1,700-g tear strength requirement. Two three-tab strip shingle samples (Samples T-3 and T-6) and two architectural laminated shingle samples (Samples L-7 and L-8) show tear strength values slightly less than the ASTM D3462 minimum.

PRODUCT SAMPLING AND "… AS MANUFACTURED …"

ASTM D3462, "Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules," provides specific requirements for sampling asphalt shingle products for testing and analysis. ASTM D3462 references ASTM D228, "Standard Test Methods for Sampling, Testing and Analysis of Asphalt Roll Roofing, Cap Sheets and Shingles Used in Roofing and Waterproofing," for sampling.

ASTM D228 directs random selection of five shingle bundles from lots of 1,000 shingle bundles or less. For lots larger than 1,000 bundles, a calculation is used to determine the minimum number of bundles to select. The random nature of ASTM D228's sample selection criteria is a key consideration. Such random selection permits a shingle bundle in a lot to have the same probability of being selected for testing. This includes, for example, the bottommost shingle bundles on a pallet.

Because the asphalt shingles used in NRCA's testing were procured by NRCA member contractors through normal distribution sources, shingle bundle procurement in strict accordance with ASTM D228's random selection criteria was not practical; it is nearly impossible.

Although the asphalt shingle selection used in NRCA's testing may not be in strict accordance with ASTM D228's requirements, NRCA considers the selection process used for the testing to be representative of asphalt shingles that may be delivered to a job site.

Also, when evaluating asphalt shingles for compliance with ASTM D3462, the standard requires asphalt shingles be tested "as manufactured."

ASTM D3462's scope indicates "… This specification is designed for the evaluation of products as manufactured. The test methods, physical requirements, and minimum masses are to be measured immediately after packaging or at a reasonable time, as agreed upon between buyer and seller, after manufacture and before installation. Physical and performance requirements after application and during in-service use of the products described herein are beyond the scope of this material specification."

Because the asphalt shingles in NRCA's test program were procured by NRCA member contractors through normal distribution sources, laboratory testing immediately after manufacturing is clearly not possible.

Although NRCA's testing may not be in strict accordance with ASTM D3462's requirements, the timing of NRCA's laboratory testing can be considered representative of the conditions (some aging and changes in temperature and humidity) asphalt shingles routinely encounter up to the time of delivery to a job site and application.

However, when considering the recognized variability in tear strength test method, these samples could be considered as complying with ASTM D3462's minimum tear strength requirement.

All eight three-tab strip shingles tested show granule loss values complying with ASTM D3462's 1.0 g maximum.

All 17 samples tested (the three-tab strip shingle samples and architectural laminated shingle samples) show fastener pull-through values complying with ASTM D3462's established minimum values.

Similarly, all 17 shingles samples tested show pliability test results complying with ASTM D3462's minimum requirement.

Comparing the results of NRCA's most recent asphalt shingle testing to the 2001 testing reveals some information worthy of consideration.

Tear strength values in the 2016 testing are notably lower than those from the 2001 testing. Samples' tear strength values in the current testing range from 797 g to 1,797 g (with a mean value of 1,394 g); only two of 17 samples tested exceeded ASTM D3462's 1,700-g minimum requirement. Samples' tear strength values in NRCA's 2001 testing ranged from 835 g to 2,451 g (with a mean value 1,606 g); eight of 15 samples tested exceeded ASTM D3462's minimum requirement.

Granule displacement and fastener pull-through results are nearly identical between 2001 and the current testing. All samples tested comply with the ASTM D3462 requirements for these physical properties.

Pliability test results are notably better in the 2016 testing than from NRCA's 2001 testing. All the samples in the current testing complied with ASTM D3462's

Test results for architectural laminated shingles					
Sample	Tear strength (g)	Fastener pull-through resistance (lbf)		Pliability	
		73 F	32 F	Top	Bottom
L-1	1,208	53.7	79.3	Pass	Pass
L-2	1,333	57.0	64.4	Pass	Pass
L-3	1,235	58.7	67.8	Pass	Pass
L-4	1,549	52.7	62.8	Pass	Pass
L-5	1,299	53.7	64.6	Pass	Pass
L-6	1,210	51.5	68.0	Pass	Pass
L-7	1,678	58.7	69.6	Pass	Pass
L-8	1,667	58.1	71.8	Pass	Pass
L-9	1,797	63.2	71.5	Pass	Pass
ASTM D3462 requirement	1,700 (minimum)	30 (minimum)	40 (minimum)	4 of 5 pass (minimum)	

Figure 2: Test results for architectural laminated shingles

WHO COMPLIED?

Only two of the 17 products evaluated in NRCA's most recent round of testing complied with the physical property requirements of ASTM D3462, "Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules."

Four other asphalt shingle products had tear strength values slightly below ASTM D3462's 1700-g minimum requirement. Based upon the known variability in the tear strength test method's results, these four products can be considered as complying with ASTM D3462's tear strength minimum requirement and, therefore, as complying with ASTM D3462's physical property requirements evaluated in NRCA's test program.

The six products (listed alphabetically) are:

- GAF Royal Sovereign®
- Malarkey Roofing Products Dura-Seal™ AR
- Owens Corning Classic® (Midwest)
- Owens Corning Oakridge® (Midwest)
- Pabco Roofing Products Premier®
- Tamko Building Products Inc. Heritage®

When considering the results of NRCA's asphalt shingle testing, understand the values and conclusions from the testing only apply to the specific product sample specimens evaluated and the specific values only may apply at the time of testing. These results may not represent all the manufacturers' products. Asphalt shingle products from different production lots and products of the same brand names manufactured in different manufacturing plants may have differing values and compliances with ASTM D3462.

Users of asphalt shingles should consult with manufacturers and suppliers regarding specific products' compliance with ASTM D3462.

four out of five passing minimum requirement while in the 2001 testing only nine of the 15 samples tested complied with ASTM D3462's requirement.

Closing thoughts

Fiberglass-reinforced asphalt shingles have a significant market share in the U.S. roofing industry and continue to perform reasonably well.

NRCA's latest testing of fiberglass-reinforced asphalt shingle products yielded some results that are cause for additional consideration.

Although all the three-tab and architectural laminated shingle product samples evaluated comply with ASTM D3462's granule displacement, fastener pull-through resistance and pliability requirements, only two of the 17 samples evaluated exceeded ASTM D3462's minimum tear strength requirement.

Some in the industry—including some asphalt shingle manufacturers—may discount this finding because the testing program does not strictly comply with ASTM D3462's product sampling and time of testing requirements. However, when comparing the notably lower current test's tear strength values with the 2001 tested values, there appears to be justifiable cause for discussion and additional consideration.

Perhaps it is time for the U.S. roofing industry to develop new criteria other than ASTM D3462's tear strength testing for evaluating and differentiating among fiberglass-reinforced asphalt shingles. When developing such new criteria, it would be useful if the methodology would correlate to actual field performance. It also would be helpful if the industry agrees a new methodology would apply not only immediately after manufacturing but also up to the time of asphalt shingle procurement, delivery to the job site and installation.

Clearly, there is expertise within the asphalt shingle industry to develop such criteria. Many of these experts already regularly attend ASTM International's Committee D08 on Roofing and Waterproofing meetings and ASTM D3462 task force meetings.

NRCA looks forward to the possibility of working constructively with asphalt shingle manufacturers, interested parties at ASTM International and other roofing professionals to develop new criteria.

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

Understanding underlayments

Some roofing underlayment products may not be code-compliant

by Mark S. Graham

Proper underlayment is a critical component for steep-slope roof system performance. Building codes provide minimum requirements for underlayments, but some of these requirements may limit underlayment options.

Code requirements

Minimum requirements for underlayment products used as components for steep-slope roof systems are provided in the *International Building Code, 2015 Edition* (IBC 2015), Section 1507—Requirements for Roof Coverings. Separate requirements are provided for each steep-slope roof system type located in areas where the nominal design wind speed (V_{asd}) is less than 120 mph or 120 mph and greater.

Similarly, the *International Residential Code, 2015 Edition* (IRC 2015) provides product requirements for steep-slope underlayments in Table R905.1.1(1) Underlayment Types. Separate requirements are provided for each steep-slope roof system type located in areas where the ultimate design wind speed (V_{ult}) is less than 140 mph or 140 mph and greater.

IRC 2015's 140-mph V_{ult} threshold is equivalent to a V_{asd} of about 108 mph, making IRC 2015's "high-wind" underlayment provisions slightly more stringent than IBC 2015's provisions.

The figure provides a summary of the underlayment product requirements for IBC 2015 and IRC 2015. It is important to note each underlayment is an asphalt-based product; no nonasphaltic or synthetic underlayments are specifically permitted by IBC 2015 or IRC 2015.

Roof system type	IBC 2015			IRC 2015		
	Section	V_{asd} < 120 mph	V_{asd} ≥ 120 mph	Section	V_{ult} < 140 mph	V_{ult} ≥ 140 mph
Asphalt shingles	1507.2	ASTM D226, Type I ASTM D4869, Type I ASTM D6757	ASTM D226, Type II ASTM D4869, Type IV ASTM D6757 ASTM D1970	R905.2	ASTM D226, Type I ASTM D4869, Type I, II, III or IV ASTM D6757	ASTM D226, Type II ASTM D4869, Type IV ASTM D6757 ASTM D1970
Clay and concrete tile	1507.3	ASTM D226, Type II ASTM D2626 ASTM D6380, Class M	ASTM D226, Type II ASTM D2626 ASTM D6380, Class M ASTM D1970	R905.3	ASTM D226, Type II ASTM D2626, Type I ASTM D6380, Class M	ASTM D226, Type II ASTM D2626, Type I ASTM D6380, Class M ASTM D1970
Metal panels	1507.4	Not applicable	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970	R905.10	Manufacturer's instructions	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970
Metal shingles	1507.5	ASTM D226, Type I ASTM D4869	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970	R905.4	ASTM D226, Type I or II ASTM D4869, Type I, II, III or IV	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970
Mineral-surfaced roll roofing	1507.6	ASTM D226, Type I ASTM D4869	ASTM D226, Type II ASTM D1970	R905.5	ASTM D226, Type I or II ASTM D4869, Type I, II, III or IV	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970
Slate shingles	1507.7	ASTM D226, Type II ASTM D4869, Type III or IV	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970	R905.6	ASTM D226, Type I ASTM D4869, Type I, II, III or IV	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970
Wood shingles	1507.8	ASTM D226, Type I ASTM D4869	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970	R905.7	ASTM D226, Type I or II ASTM D4869, Type I, II, III or IV	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970
Wood shakes	1507.9	ASTM D226, Type I ASTM D4869	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970	R905.8	ASTM D226, Type I or II ASTM D4869, Type I, II, III or IV	ASTM D226, Type II ASTM D4869, Type IV ASTM D1970

IBC 2015 and IRC 2015 product requirements for steep-slope underlayments

Careful selection

NRCA recommends underlayment products for steep-slope roof systems be carefully selected based on specific project requirements, building code requirements and the steep-slope roofing product manufacturer's recommendations.

If use of a nonasphaltic or synthetic underlayment product is being considered for a specific project, code acceptance can be sought by making a specific request to the authority having jurisdiction (AHJ). AHJs typically will request an evaluation report, such as those provided by ICC Evaluation Service or Underwriters Laboratories Inc. AHJs may grant code acceptance for alternative underlayment products on a project-by-project basis and typically not a blanket acceptance applying to all future projects in a specific jurisdiction.

Additional information regarding steep-slope underlayment products is provided in *The NRCA Roofing Manual: Steep-slope Roof Systems—2017.*

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