Annual Meeting & Trade Show
November 5, 2015

Technical update – 2015 and beyond

presented by

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Topics

- Roof product/system performance
- Moisture in concrete roof decks
- Insulation R-values, code compliance and payback
- Field uplift testing
- MB sheet testing
- Impact-resistant asphalt shingles

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Material/product/system performance

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Moisture in concrete roof decks

- Normal-weight structural concrete
  - 150 pounds per cubic foot
- Lightweight structural concrete
  - 85 to 120 pounds per cubic foot
- ~~Lightweight insulating concrete~~
  - ~~20 to 40 pounds per cubic foot~~

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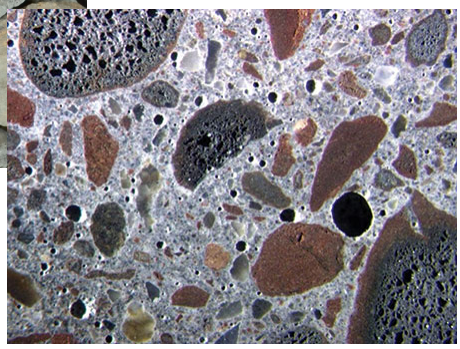
An up-close look



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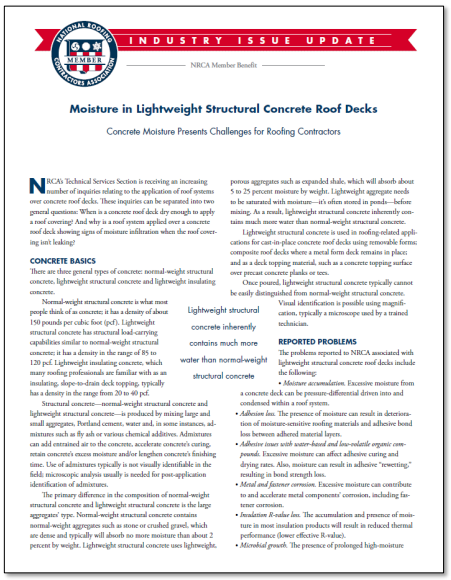

INDUSTRY ISSUE UPDATE

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 "Industry Issue Update," August 2013:

- Reported problems
- Deck dryness tests:
  - Conventional dryness tests are not reliable
  - Suggested using ASTM F2170
- NRCA recommendations:
  - Contractors should not determine deck dryness
  - Don't use lightweight structural concrete
  - Remedial repair suggestions

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Insulation R-values

NRCA R-value testing:

- Polyisocyanurate (2009 and previous)
- Expanded polystyrene (2010)
- Extruded polystyrene (2010)
- Polyisocyanurate (2015)

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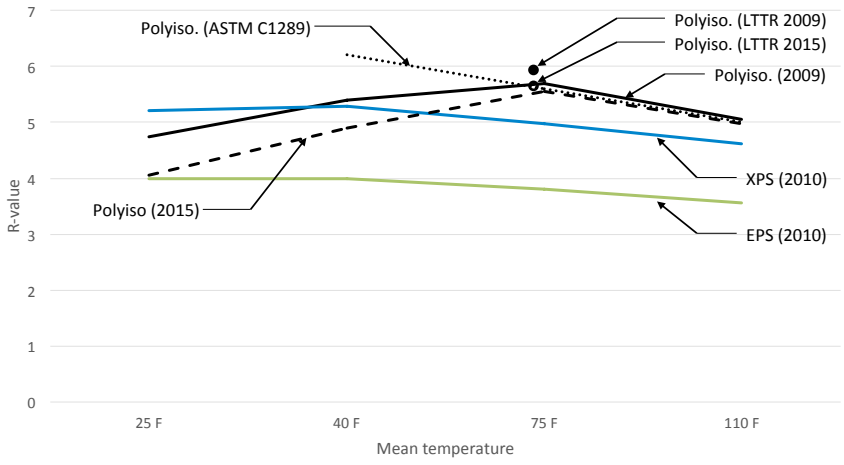
NRCA R-value testing



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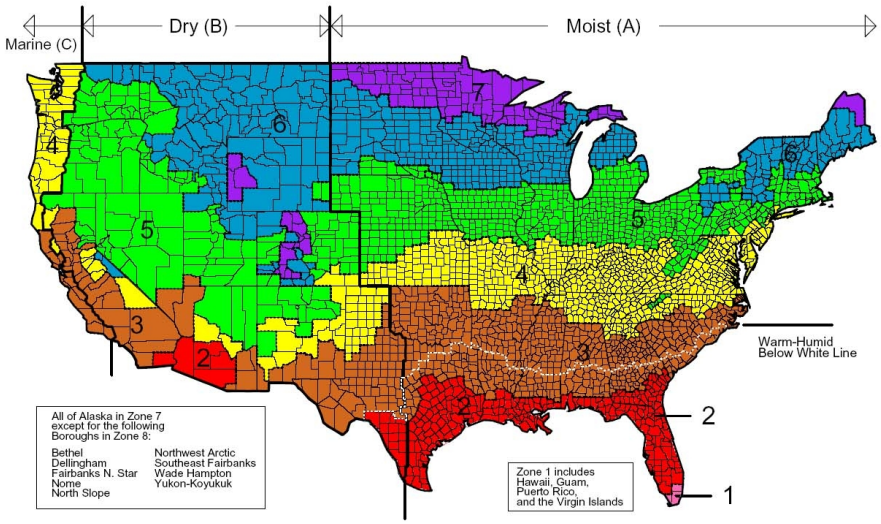
Climate zone map



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Energy Code's prescriptive insulation requirements

Insulation entirely above deck roof assembly configuration

Climate Zone	IECC 2006	IECC 2009	IECC 2012*	IECC 2015*
1	R-15ci	R-15ci	R-20 ci	R-20 ci
2		R-20ci		R-25 ci
3				
4			R-25 ci	R-30 ci
5	R-20ci			
6				
7	R-25 ci	R-25ci	R-30ci	R-35 ci
8				

* Applies to roof replacement projects
ci = continuous insulation

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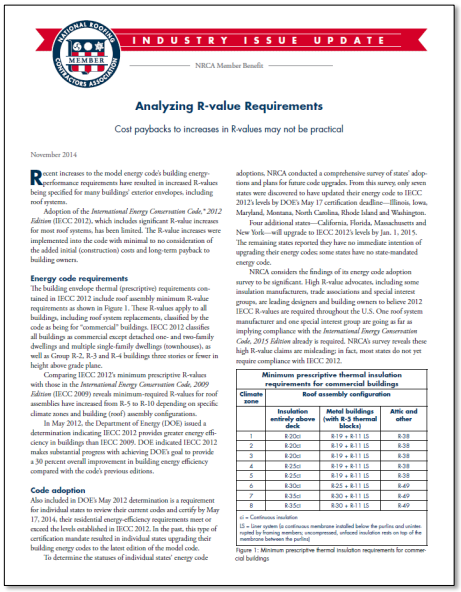

INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Analyzing R-value Requirements

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

November 2014

Recent increases to the model energy code's building energy-performance requirements have resulted in increased R-values being specified for many buildings' exterior envelopes, including roof systems.

Adoption of the *International Energy Conservation Code,® 2012 Edition* (IECC 2012), which includes significant R-value increases for most roof systems, has been limited. The R-value increases were implemented into the code with minimal to no consideration of the added initial (construction) costs and long-term payback to building owners.

Energy code requirements

The building envelope thermal (prescriptive) requirements contained in IECC 2012 include roof assembly minimum R-value requirements as shown in Figure 1. These R-values apply to all buildings, including roof system replacements, classified by the code as being for "commercial" buildings. IECC 2012 classifies all buildings as commercial except detached one- and two-family dwellings and multiple single-family dwellings (townhouses), as well as Group R-2, R-3 and R-4 buildings three stories or fewer in height above grade plane.

Comparing IECC 2012's minimum prescriptive R-values with those in the *International Energy Conservation Code, 2009 Edition* (IECC 2009) reveals minimum-required R-values for roof assemblies have increased from R-5 to R-10 depending on specific climate zones and building (roof) assembly configurations.

In May 2012, the Department of Energy (DOE) issued a determination indicating IECC 2012 provides greater energy efficiency in buildings than IECC 2009. DOE indicated IECC 2012 makes substantial progress with achieving DOE's goal to provide a 30 percent overall improvement in building energy efficiency compared with the code's previous editions.

Code adoption

Also included in DOE's May 2012 determination is a requirement for individual states to review their current codes and certify by May 17, 2014, their residential energy-efficiency requirements meet or exceed the levels established in IECC 2012. In the past, this type of certification mandate resulted in individual states upgrading their building energy codes to the latest edition of the model code.

To determine the statuses of individual states' energy code adoptions, NRCA conducted a comprehensive survey of states' adoptions and plans for future code upgrades. From this survey, only seven states were discovered to have updated their energy code to IECC 2012's levels by DOE's May 17 certification deadline—Illinois, Iowa, Maryland, Montana, North Carolina, Rhode Island and Washington.

Four additional states—California, Florida, Massachusetts and New York—will upgrade to IECC 2012's levels by Jan. 1, 2015. The remaining states reported they have no immediate intention of upgrading their energy codes; some states have no state-mandated energy code.

NRCA considers the findings of its energy code adoption survey to be significant. High R-value advocates, including some insulation manufacturers, trade associations and special interest groups, are leading designers and building owners to believe 2012 IECC R-values are required throughout the U.S. One roof system manufacturer and one special interest group are going as far as implying compliance with the *International Energy Conservation Code, 2015 Edition* already is required. NRCA's survey reveals these high R-value claims are misleading; in fact, most states do not yet require compliance with IECC 2012.

Minimum prescriptive thermal insulation requirements for commercial buildings

Climate zone	Roof assembly configuration		
	Insulation entirely above deck	Metal buildings (with R-5 thermal blocks)	Attic and other
1	R-20ci	R-19 + R-11 LS	R-38
2	R-20ci	R-19 + R-11 LS	R-38
3	R-20ci	R-19 + R-11 LS	R-38
4	R-25ci	R-19 + R-11 LS	R-38
5	R-25ci	R-19 + R-11 LS	R-38
6	R-30ci	R-25 + R-11 LS	R-49
7	R-35ci	R-30 + R-11 LS	R-49
8	R-35ci	R-30 + R-11 LS	R-49

ci = Continuous insulation
LS = Liner system (a continuous membrane installed below the purlins and uninterrupted by framing members; uncompressed, unfaced insulation rests on top of the membrane between the purlins)

Figure 1: Minimum prescriptive thermal insulation requirements for commercial buildings

NRCA "Industry Issue Update," November 2014

Payback analysis:

- 100 sq. single story building
- Costs per R+5 increases
- Energy savings per R+5 increases
- Local energy costs
- Cost ÷ Savings = Payback
- 16 cities in 8 climate zones

Payback results:

- R-10 to R-15: 7 to 19 yrs.
- R-15 to R-20: 14 to 38 yrs.
- R-20 to R-25: 22 to 61 yrs.
- R-25 to R-30: 49 to 133 yrs.

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Conclusion

Building energy usage will be more in focus…
and a topic of litigation.

NRCA recommendation

In purchase orders and contracts, identify insulation by its thickness, not its R-value.

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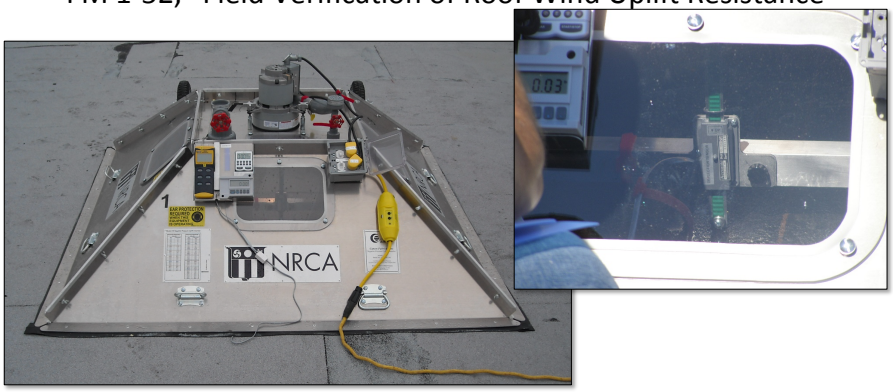
Field uplift testing

- ASTM E907, "Standard Test Method for Field Testing Uplift Resistance for Adhered membrane Roofing Systems"
- FM 1-52, "Field Verification of Roof Wind Uplift Resistance"



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INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Field-uplift testing

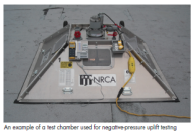
ASTM E907 and FM 1-52 tests continue to be problematic

June 2015

NRCA continues to receive a significant number of reports from roofing contractors, manufacturers and designers regarding the use of and problems associated with field-uplift tests as post-installation quality assurance measures for membrane roof systems. NRCA has addressed these testing issues a number of times during the years. Following is a summary of NRCA's previous discussions, as well as updated information and recommendations.

ASTM E907/FM 1-52

There are two recognized field test methods for determining adhered membrane roof systems' uplift resistances: ASTM E907, "Standard Test Method for Field Testing Uplift Resistance of Adhered Membrane Roofing Systems," and FM Global Loss Prevention Data Sheet 1-52 (FM 1-52), "Field Verification of Roof Wind Uplift Resistance."



An example of a test chamber used for negative-pressure uplift testing

Both test methods are similar and provide for affixing a 5- by 5-foot dome-like chamber to a roof surface's topside and applying a defined negative (uplift) pressure inside the chamber to the roof system's exterior-side surface using a vacuum pump (see photo). During the test, membrane surface deflection inside the chamber is visually monitored and measured to determine whether a roof system passes or is "suspect."

Using ASTM E907, a roof system is considered to be suspect if the deflection measured during the test is 25 mm (about 1 inch) or greater. During FM 1-52 testing, a roof system is suspect if the measured deflection is between ¼ of an inch and ⅜ of an inch depending on the maximum test pressure: 1 inch where a thin topping board (cover board) is used; or 2 inches where a thin cover board or flexible, mechanically attached insulation is used.

If an ASTM E907 or FM 1-52 test yields a suspect result, a test cut should be taken in the test area to determine whether failure has occurred and the specific failure mode.

ASTM E907 and FM 1-52 differ notably in their test cycles and maximum test pressures for determining roof system deflections and whether a roof system passes or is suspect. ASTM E907 testing is conducted in 15-pounds per square foot (psf) pressure intervals up to the calculated design wind (uplift) pressure for the specific roof system being evaluated. FM 1-52 testing is conducted using an initial 15-pounds psf pressure followed by 7.5-pound psf increments up to a maximum test pressure of 1.25 times the design uplift pressure for the specific roof system being evaluated.

Considering maximum test loading and allowable test deflections in combination, FM 1-52 requires 25 percent higher test loads, yet only allows as little as ¼ the test deflection of ASTM E907. That said, FM 1-52 is a significantly more stringent test than ASTM E907.

ASTM E907 originally was published as a recognized consensus standard in 1983, and it was revised in 1996. In 2013, ASTM withdrew ASTM E907 because a consensus could not be reached regarding necessary revisions—most significantly, defining the test method's precision and bias (accuracy). ASTM E907-96 still is available for use and can be obtained directly from ASTM's website, www.astm.org.

FM 1-52 is an FM Global-promulgated evaluation method and not a recognized industry-consensus test standard. FM 1-52's scope indicates it only is intended to confirm acceptable wind-uplift resistance on completed roof systems in hurricane-prone regions, where a partial blow-off has occurred or where inferior roof system construction is suspected or known to be present.

FM 1-52 originally was published by FM Global in October 1970. The negative-pressure uplift test was added in August 1980 and has been revised several times. The current edition is dated July 2012 and includes an option for "visual construction observation (VCO)" as an alternative to negative-pressure uplift testing. VCO provides for full-time, third-party monitoring of a roof system application to verify roof system installation in accordance with contract documents.

NRCA "Industry Issue Update," June 2015

NRCA's experience:

- Most tests not conducted in accordance with ASTM E907 or FM 1-52.
- No correlation between field test vs. lab. results/classifications
- NRCA survey: 55% passing

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The latest…

Designers specifying roof systems designs that have not been FM tested/classified, but require the contractor to pass FM 1-52 to receive payment

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NRCA recommendations

- Consider avoiding projects where field-uplift testing is indicated in the contract documents as a basis for acceptance of roofing work
- Add proposal/contract language (see Industry Issue Update).

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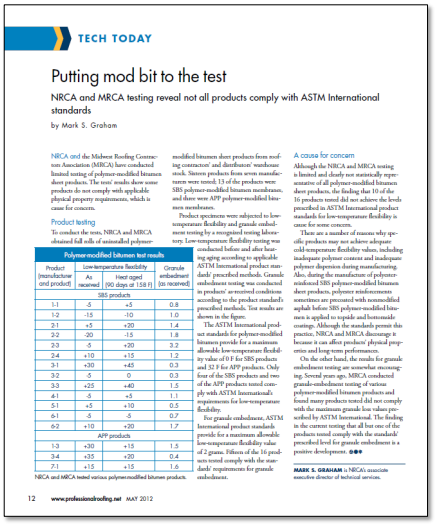
Modified bitumen sheet testing



TECH TODAY

Putting mod bit to the test

NRCA and MRCA testing reveal not all products comply with ASTM International standards

by Mark S. Graham

NRCA and the Midwest Roofing Contractors Association (MRCA) have conducted limited testing of polymer-modified bitumen sheet products. The tests' results show some products do not comply with applicable physical property requirements, which is cause for concern.

Product testing

To conduct the tests, NRCA and MRCA obtained full rolls of uninstalled polymer-modified bitumen sheet products from roofing contractors' and distributors' warehouse stock. Sixteen products from seven manufacturers were tested; 13 of the products were SBS polymer-modified bitumen membranes, and three were APP polymer-modified bitumen membranes.

Product specimens were subjected to low-temperature flexibility and granule embedment testing by a recognized testing laboratory. Low-temperature flexibility testing was conducted before and after heat aging according to applicable ASTM International product standards' prescribed methods. Granule embedment testing was conducted in products' as-received conditions according to the product standard's prescribed methods. Test results are shown in the figure.

The ASTM International product standards for polymer-modified bitumen provide for a maximum allowable low-temperature flexibility value of 0 F for SBS products and 32 F for APP products. Only four of the SBS products and two of the APP products tested comply with ASTM International's requirements for low-temperature flexibility.

For granule embedment, ASTM International product standards provide for a maximum allowable low-temperature flexibility value of 2 grams. Fifteen of the 16 products tested comply with the standards' requirements for granule embedment.

A cause for concern

Although the NRCA and MRCA testing is limited and clearly not statistically representative of all polymer-modified bitumen sheet products, the finding that 10 of the 16 products tested did not achieve the levels prescribed in ASTM International product standards for low-temperature flexibility is cause for some concern.

There are a number of reasons why specific products may not achieve adequate cold-temperature flexibility values, including inadequate polymer content and inadequate polymer dispersion during manufacturing. Also, during the manufacture of polyester-reinforced SBS polymer-modified bitumen sheet products, polyester reinforcements sometimes are precoated with nonmodified asphalt before SBS polymer-modified bitumen is applied to topside and bottomside coatings. Although the standards permit this practice, NRCA and MRCA discourage it because it can affect products' physical properties and long-term performances.

On the other hand, the results for granule embedment testing are somewhat encouraging. Several years ago, MRCA conducted granule-embedment testing of various polymer-modified bitumen products and found many products tested did not comply with the maximum granule loss values prescribed by ASTM International. The finding in the current testing that all but one of the products tested comply with the standards' prescribed level for granule embedment is a positive development.

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

Polymer-modified bitumen test results

Product (manufacturer and product)	Low-temperature flexibility: As received	Low-temperature flexibility: Heat aged (90 days at 158 F)	Granule embedment (as received)
SBS products			
1-1	-5	+5	0.8
1-2	-15	-10	1.0
2-1	+5	+20	1.4
2-2	-20	-15	1.8
2-3	-5	+20	3.2
2-4	+10	+15	1.2
3-1	+30	+45	0.2
3-2	-5	0	0.3
3-3	+25	+40	1.5
4-1	-5	+5	1.1
5-1	+5	+10	0.5
6-1	-5	-5	0.7
6-2	+10	+20	1.7
APP products			
1-3	+30	+15	1.5
3-4	+35	+20	0.4
7-1	+15	+15	1.6

NRCA and MRCA tested various polymer-modified bitumen products.

12 www.professionalroofing.net MAY 2012

NRCA's 2011 testing:

- 16 products tested:
  - 13 SBS
  - 3 APP
- 10 of 16 do not comply with their applicable product standards:
  - Low-temp. flexibility
  - Granule embedment

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2015 MB sheet testing

- 12 products tested:
  - 9 SBS products
  - 3 APP products
- 3 of 12 products tested did not comply with their applicable product standards:
  - Low-temperature flexibility
  - Granule embedment

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NRCA recommendations

- Choose time-tested and proven MB sheet products
- Consider requesting a "third-party certification of compliance" from manufacturers
  - Dade County approval
  - ICC ES evaluation report
  - Third-party (e.g., UL) test data

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Impact-resistant asphalt shingles

- Tested and classified according to UL 2218, "Impact Resistance of Prepared Roof Coverings":
  - Class 1 through Class 4
- Homeowner's insurance premium discounts in many states
- Has been an effective marketing and upselling tool

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IBHS testing

Presented at the 2015 IRE

Testing of impact-resistant architectural shingles:

- Class 1 impacts: 77% passing
- Class 2 impacts: 71% passing
- Class 3 impacts: 60% passing
- Class 4 impacts: 41% passing

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What has since happened….

Several asphalt shingle manufacturers have withdrawn their "impact resistant" asphalt shingle products from the marketplace

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NRCA's recommendations

- Check with asphalt shingle manufacturers
- Be careful not to represent "hail resistant"
- Use terminology such as:

  "…certified to comply with UL 2218, Type __ for impact resistance…"

  [insert 1, 2, 3 or 4 after Type]
- Educate yourself on state and individual insurance company impact-resistant roofing product rebate opportunities

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The NRCA Roofing Manual

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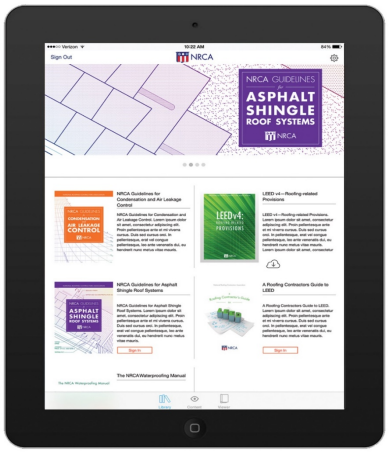
NRCA App



- 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

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Manual online

www.nrca.net

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

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