NRCA University Webinar
July 28, 2016

Roofing Industry Technical Update

presented by

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

Moisture in concrete roof decks

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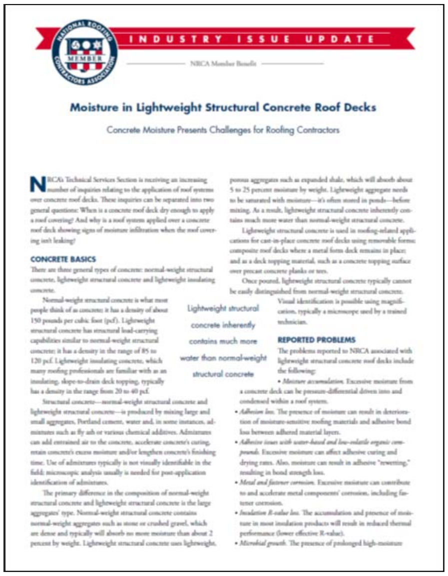

INDUSTRY ISSUE UPDATE

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 no longer reliable
  - Suggested using ASTM F2170
- NRCA recommendations:
  - Contractors should <u>not</u> determine deck dryness
  - Don't use lightweight structural concrete
  - Remedial repair suggestions

<u>Concrete roof deck moisture research</u>

- NRCA
- Chicago Roofing Contractors Association
- Chicagoland Roofing Council
- Several manufacturers

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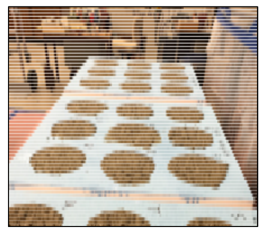
Concrete deck moisture research

Concrete pour: Monday, July 11, 2016



We expect to have some preliminary results after the first of the year…

…look for a status report at the 2017 IRE

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Polyisocyanurate insulation issues

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Professional Roofing, February 2016

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PIMA PERFORMANCE BULLETIN

Measuring the R-value of Polyiso Roof Insulation

BACKGROUND: The 2016 edition of the Roofing Manual of the National Roofing Contractors Association (NRCA) includes a recommendation for the use of an arbitrary unit R-value of 5.0 for all thicknesses and configurations of polyiso roof insulation in lieu of current ASTM C-1289 Long-Term Thermal Resistance (LTTR) values as published by polyiso insulation manufacturers. After reviewing the NRCA manual and related documents and presentations, the Polyisocyanurate Insulation Manufacturers Association (PIMA) has developed this Performance Bulletin to provide additional information to support and validate the use of PIMA member published LTTR values as the most reliable measure of polyiso thermal value for building owners, designers, specifiers, and contractors.

The North American Standard for R-value Measurement of Polyiso Roof Insulation

The R-value recommendation and underlying data published by NRCA differ from the long-established Long-Term Thermal Resistance (LTTR) data published by PIMA members for over a decade. Based on years of research and development, LTTR:

- Remains the most reliable and relevant measure of long-term polyiso roof insulation R-value for the building designer, specifier and roofing contractor.
- Is supported by years of scientific study conducted by leading research organizations, including Oak Ridge National Laboratory (ORNL) and the National Research Council of Canada (NRC-CNRC).
- Has been established as a reliable national consensus standard both in the United States (ASTM C1289) and Canada (CAN/ULC- S704) and is incorporated within all North American building codes as the designated measure of polyiso roof insulation performance.

Third-party Certified for Over Ten Years

Polyiso roof insulation LTTR values are further supported by PIMA's QualityMark℠ program, a voluntary program that allows participating polyiso manufacturers to certify LTTR values through an independent third party.

- QualityMark covers over 30 participating plants across North America, and each facility must submit to an annual verification of LTTR product values.
- During verification, an independent third-party representative visits each manufacturing facility and randomly selects a minimum of five boards for testing.
- Each selected board is sent to an approved testing laboratory, and the overall verification process is administered by FM Global, a leading independent construction testing and standards organization.
- The QualityMark program is supported by over 2,000 polyiso insulation samples tested over the past ten years, and the ultimate evidence of the success of the program is that all participating manufacturing facilities have maintained continuous certification since the program's inception.

PIMA

PIMA bulletin

www.polyiso.org

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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

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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

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Stay tuned…

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Concerns with steel roof decks

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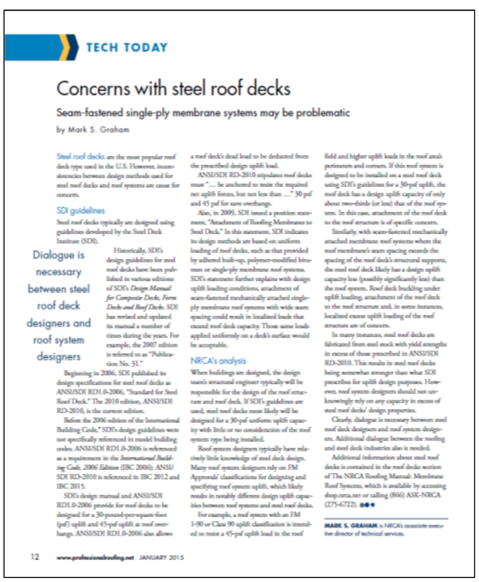
TECH TODAY

Concerns with steel roof decks

Seam-fastened single-ply membrane systems may be problematic

by Mark S. Graham

SDI guidelines

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

NRCA's analysis

Professional Roofing,
January 2015

- SDI guidelines vs. FM guidelines
- Uniformly-distributed loading vs. concentrated loading

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NRCA has arranged a meeting with AISI, SDI, SJI to discuss the issue(s) and possible solutions

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FM document updates

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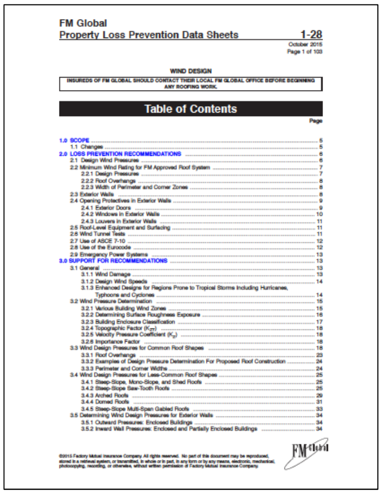
FM 1-28 has been updated

www.fmglobaldatasheets.com

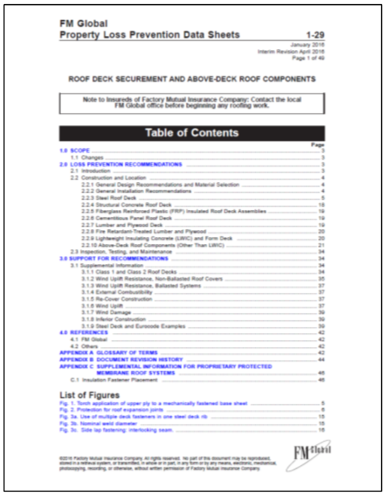


- Use RoofNav's ratings calculator
- Apply a 2.0 safety factor
- Roof overhang factors (Table 7)
- Windborne debris separation distances
- Roof-mounted equipment (ASCE 7-10)
- Tornado-resistant design (Appendix)

Professional Roofing,
March 2016

FM 1-29 has just been updated

www.fmglobaldatasheets.com



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ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS

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

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Revised/now criteria:

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

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2.2.3.2 When designing the steel deck, give consideration to the needed wind rating, and how the load is applied (concentrated vs. uniformly distributed) from the above-deck components to the deck. Where the distance between rows of roof cover fasteners is greater than half the deck span, treat as a concentrated load.

As an alternative to using Tables 1A or 1B for concentrated loads, a performance-based approach may be used if calculations are conducted by a licensed S.E. or P.E. in structural engineering. This applies to situations where the distance between rows of roof cover fasteners is greater than one-half the deck span. Make the following assumptions:

A. Assume a 3-span structural condition.

B. Assume the first row of roof cover fasteners is located at mid-point of the first deck span.

C. Assume maximum allowable stresses are determined using allowable strength design (ASD) in accordance with AISI S100-2012, or comparable standard outside the United States

Due to the more brittle nature of higher grade steels, the maximum yield stress used in the analysis is 60,000 psi (414 MPa), even for 80,000 psi (552 MPa) yield stress steel. Use Tables 1A through 1E as follows to facilitate deck selection:

Table 1A. Use for roof covers or base plies that are mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is more than half the deck span and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with a minimum yield stress of 33,000 psi (228 MPa).

Table 1B. Use for roof covers or base plies that are mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is more than half the deck span and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with a minimum yield stress of 60,000 psi (414 MPa).

Note: Where the minimum specified yield stress is between 33,000 psi (228 MPa) and 60,000 psi (414 MPa), it is reasonably accurate to interpolate the maximum deck span linearly based on Tables 1A and 1B.

Table 1C. Use for roof covers or base plies that are adhered to insulation or cover board, or mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is one-half the deck span or less and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with minimum yield stresses of 33,000 psi (228 MPa) and ultimate wind ratings of from 60 to 225 psf (2.9 to 10.8 kPa).

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Table 1C. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, Wide Rib (Type B) Steel Deck with an Adhered Roof Cover, for Wind Ratings from 60 to 225 psf (2.9 to 10.8 kPa)
(NOTE: Use this table when the distance between rows of roof cover fasteners is one-half the deck span or less. Green font indicates that deflection governs over bending stress.)

Yield Stress psi	*Deck Gauge*	*Ultimate Wind Rating per RoofNav (psf)* Maximum Span (ft) 60	75	90	105	120	135	150	165	180	195	210	225
33,000	22	7.10	7.10	7.10	7.10	7.07	6.67	6.33	6.03	5.78	5.55	5.35	5.17
	20	7.78	7.78	7.78	7.78	7.78	7.43	7.05	6.72	6.44	6.18	5.96	5.76
	18	9.08	9.08	9.08	9.08	9.08	8.66	8.22	7.84	7.50	7.21	6.95	6.71
	16	10.36	10.36	10.36	10.36	10.36	9.89	9.38	8.94	8.56	8.23	7.93	7.66
40,000	22	7.10	7.10	7.10	7.10	7.10	7.10	6.96	6.64	6.35	6.10	5.88	5.68
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.76	7.40	7.08	6.80	6.56	6.33
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.04	8.62	8.25	7.93	7.64	7.38
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.32	9.84	9.42	9.05	8.72	8.43
45,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.04	6.74	6.48	6.24	6.03
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.51	7.22	6.95	6.72
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	8.76	8.41	8.11	7.83
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	9.99	9.60	9.25	8.94
50,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.93	6.66	6.42	6.20
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.72	7.42	7.15	6.91
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.00	8.65	8.33	8.05
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.28	9.87	9.51	9.19
55,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.90	6.67
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.69	7.43
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	8.97	8.66
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.24	9.89
60,000 +	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.97
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.77
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.06
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.34

Green font indicates that deflection governs over bending stress.

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Table 1A. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, 33,000 psi (228 MPa) Yield Stress with a Mechanically Fastened Roof Cover (continued)
(Note: Use this table when the distance between rows of roof cover fasteners is more than one-half the deck span.)

Max Deck Spans By Wind Rating/Fastener Spacing, Sheet Gauge for 33 ksi, 1½ in. Deep Wide Rib Deck

Roof Cover Fastener Row Spacing (ft)	Gauge	Wind Rating [psf] 330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
8	18	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5.5	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	6
8.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	6
9	18	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5
9.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	4.5	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5
10	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5
10.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5
11	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5
11.5	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
12	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		4	5
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			4
Roof Cover Fastener Row Spacing	Gauge	330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
		Wind Rating [psf]																		

Green font indicates that deflection governs over bending stress.

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2.2.4.2 Lightweight Structural Concrete (LWSC) Roof Deck

2.2.4.2.1 Where the structure will not safely support normal-weight concrete and therefore lightweight structural concrete (90-115 pcf [14401840 kg/m^3]) must be used (e.g., to provide required fire-resistance ratings), design the concrete and its reinforcement as a noncomposite type and pour the LWSC over removable forms.

Lightweight aggregate retains a great deal of moisture that will be released for several months after the concrete has hardened and will be absorbed by abovedeck components. This will damage and weaken those components, resulting in damage from winds below design speeds, or premature deterioration requiring replacement.

2.2.4.2.2 Where the use of removable forms is not practical, take the following precautions to prevent moisture damage to above-deck roof components:

A. Use the lowest reasonable water-to-cement (w/c) ratio in the concrete mix. "Water reducers" may be used in the concrete mix; however, do not use water-reducing admixtures that contain calcium chloride or other chloride salts that are corrosive to the steel form deck.

In addition, do **one** of the following (B or C):

B. Use an FM Approved assembly consisting of a mechanically fastened modified bitumen base sheet directly over a concrete deck followed by adhered components above, or

C. Ensure the concrete roof deck is dry before installing the above-deck components. In some cases, this could take months. Perform a test to ensure the moisture migration has been reduced to a level where damage to above-deck components is unlikely based on the product manufacturer's recommendations (note: neither the Plastic Sheet Method Test [ASTM D4263] nor the Calcium Chloride Test [ASTM F1869] are recommended for this purpose). The test procedures and acceptance criteria must first be agreed upon by all stakeholders.

Note: The following are NOT considered substitutes for the above recommendations:

- The use of a vented steel form deck alone (without one of the above alternatives) because it will have limited impact on moisture reduction.
- The use of above-deck components that are resistant to moisture.

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Professional Roofing,
July 2016

NRCA technical program/document updates

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Roof Wind Designer update

www.roofwinddesinger.com

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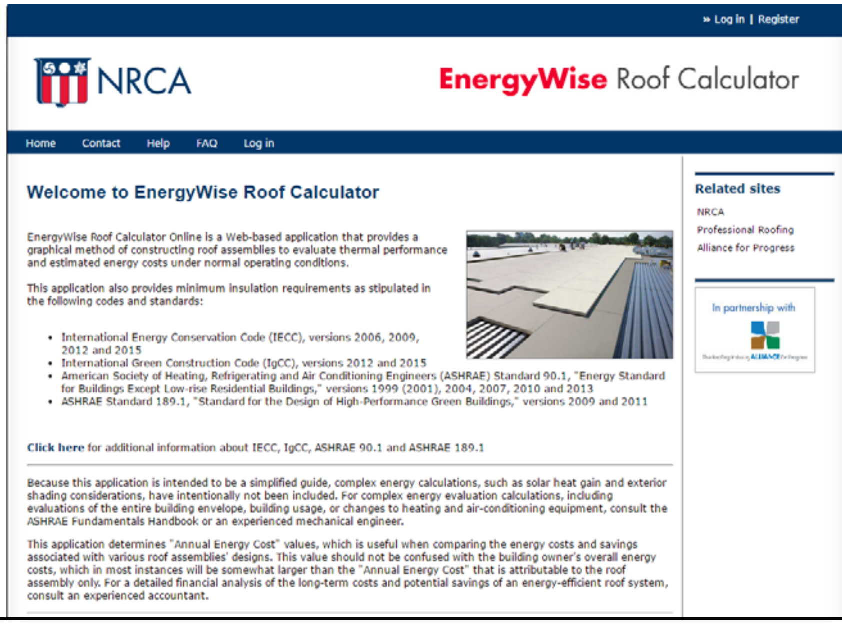
EnergyWise Roof Calculator update

energywise.nrca.net



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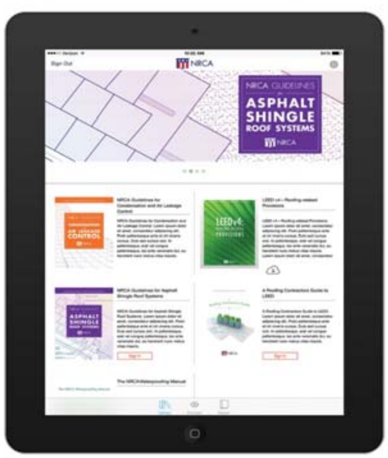
The NRCA Roofing Manual

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

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