



**Low Slope Roofing Systems**  
**The University of Wisconsin Madison**  
Madison, Wisconsin – December 1-2, 2020

**Roof decks and wind design**

presented by

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

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**Definition**

*International Building Code, 2021 Edition*

**Roof deck:** The flat or sloped surface constructed on top of the *exterior walls* of a building or other supports for the purpose of enclosing the *story* below, or shelter an area, to protect it from the elements, not including its supporting members or vertical supports



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### A roof deck....

- is a building's structural component of the roof assembly
- must be capable of safely supporting the design dead and live loads, including the weight of the roof system, and any additional loads that may be required by the applicable building code
- also provides the substrate to which roof systems are applied
- are categorized as either noncombustible (steel, concrete) or combustible (plywood, OSB, wood planks, wood boards)
- can also be categorized as "nailable" (attachment) or "non-nailable" (adhesion)

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## Types of roof decks

- Cementitious wood fiber panels
- Lightweight insulating concrete
- Steel
- Structural concrete (cast-in-place, precast-prestressed and post-tensioned)
- Wood panels (plywood, OSB)
- Wood planks and wood boards



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## Cementitious wood fiber panels



- Noncombustible
- Nailable
- Available as a composite product with rigid board insulation
- NRDC 600, "Guidelines for the Application of Cementitious Wood Fiber Roof Deck Systems ([Link](#))"



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## Lightweight insulating concrete



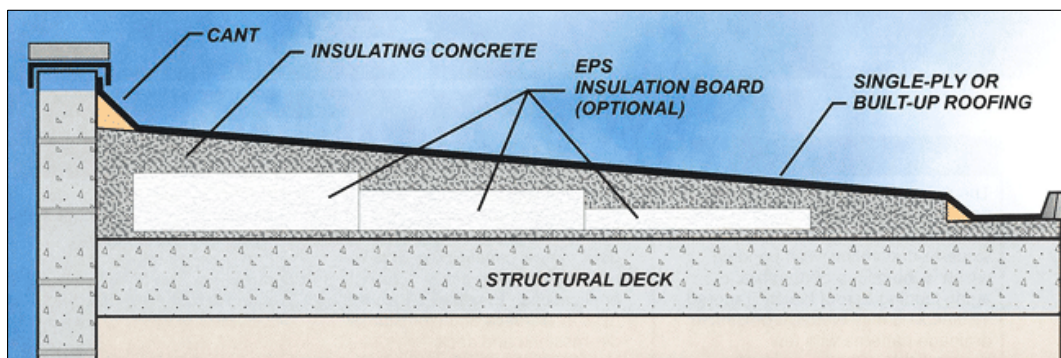
- Noncombustible
- Nailable
- Poured in place
- Two types:
  - Lightweight aggregate
  - Lightweight cellular
- NRDCA 100: aggregate ([Link](#))
- NRDCA 175: cellular ([Link](#))
- Drying & venting considerations



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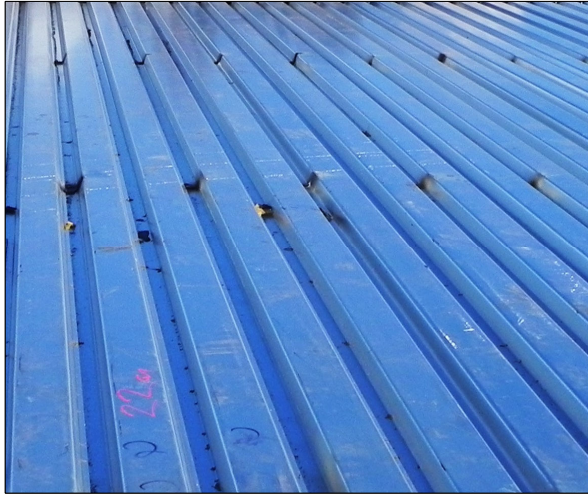
## Cross section view

Lightweight insulating concrete



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### Steel roof deck

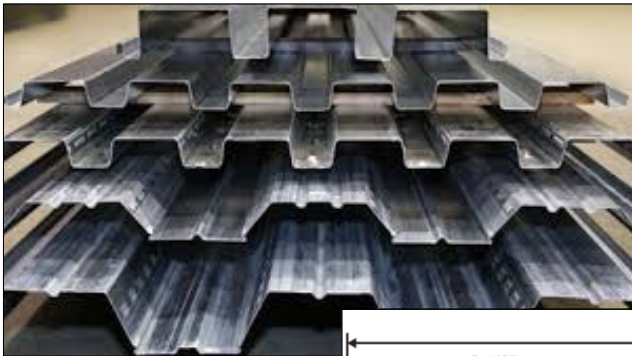


- Noncombustible
- Mechanical fasteners
- Multiple profiles/spans
- Prime painted and galvanized
- Two strength types:
  - 33 KSI
  - 80 KSI
- SDI RD-100, “Steel Roof Deck”

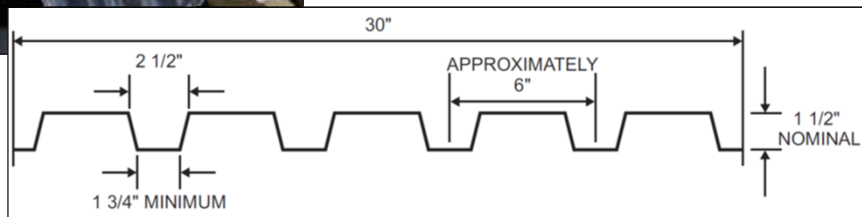


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### Steel roof deck -- continued



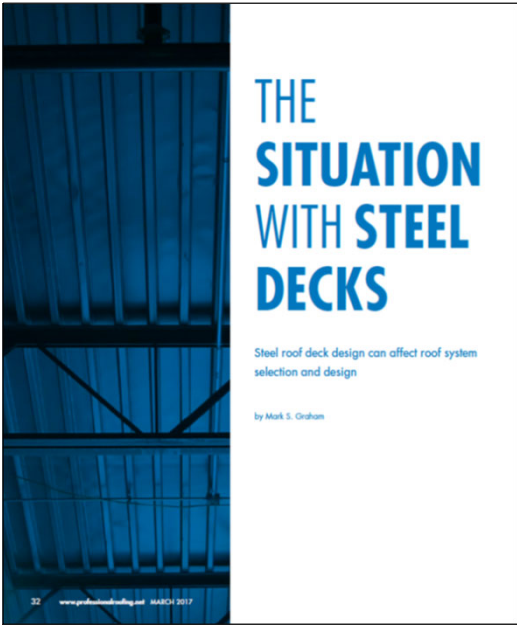
Steel roof deck configurations



Wide-rib steel roof deck (Type B)



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**Professional Roofing**  
March 2017

[Link](#)

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### Structural concrete



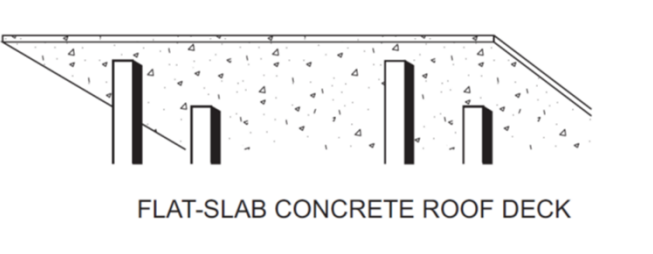
- Noncombustible
- Non-nailable
- Composition types:
  - Normal weight (150 lbs./ft<sup>3</sup>)
  - Lightweight (90-110 lbs./ft<sup>3</sup>)
- Construction types:
  - Cast-in-place (incl. post tensioned)
  - Precast-prestressed
- Curing and drying considerations

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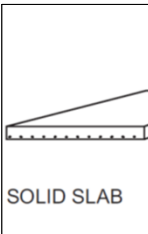


## Structural concrete -- continued

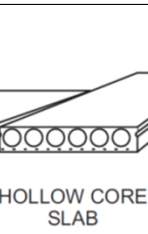


FLAT-SLAB CONCRETE ROOF DECK


Cast-in-place concrete roof deck



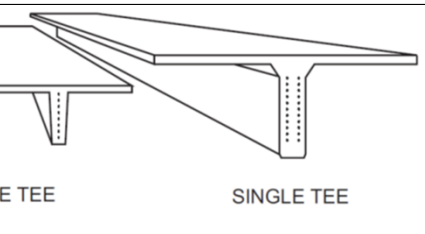
SOLID SLAB



HOLLOW CORE SLAB




DOUBLE TEE



SINGLE TEE

Precast concrete units



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**Concerns with Concrete Roof Decks / Moisture Release Present Challenges**  
**by Mark S. Graham, Vice President, Technical Services, National Roofing Contractors Association (NRCA)**

Newly poured and, in some instances, existing structural concrete roof decks present unique moisture migration problems for the roofing industry. In a number of instances reported to NRCA, significant amounts of water have been found in roof systems within as soon as several months after construction. In most of these situations, it was determined the roof membranes were watertight and not the sources of the moisture infiltration. In many of these situations, this moisture infiltration resulted in damage to the roof systems, including adhesion loss, issues with water-based and low-VOC adhesives, metal and fastener corrosion, insulation R-value loss and microbial growth.

**Concrete basics and dryness**  
 When mixed, poured and formed, normal-weight and lightweight structural concrete contain significant amounts of water. As concrete cures and hardens, it consumes large amounts of water through hydration and evaporation. For example, a 4-inch-thick concrete slab will release about 1 quart of water for each square foot of its surface area.

Previously, the roofing industry had used a minimum 28-day drying period as a guideline for applying roofing materials over newly poured concrete decks. This 28-day period coincided with the curing time of concrete before it is tested for design compressive strength. In reality, there is little to no correlation between this 28-day period and concrete's true "dryness."

Similar to the roofing industry, the concrete industry has seen significant advances in technology regarding concrete mix design, placement and curing. For example, the use of admixtures in concrete mix designs can accelerate concrete's curing and strength development but retard the release of concrete's free moisture. Similarly, weather conditions, covering newly poured concrete, timing of form removal, and temporary heating or ventilating of a building's interior after placement can affect concrete's upward or downward release of free moisture.

## Concerns with concrete roof decks: Moisture release present challenges

June 2020

[Link](#)

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### Plywood and OSB panels



- Combustible
- Nailable
- Thickness and span
- Standards:
  - PS 1: Plywood
  - PS 2: OSB
  - APA PRP-108: Plywood or OSB
- APA Engineered Wood Construction Guide (E30): Roof Construction ([Link](#))



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### Wood plank and wood boards



- Combustible
- Nailable
- Wood planks: 2-5 inches thick with straight edges or T & G
- Wood boards: Less than 2 inches thick with square edges
- Species, thickness and span
- American Timber Council (ATC) *Timber Construction Manual*



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## **Other roof deck types**

Sometimes encountered in reroofing

- Gypsum
  - Poured in place
  - Panels
- Thermal-setting fills
- Tile or masonry
- Various fills:
  - “Actinolite”
- Various composites
  - “Loadmaster”



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## **Additional considerations**

Roof decks

- Deflection and smoothness
- Slope to drain
- Temporary weather protection
- Structural expansion joints & roof control joints
- Construction loading
- Deck “acceptance”



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**A Roofing Contractor’s “acceptance”  
of a roof deck should be limited to:**

- Cleanliness: Broom clean (maybe leaf-blower clean)
- No visible surface moisture

*Any additional acceptance criteria is likely  
beyond a roofing contractor’s expertise*



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**Questions**

Roof decks



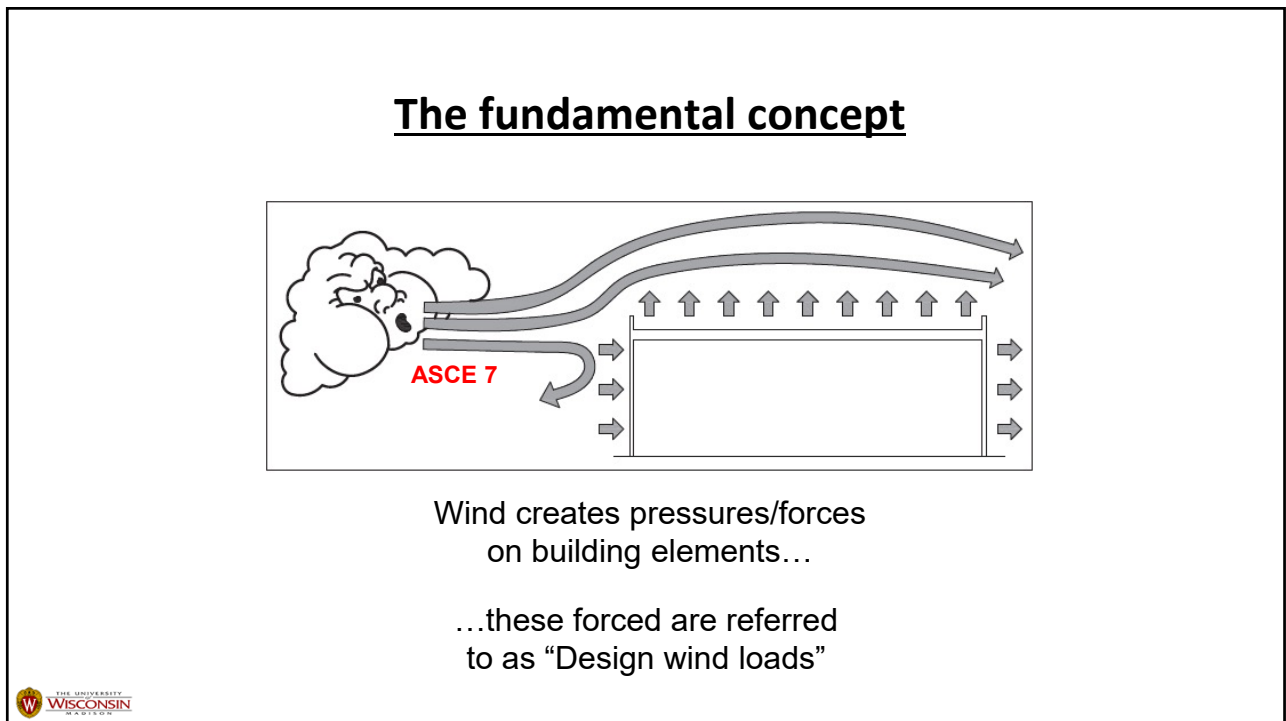
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## Wind design

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## The fundamental concept -- continued

A roof system needs to be able to “resist” the design wind loads acting on a building.

- Roof systems are tested for their “resistance” (attachment, adhesion):
  - FM Approvals classifications (FM 1-60, 1-90, 1-120, etc.)
  - UL classifications (UL Class 30, 60, 90)
  - Engineering analysis



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## The fundamental concept -- continued

Design wind loads  $\leq$  Tested resistance\*

ACE 7-16  $\leq$  FM Approvals classification or  
UL classification\* or  
Engineering analysis\*

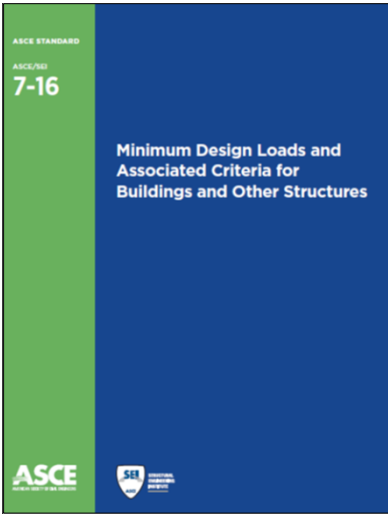
- \* A “safety factor”, typically 2.0 (i.e., 1/2 of tested resistance), is applied to account for variations in designs, materials, application and roof system aging/deterioration.



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### Design wind loads

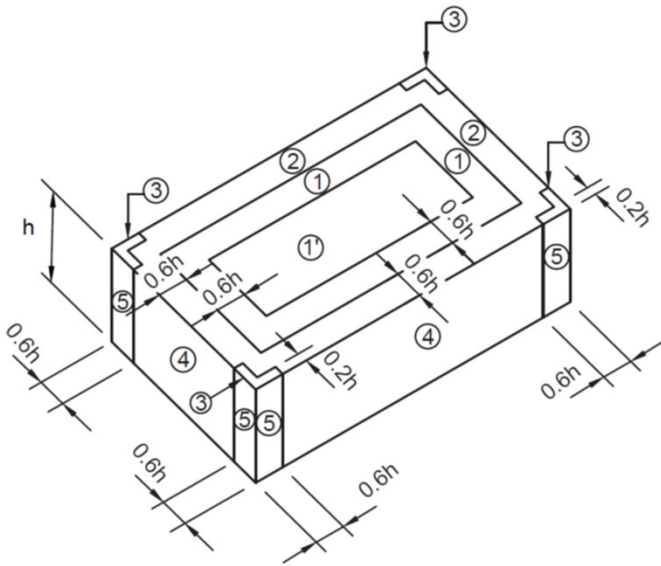


**ASCE 7-16, “Minimum Design Loads and Associated Criteria for Buildings and Other Structures”**

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### Roof zones

For buildings up to 60 high



**Pressure coefficients (ASCE 7-16)**

- Zone 1': 0.9
- Zone 1: 1.7
- Zone 2: 2.3
- Zone 3: 3.2

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### Roof zones -- continued

For buildings greater than 60 high

**Pressure coefficients**

- Zone 1: 1.7
- Zone 2: 2.3
- Zone 3: 3.2

a = 10% of the least horizontal dimension, or 0.4 times the building height, whichever is smaller; but not less than either 4% of the least horizontal Dimension or 3 feet

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### Example design wind load calculation using ASCE 7-16

**Example:** A low-rise office building (Risk Category II) is located in Madison, WI. The building is an enclosed structure with a mean roof height of 60 ft. The building is located in an open terrain area that can be categorized as Exposure Category C.

Document	Basic wind speed (mph)	Design wind pressure (psf)			
		Zone 1' (Center)	Zone 1 (Field)	Zone 2 (Perimeter)	Zone 3 (Corners)
ASCE 7-16 Ult.	$V_{ULT} = 105$	29.5	51.2	67.6	92.0
ASCE 7-16 ASD	$V_{ASD} = 90$	17.7	30.7	40.5	55.2

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### Example design wind load calculation using ASCE 7-16

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An FM 1-75 classification provides adequate resistance



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### Considerations/Reminders

- Design wind loads should be determined by the building/roof assembly designer
- Taller buildings, higher wind pressures
- Increasing basic wind speeds, higher wind pressures
- Don't confuse (basic) wind speeds, with pressures:
  - For example, FM 1-90 means 45 psf, not 90 mph
- Proper wind design is relatively complicated



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## Roof Wind Designer

www.roofwinddesigner.com

**roofwinddesigner.com**

ASCE 7-05, ASCE 7-10 and ASCE 7-16

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Roof Wind Designer is intended to provide users with an easy-to-use means for determining roof systems' design wind loads for many commonly encountered building types that are subject to building code compliance.

Design-wind loads are derived using the American Society of Civil Engineers (ASCE) Standard ASCE 7, "Minimum Design Loads for Buildings and Other Structures." This standard is a widely recognized consensus standard and is referenced in and serves as the technical basis for wind load determination in the International Building Code and NFPA 5000: Building Construction and Safety Code. Roof Wind Designer allows users to choose between ASCE 7's 2005, 2010, and 2016 editions. Roof Wind Designer uses ASCE 7-05's Method 1—Simplified Method, ASCE 7-10's Envelope Procedure, Part 2: Low-rise Buildings (Simplified) of Chapter 30, ASCE 7-16's Envelope Procedure, Part 2: Low-rise Buildings (Simplified) of Chapter 30, and Part 4: Buildings with  $60\text{ft} < h \leq 160\text{ft}$  (Simplified). For a more detailed explanation of ASCE 7's three editions, please [click here](#).

Also, Roof Wind Designer determines roof systems' minimum recommended design wind-resistance loads, which are derived from the building's design wind loads, taking into consideration a safety factor in reliance of [ASTM D6630](#), "Standard Guide for Low Slope Insulated Roof Membrane Assembly Performance," [AISI S100](#), "North American Specification for the Design of Cold-formed Steel Structural Members" and [AA ADM1](#), "Aluminum Design Manual: Part 1-A—Specification for Aluminum Structures, Allowable Stress Design; and Part 1-B—Aluminum Structures, Load and Resistance Factor Design." Using these minimum recommended design wind-resistance loads, users can select appropriate wind resistance classified roof systems.

Edge-metal flashing systems take into consideration a safety factor in reliance of [ANSI/SPR1ES-1](#) "Test Standard for Edge Systems Used with Low Slope Roofing Systems."

Roof Wind Designer has been developed and is maintained by the National Roofing Contractors Association (NRCA), with initial support of the Midwest Roofing Contractors Association (MRCA) and the North/East Roofing Contractors Association (NERCA). The application is currently available at no cost.

Questions regarding Roof Wind Designer can be directed to the [Contact Us](#) page.

To register for a new account [click here](#). If you already have an account, [click here](#) to login.

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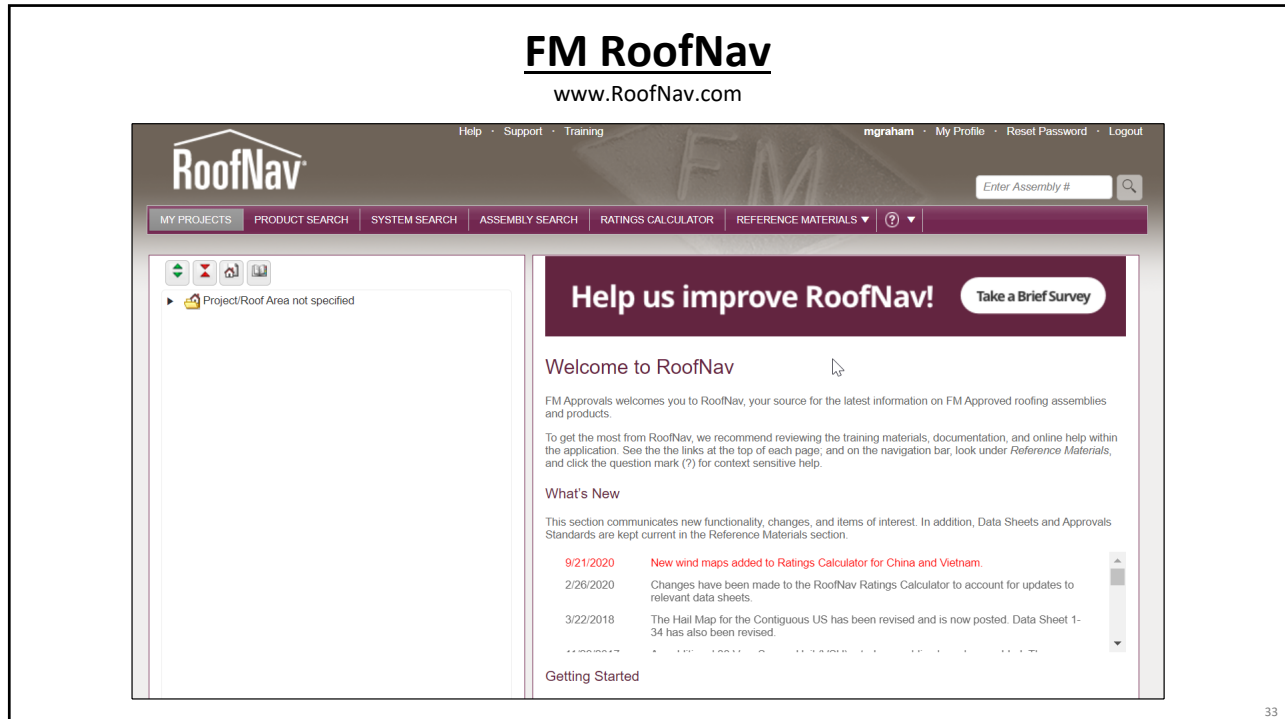
Review Results



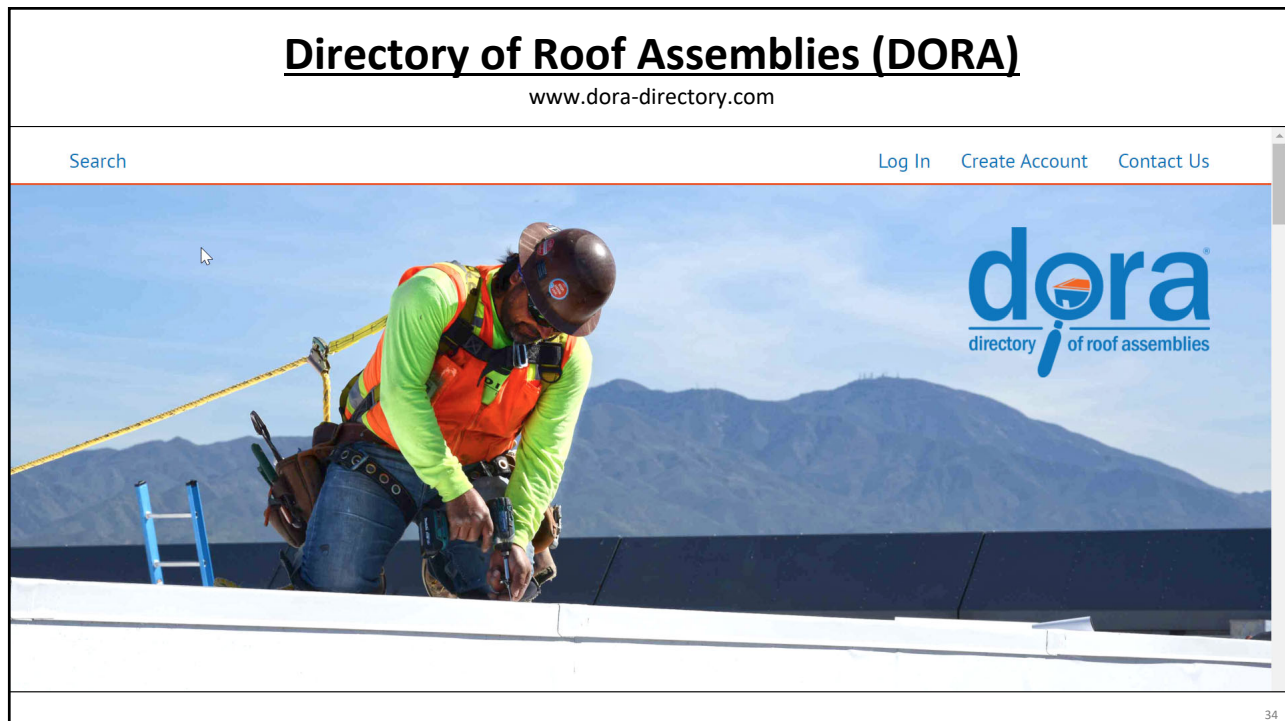
Certification Information

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# FM Global Loss Prevention Data Sheets

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**FM Global Property Loss Prevention Data Sheets 1-28**  
October 2015  
Interim Revision October 2020  
Page 1 of 100

**WIND DESIGN**

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## FM 1-28, Wind Design

### Design wind load determination

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# FM Global Loss Prevention Data Sheets

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**ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS**

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## FM 1-29, Roof Deck Securement and Above-deck Roof Components Resistance

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### Comparing ASCE 7-16's design wind loads to FM 1-28's

**Example:** A low-rise office building (Risk Category II) is in Madison, WI. The building is an enclosed structure with a mean roof height of 60 ft. The building is in an open terrain area that can be categorized as Exposure Category C.

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FM 1-90



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## Questions

Roof decks



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**Mark S. Graham**

Vice President, Technical Services  
National Roofing Contractors Association  
10255 West Higgins Road, 600  
Rosemont, Illinois 60018-5607

(847) 299-9070  
mgraham@nrca.net  
www.nrca.net

Personal website: [www.MarkGrahamNRCA.com](http://www.MarkGrahamNRCA.com)