Low Slope Roofing Systems
The University of Wisconsin Madison
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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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Steel roof deck

Steel roof deck on steel joists on steel beams

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A roof deck….

- is a building's structural component of the roof assembly
- must be capable of safety 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 bord insulation
- NRDCA 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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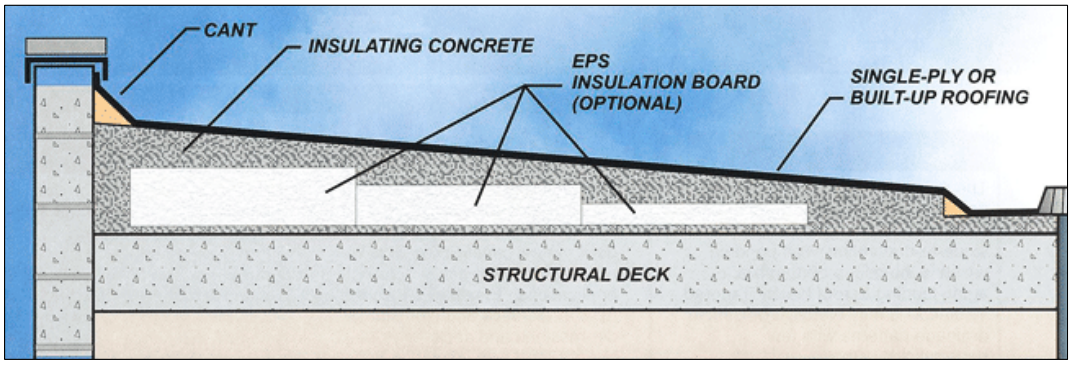
Cross section view

Lightweight insulating concrete



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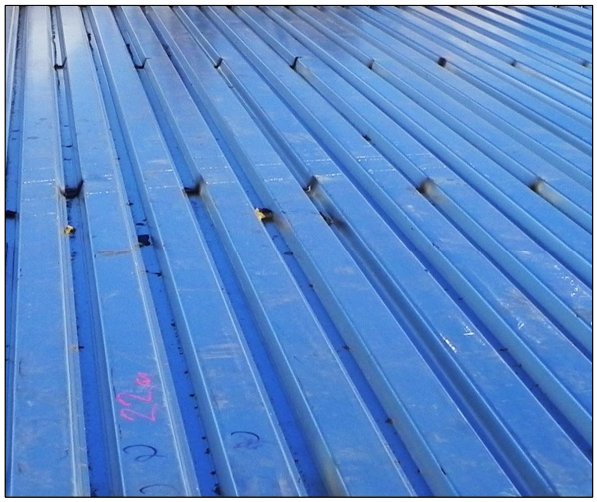
Steel roof deck



- 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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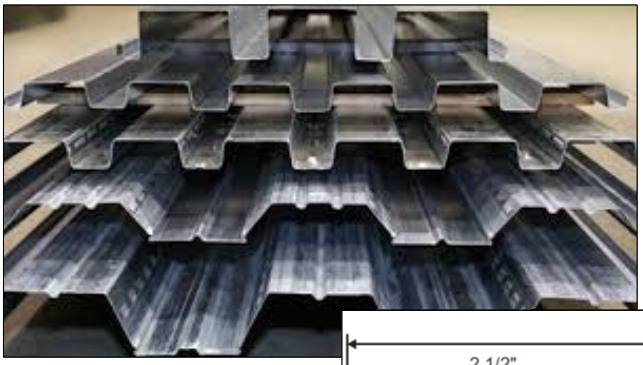
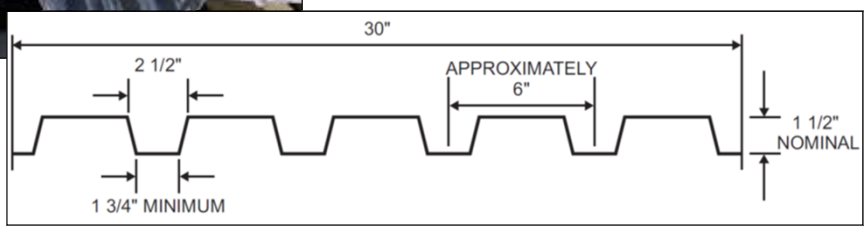
Steel roof deck -- continued



Steel roof deck configurations



Wide-rib steel roof deck (Type B)

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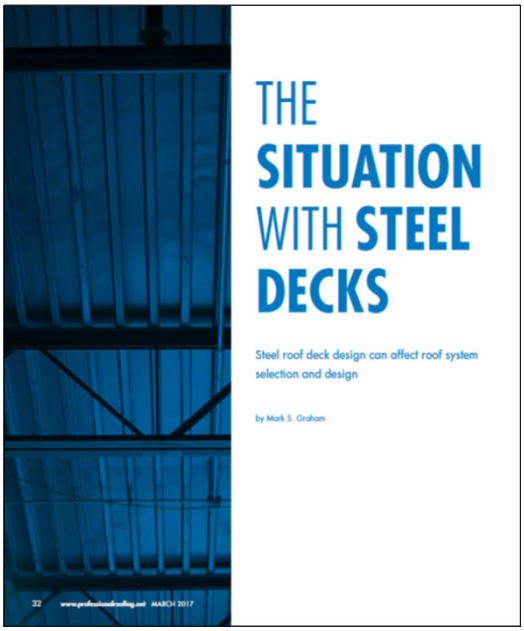

Professional Roofing
March 2017

Link

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Structural concrete

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

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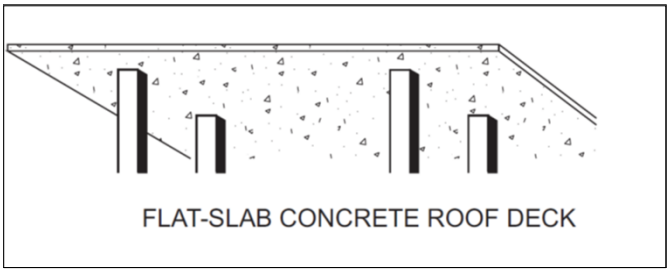
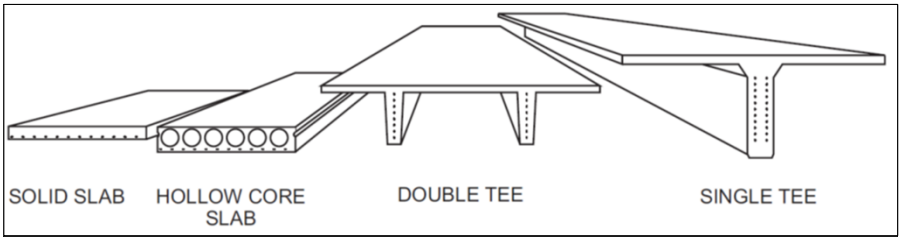
Structural concrete -- continued



Cast-in-place concrete roof deck



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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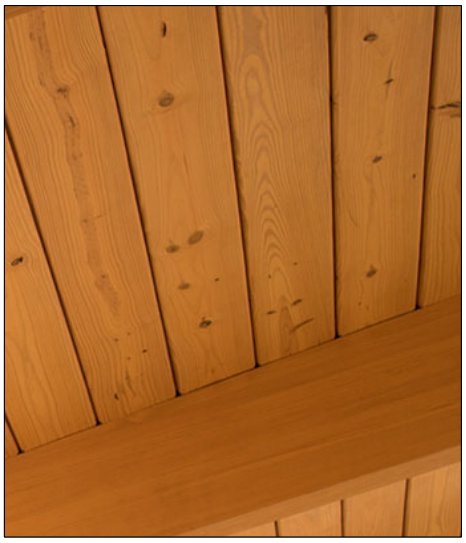
Wood plank and wood boards



- 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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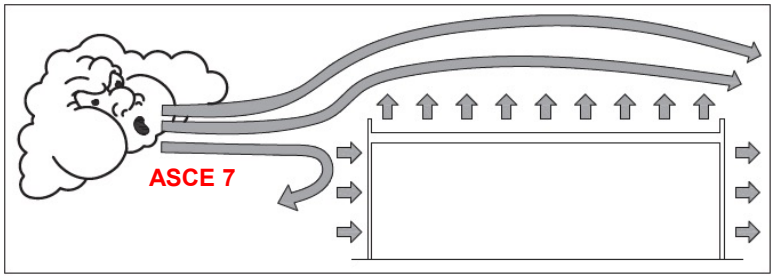
The fundamental concept



Wind creates pressures/forces
on building elements…

…these forced are referred
to as “Design wind loads”

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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 ≤ Tested resistance*

ACE 7-16 ≤ 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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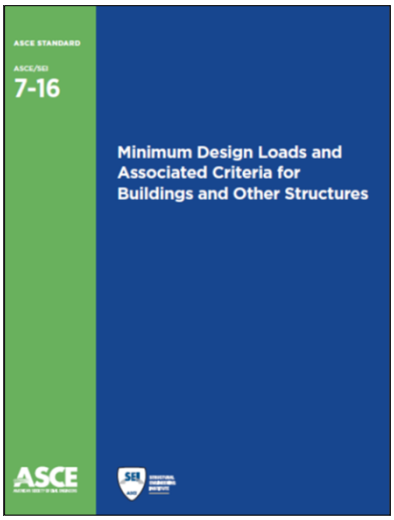
Design wind loads



ASCE 7-16, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures"

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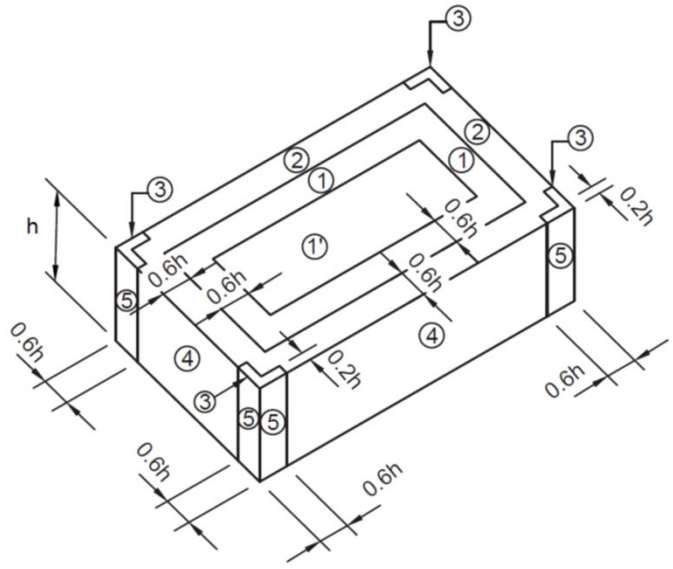
Roof zones

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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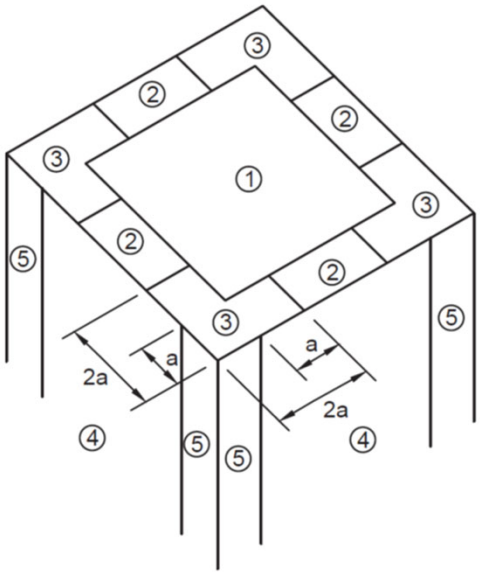
Roof zones -- continued

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, hihger 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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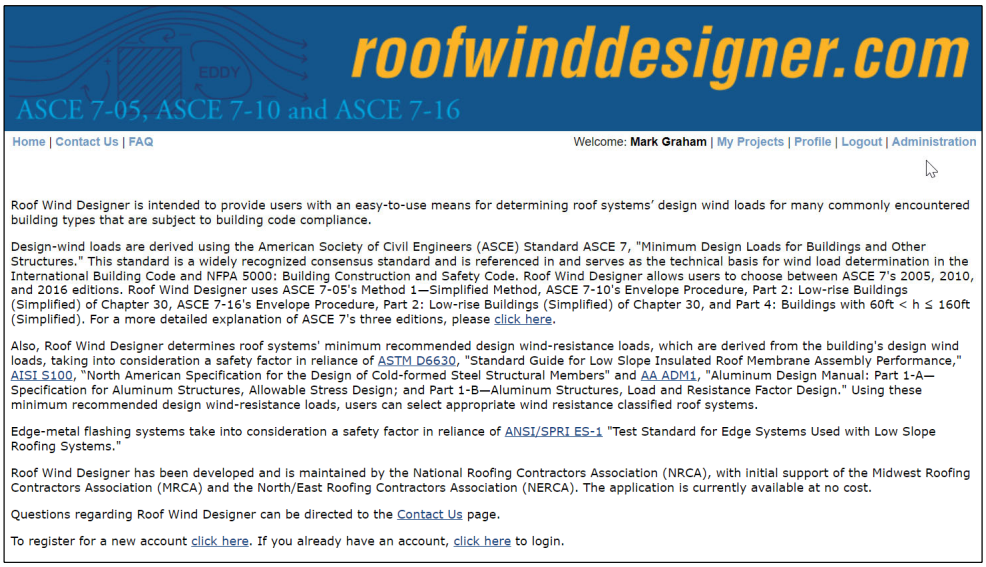
Roof Wind Designer

www.roofwinddesigner.com



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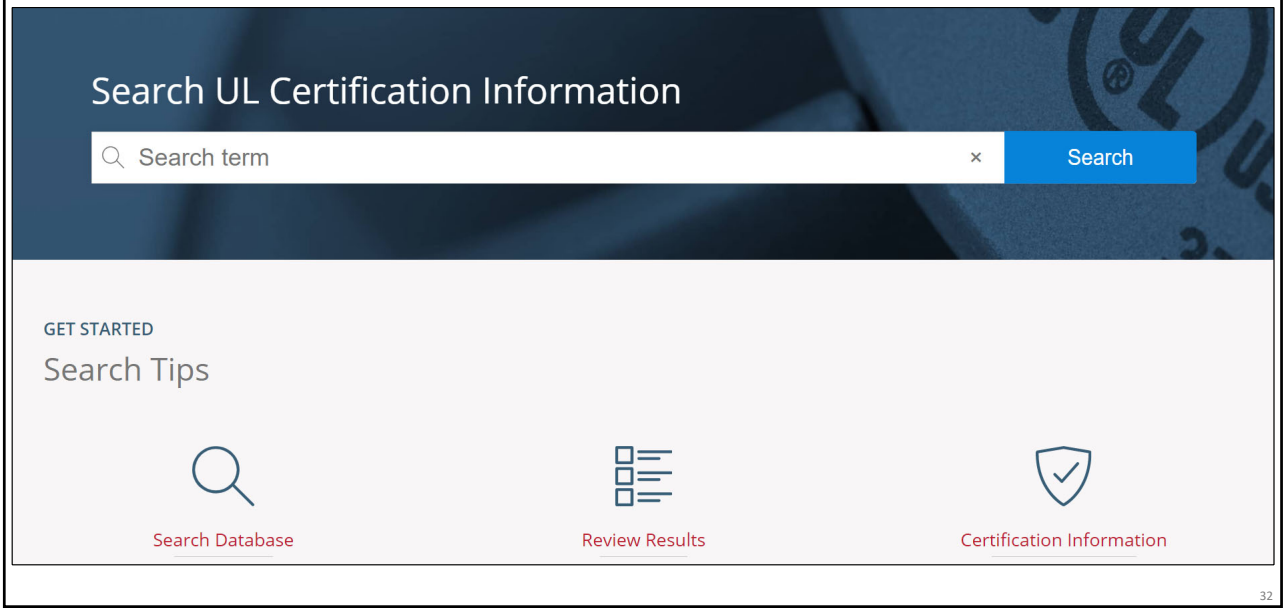
UL Product iQ

www.productiq.ulprospector.com



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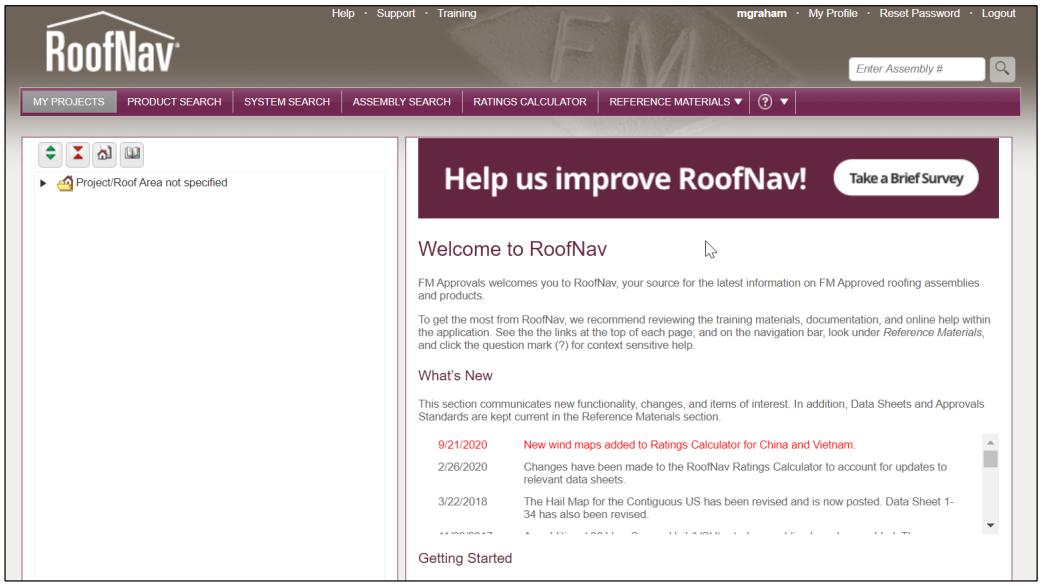
FM RoofNav

www.RoofNav.com



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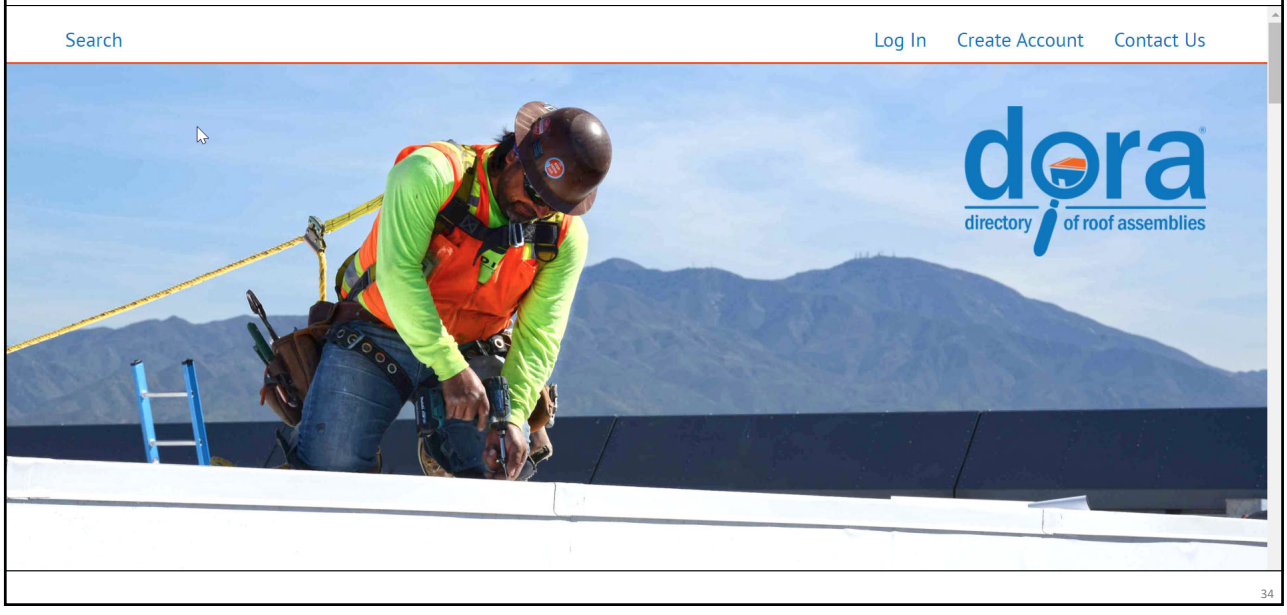
Directory of Roof Assemblies (DORA)

www.dora-directory.com



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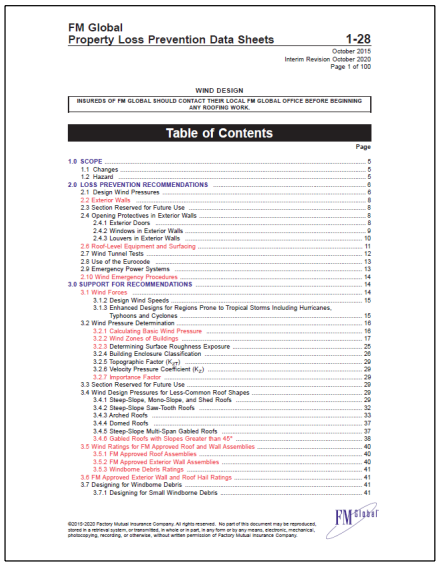
FM Global Loss Prevention Data Sheets

www.FMGlobalDataSheets.com



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October 2015
Interim Revision October 2020
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WIND DESIGN

INSUREDS OF FM GLOBAL SHOULD CONTACT THEIR LOCAL FM GLOBAL OFFICE BEFORE BEGINNING ANY ROOFING WORK.

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FM 1-28, Wind Design

Design wind load determination

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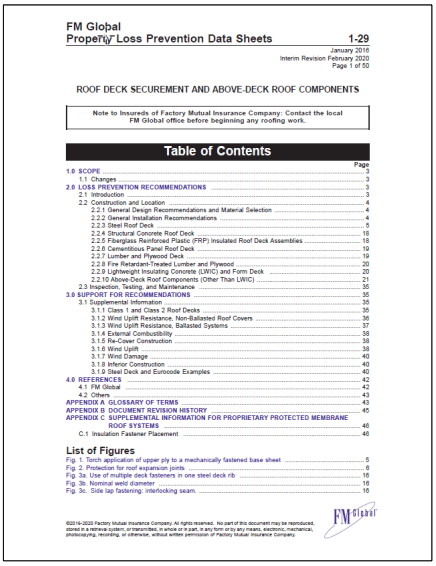

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Interim Revision February 2020
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ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS

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

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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

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ASCE 7-16 ASD	V_{ASD} = 90	17.7	30.7	40.5	55.2
FM 1-28	V_{ASD} = 90	24	43	57	77

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

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