Blown Away: Code requirements for membrane roofs

May 18, 2021

ROOFING CONTRACTORS ASSOCIATION OF BRITISH COLUMBIA | RoofStar GUARANTEED. BETTER.

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Introduction

Bio for:

James Klassen*

RoofStar Technical Advisor

- ☆ 14 years as an independent claims adjuster
- ☆ Estimating and OH&S for northern RCABC Member
- ☆ Manager of facilities, grounds and transportation (MEI Schools, Abbotsford)
- ☆ Technical Advisor with the RCABC since 2014

* 55 years with hair

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Agenda

- ☆ A brief intro
- ☆ Why wind matters
- ☆ The British Columbia Building Code
  - ☆ an overview
  - ☆ designing for wind
- ☆ Who’s in charge here? – Design responsibility
- ☆ Using the tools: from Code to actual design
- ☆ Specifying a Code-compliant roof

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- 54 Member Contractors around BC
- 33 Accepted Observer Firms
- 65 Manufacturers and Suppliers

Why wind matters

Why wind matters

☆ Wind pushes…

Why wind matters

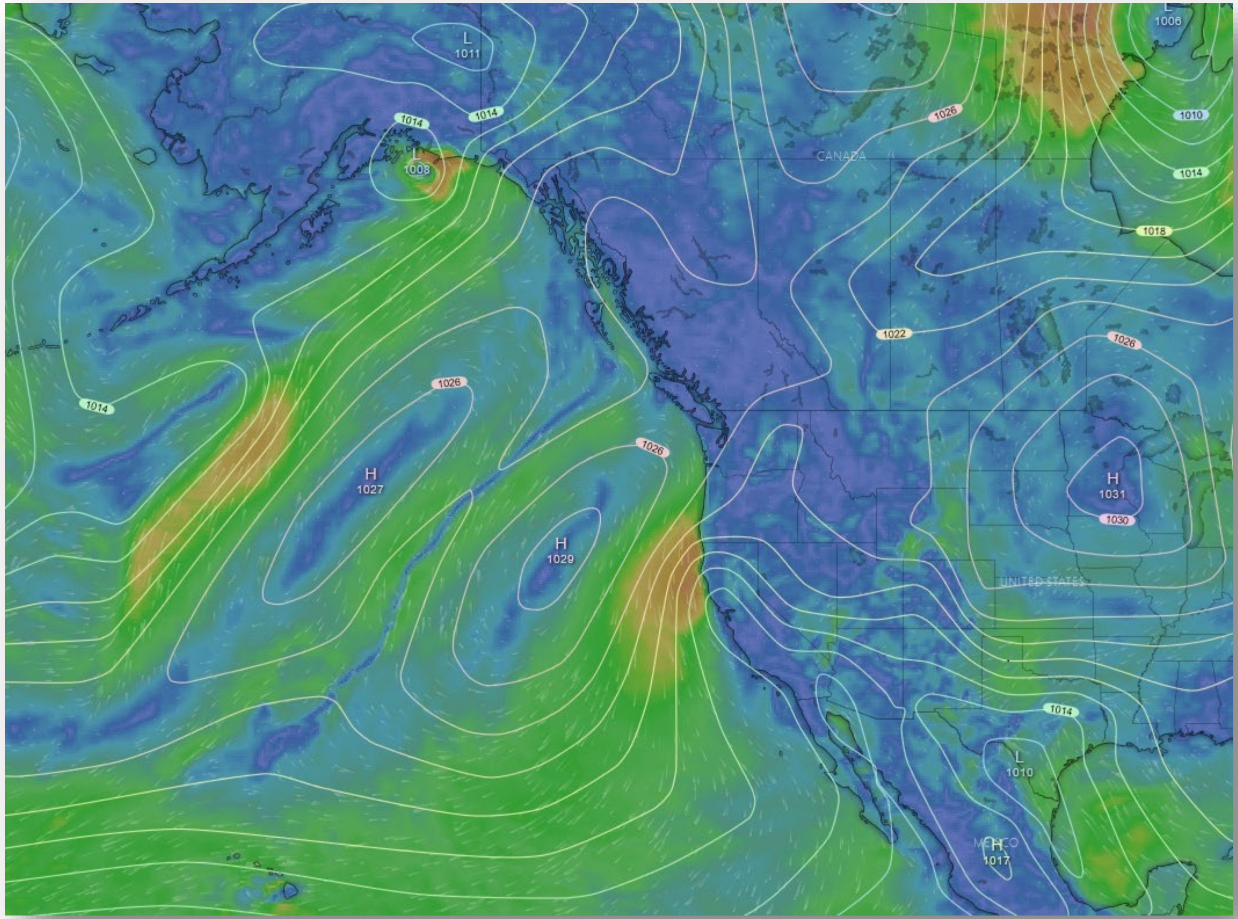
- ☆ …but it also pulls (or sucks)

Why wind matters

Wind that "sucks"

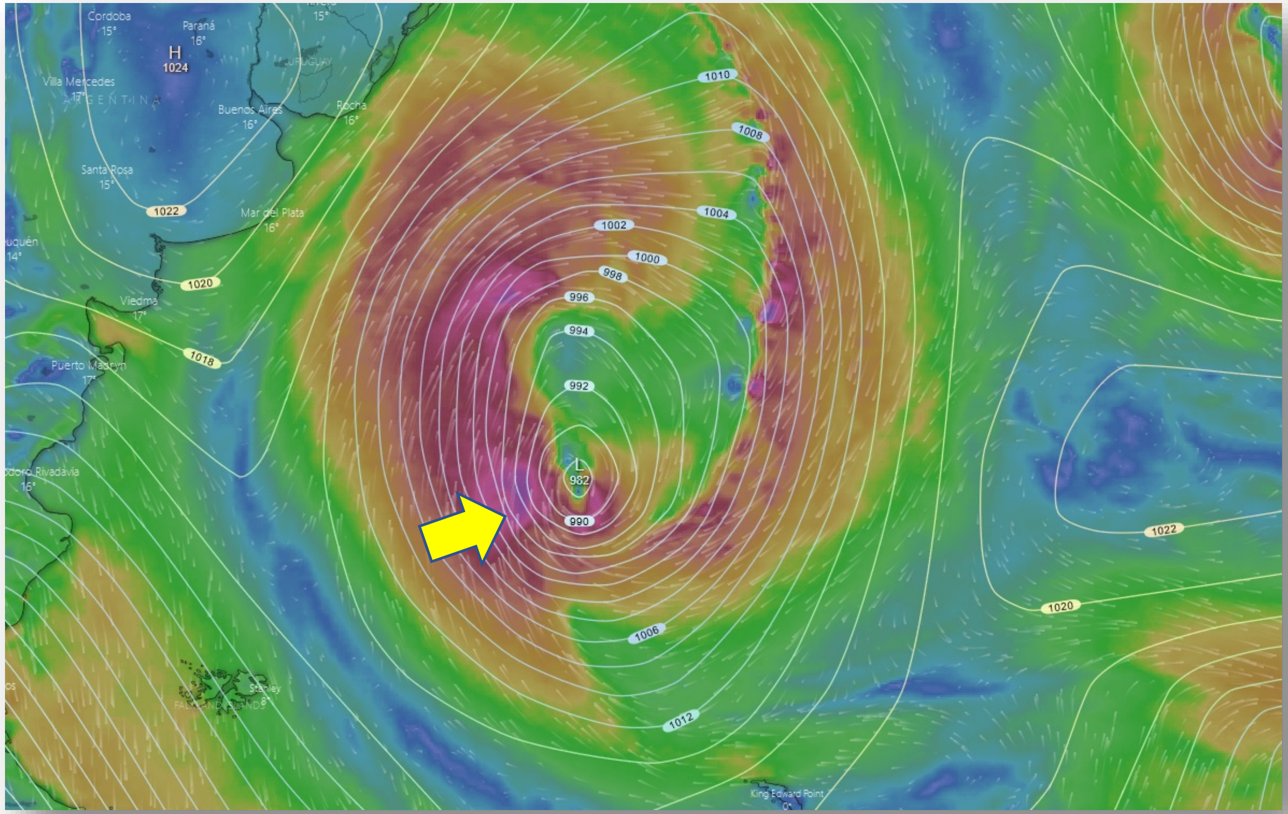
Why wind matters

☆ Wind is generated by atmospheric highs and lows



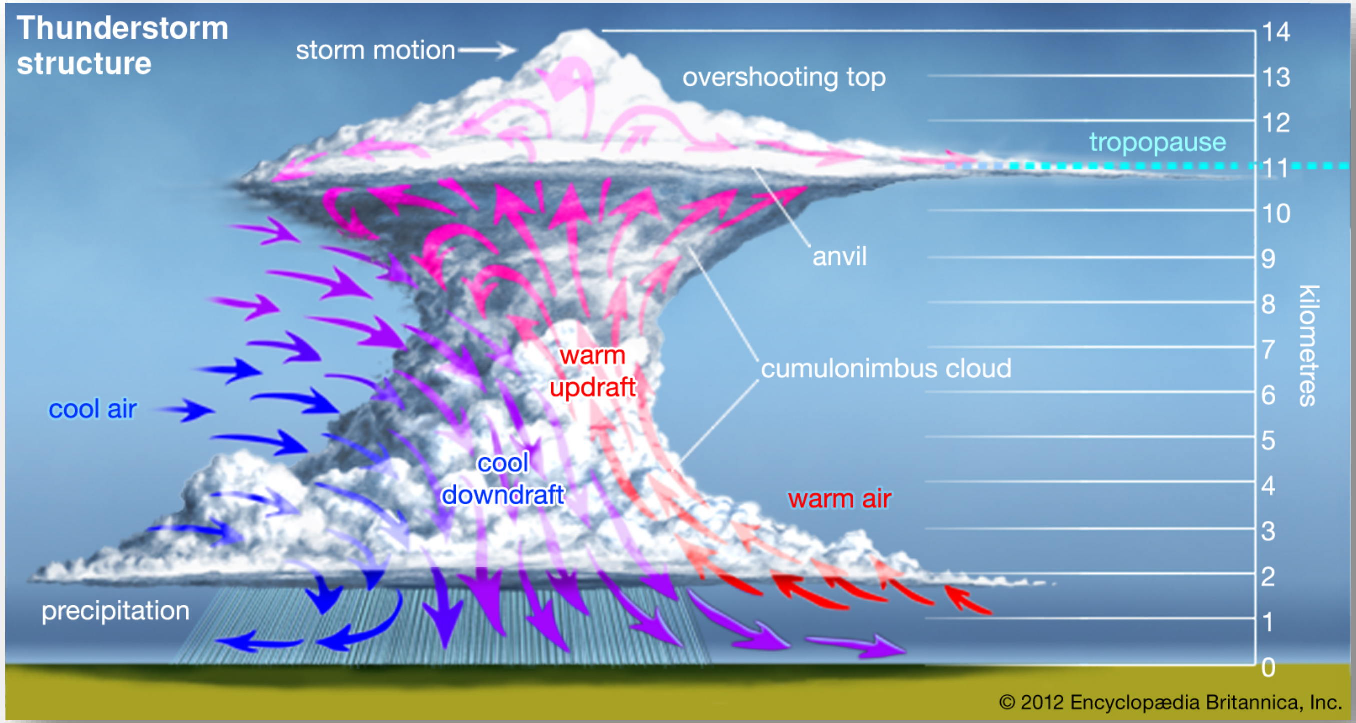
Why wind matters

- Strong winds are generated by low pressure systems that cycle counter-clockwise
  (NOTE: the magenta areas show the highest wind speeds)



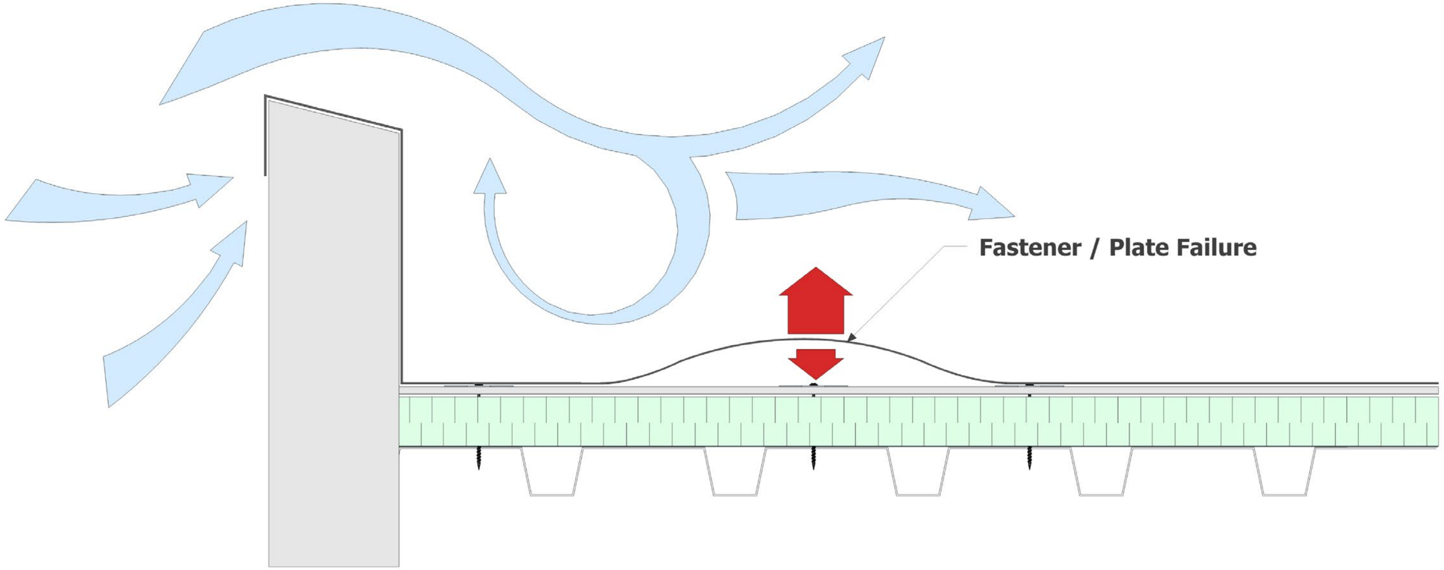
Why wind matters

- ☆ Localized winds that are not system-driven occur as the land warms up and generates thermals. A version of this, referred to as 'inflow/outflow winds', is quite common along the BC coast, particularly in long fjords.



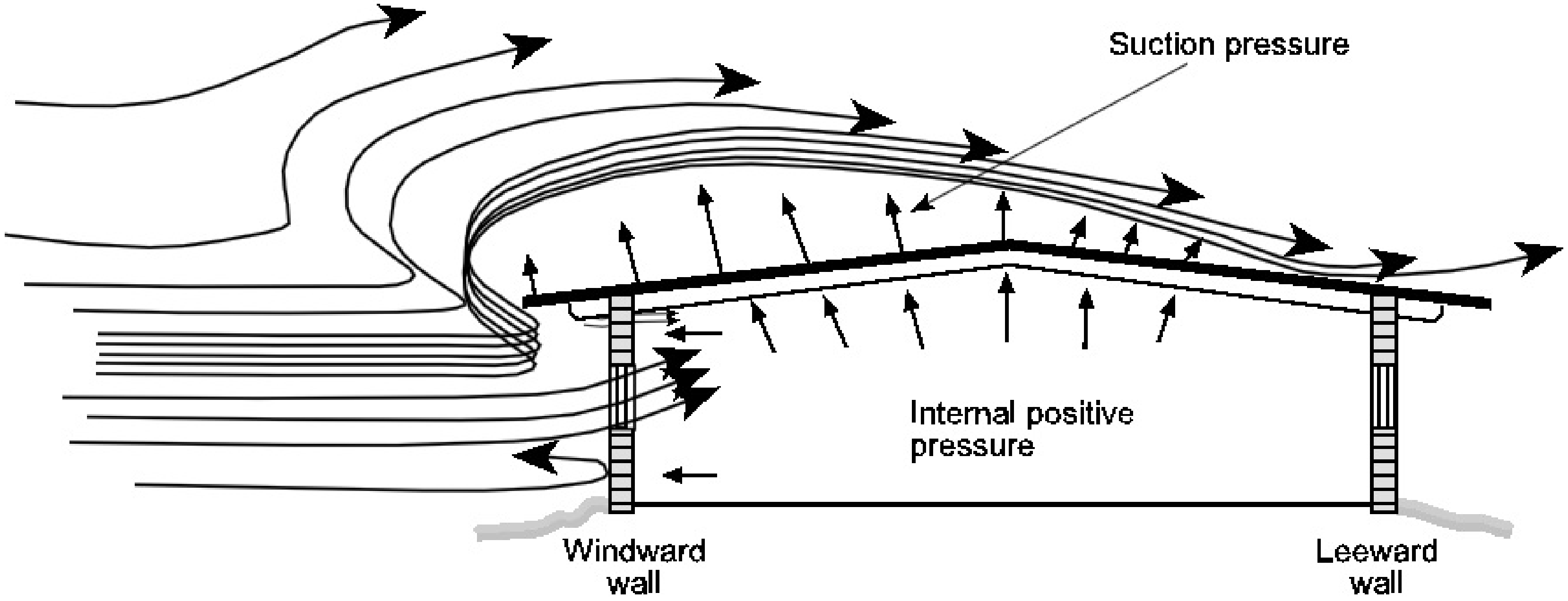
Why wind matters

☆ Wind that moves over and around objects generates variable pressures



Why wind matters

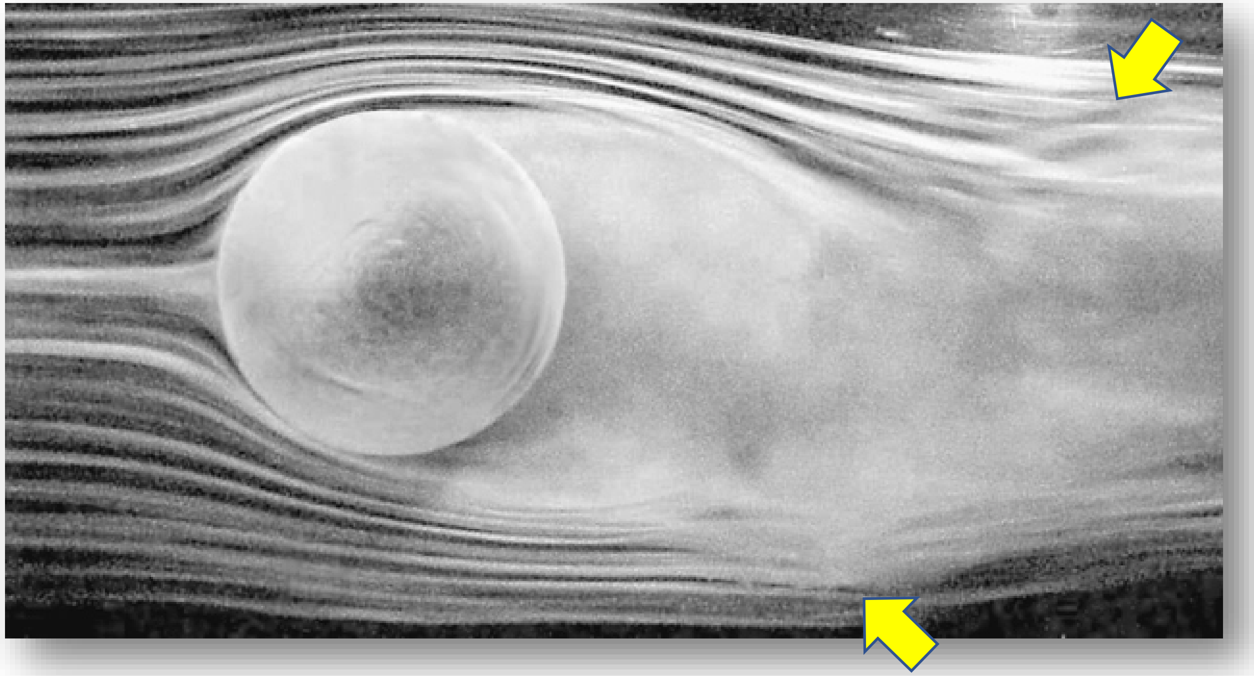
☆ As wind strikes a building, it flows around and through it, generating lifting ('sucking') and pushing forces that can affect the roof surface.



- Credit: National Research Council of Canada

Why wind matters

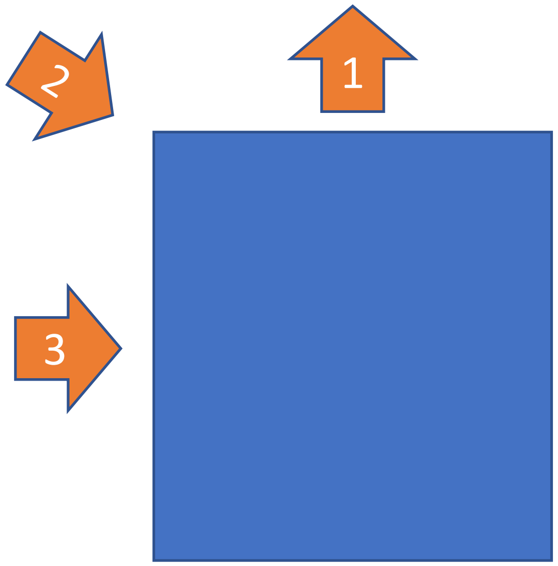
☆ The forces of wind are dynamic and never static. This is because of the dynamic and ever-changing causes of wind (heating and cooling of the earth's surface, the azimuth of the sun, etc.). The dynamic nature of wind is also a function of the objects that obstruct or even deflect wind (fluid dynamics).



Why wind matters

☆ Generally speaking, wind exerts three types of loads on objects in its way:

1. Uplift load (negative pressures that create 'lift')
2. Shear load (diagonal loads that threaten to tilt an object)
3. Lateral load (horizontal pushing)



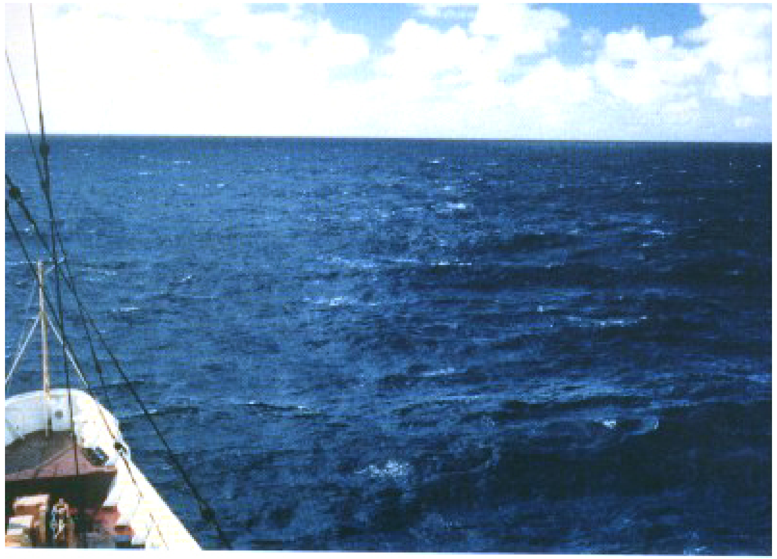
Why wind matters

- Wind velocity can be used to gauge wind force (pressure), but it isn't precise and can be affected by numerous variables. However, a theoretically unimpeded wind (no obstructing objects or landforms that would induce drag) will increase in force exponentially as wind velocity increases.

Credit: UBC EOAS (eoas.ubc.ca)

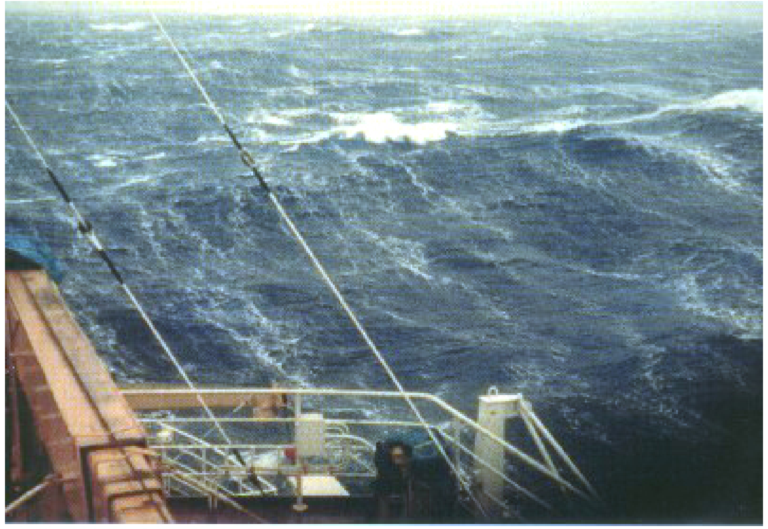
Why wind matters

☆ To put it into perspective, an 80 km/h wind is not twice as powerful as a 40 km/h wind; it's four times as powerful!



BEAUFORT FORCE 5
WIND SPEED: 17-21 KNOTS

SEA: WAVE HEIGHT 2-2.5M (6-8FT), MODERATE WAVES TAKING MORE PRONOUNCED LONG FORM, MANY WHITE HORSES, CHANCE OF SOME SPRAY



BEAUFORT FORCE 8
WIND SPEED: 34-40 KNOTS

SEA: WAVE HEIGHT 5.5-7.5M (18-25FT), MODERATELY HIGH WAVES OF GREATER LENGTH, EDGES OF CREST BEGIN TO BREAK INTO THE SPINDRIFT, FOAM BLOWN IN WELL MARKED STREAKS ALONG WIND DIRECTION.

Credit: Oceanic.com

Why wind matters

- ☆ Which is why this kind of thing happens when wind speed increases and roof systems (particularly membrane roofs) are not designed to resist uplift forces.

Credit: Saskatoon Star Phoenix

Why wind matters

And that can really 'suck'!

Credit: CTV News Saskatoon

Why wind matters

Haviland, Kansas elementary school – April 2018

(wind velocity = max. 80 km/h; but look at the basketball net…)

Credit: source unknown

Why wind matters

Harbour Restaurant, Port-aux-Basque, NLD – November 2018

(wind velocity = approx. 80 km/h)

Credit: source unknown

Why wind matters

Calgary apartment building - 2016

Credit: source unknown

Why wind matters

Mission, BC hotel – 2018

Credit: Ed Vischer, RCABC

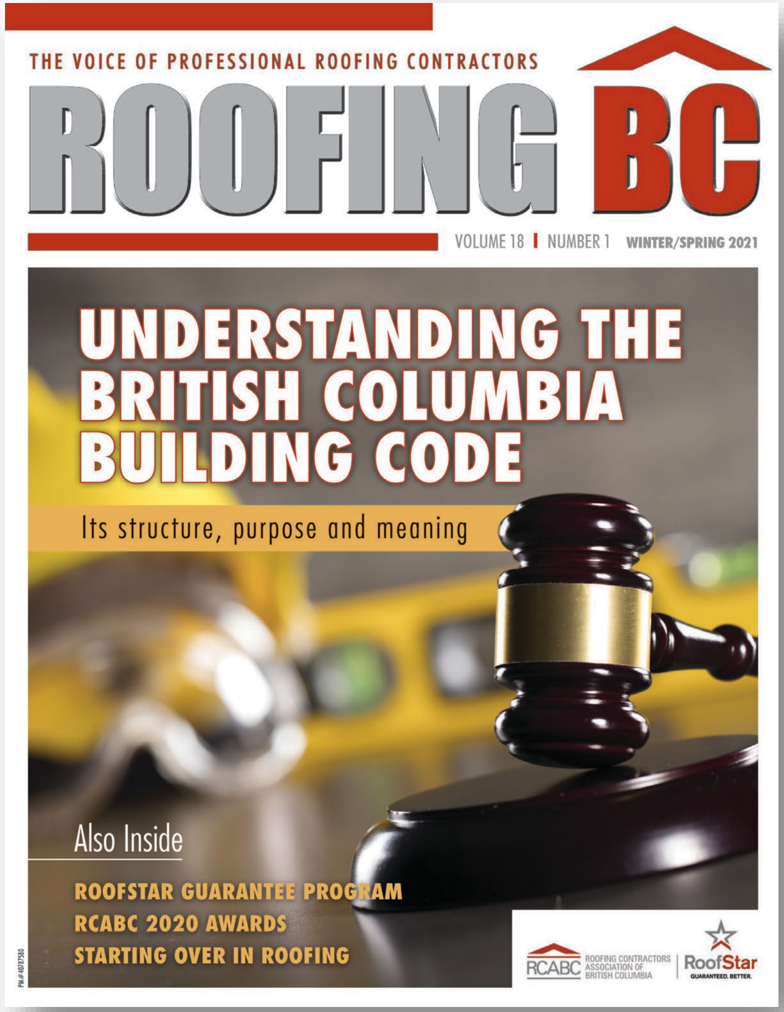
The British Columbia Building Code: a brief overview

The British Columbia Building Code: a brief overview

- ☆ For more of an introduction to the Building Code, you can read my article on the Code published in the latest edition of Roofing BC.

The materials presented today will form the core of my next two articles, set for publishing in the summer/fall edition.

Read it online by finding the link in the footer of our website (www.rcabc.org). If you're not already subscribed and want a print edition, you can sign up for a Roofing BC subscription by emailing roofing@rcabc.org.



The British Columbia Building Code: a brief overview

- The Building Code:
  - Under the jurisdiction of
    - the British Columbia Building Regulation, which is the practical enactment of
      - **the British Columbia Building Act**
  - Functions as the “Technical Requirements” of the Regulation
  - Has more regulatory power than standards
  - Mandatory in nature, carrying the force of law

The British Columbia Building Code: a brief overview

☆ Offspring of the model Building Code:

- Model codes are developed by the Canadian Commission on Building and Fire Codes (CCBFC)
  - Model codes include:
    - ✓ **National Building Code (NBC)**
    - ✓ **National Fire Code (NFC)**
    - ✓ **National Plumbing Code (NPC)**
    - ✓ **National Energy Code for Buildings (NECB)**
  - CCBFC also publishes the Canadian National Master Construction Specification (NMS)

The British Columbia Building Code: a brief overview

☆ The Building Code is two books

- Book 1 (Building Code)
- Book 2 (Plumbing Code)

Often referred to in popular discourse as separate Codes

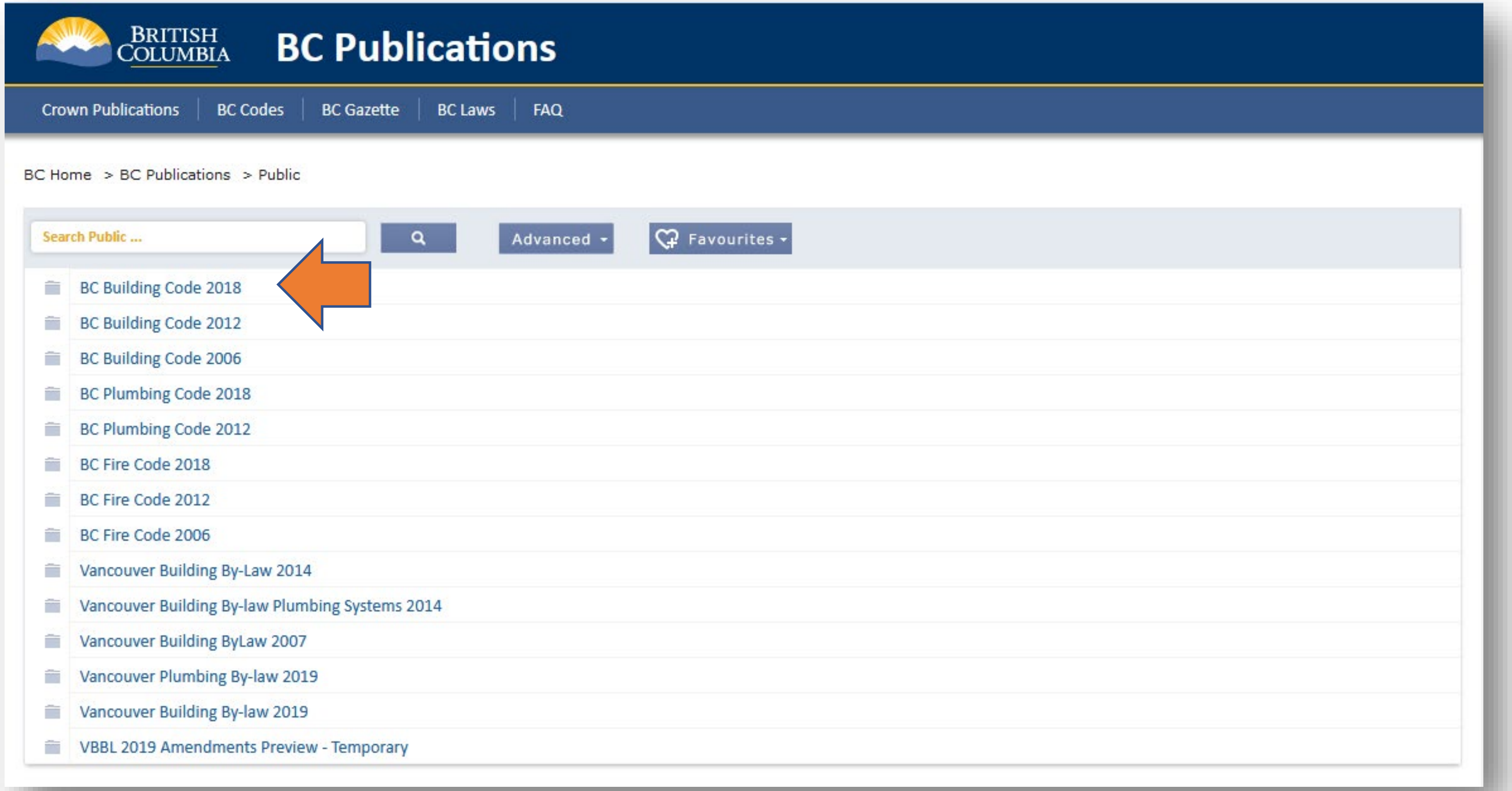
The British Columbia Building Code: a brief overview

- ☆ 2018 Building Code: performance-based, rather than prescriptive (a seismic shift from the 2012 Building Code)

The British Columbia Building Code: a brief overview

☆ Where to find the Code

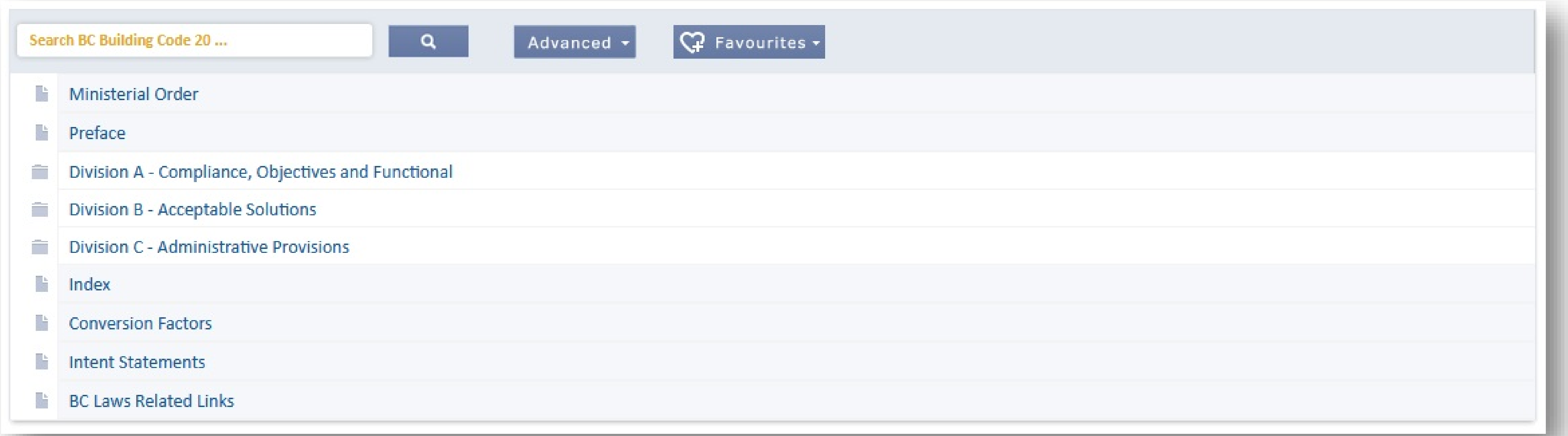
https://free.bcpublications.ca/civix/content/public/?xsl=/templates/browse.xsl



The British Columbia Building Code: a brief overview

☆ Some things are different, some the same

- No appendices (those have been replaced by the Notes pages)
- Three principal Divisions



The British Columbia Building Code: a brief overview

Not that kind.

The British Columbia Building Code: a brief overview

This kind.

- Ministerial Order
- Preface
- Division A - Compliance, Objectives and Functional
- Division B - Acceptable Solutions
- Division C - Administrative Provisions
- Index
- Conversion Factors
- Intent Statements
- BC Laws Related Links

The British Columbia Building Code: a brief overview

- Three Divisions:
  - **Division A** – “Compliance, Objectives and Functional Statements” (the “About” Division)
    - Defines the scope of the Code
    - Outlines “the main objectives and functional statements for technical building requirements”
    - Explains why a requirement must be met, and how to evaluate alternative solutions.

The British Columbia Building Code: a brief overview

☆ Three Divisions:

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  - ➢ Defines the scope of the Code
  - ➢ Outlines "the main objectives and functional statements for technical building requirements"
  - ➢ Explains why a requirement must be met, and how to evaluate alternative solutions.
- **Division B** – "Acceptable Solutions" (the "How To" Division)
  - ➢ Technical solutions to achieve main objectives
  - ➢ Divided into 9 Parts

The British Columbia Building Code: a brief overview

- Three Divisions:
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  - **Division B** – "Acceptable Solutions" (the "How To" Division)
    - Technical solutions to achieve main objectives
    - Divided into 9 Parts
  - **Division C** – "Administrative Provisions" (the "Who" Division)
    - Who is responsible for building design
    - Guidance for alternative solutions
    - Can be jurisdiction-specific (i.e. province or territory)

The British Columbia Building Code: a brief overview

☆ What the Building Code is:

- Mandatory minimum requirements to govern
  - ✓Building fire safety
  - ✓Structural soundness and stability
  - ✓Occupant comfort
  - ✓Interior environment safety
  - ✓Ingress and egress
  - ✓Control of building interior climate

These objectives do not exist in isolation. Structural soundness, as we will see, has a direct bearing on

- **Occupant comfort**
- **Interior environment safety**
- **Control of building interior climate**

The British Columbia Building Code: Designing for Wind

Credit: unknown (Humbolt, SK 2017)

The British Columbia Building Code and Wind

- ☆ What does the Building Code say about wind?
- ☆ Are wind-induced catastrophes avoidable?

Let's take a look…

The British Columbia Building Code and Wind

- First, let's get one thing clear: the Building Code applies to new *and* existing buildings…

The British Columbia Building Code and Wind

- ☆ The Building Code applies to new and existing buildings?

The British Columbia Building Code and Wind

☆ Yup! Read *Division A, Part 1 (Compliance)*, Article **1.1.1.1. Application of this Code**.

Section 1.1. General

1.1.1. Application of this Code

1.1.1.1. Application of this Code

1) This Code applies to any one or more of the following:

a) the design and construction of a new *building*,

b) the *occupancy* of any *building*,

c) a change in *occupancy* of any *building*,

d) an *alteration* of any *building*,

e) an addition to any *building*,

f) the demolition of any *building*,

g) the reconstruction of any *building* that has been damaged by fire, earthquake or other cause,

h) the correction of an *unsafe condition* in or about any *building*,

i) all parts of any *building* that are affected by a change in *occupancy*

The British Columbia Building Code and Wind

- ☆ Italicized words used in the Code are always defined (see *Division A, Part 1 (Compliance)*, Section 1.4 Terms and Abbreviations (Rev 2):
  - *Building* – "means any structure used or intended for supporting or sheltering any use or occupancy"
  - *Alteration* – "means a change or extension to any matter or thing or to any *occupancy* regulated by this Code."

Notice that word "or". When a "thing" (read *roof*) is "changed", the Code applies to the change.

The British Columbia Building Code and Wind

- ☆ The word "changes"
  - <u>does not</u> mean
    - Cosmetic changes (paint, wallpaper).
    - Replacing appliances (the Code actually says that), such as changing out the kitchen stove/range.
  - <u>does</u> mean
    - Altering structural elements, like walls…and roofs.

The British Columbia Building Code and Wind

- What the Code says, and what the local Authority Having Jurisdiction enforces…well, those can be two different things.
  - The Code doesn't offer much explicit guidance for "alterations", so enforcing the Code for *alterations* becomes a matter of judgement.
  - Some jurisdictions require permits for certain *alterations*, but rarely is a permit required for replacement roofing. Not "never". Just rarely.
  - The NRC is currently examining the subject with a view to developing requirements for "alterations" of roofs.

The British Columbia Building Code and Wind

- About roofs:
  - The Building Code does not clearly define roofs by how they function (it is implied rather than articulated).
  - Defining and understanding how a roof functions is material to understanding the Code and how it applies to each circumstance.
  - The RCABC Roofing Practices Manual defines roofs by function.

The British Columbia Building Code and Wind

☆ Waterproofing roofs

- resist hydrostatic pressure.
- usually (though not exclusively) are “flat” (slope to drain is less than 1:6).
- commonly constructed with a membrane.

Membrane roof (SBS-modified bitumen)

The British Columbia Building Code and Wind

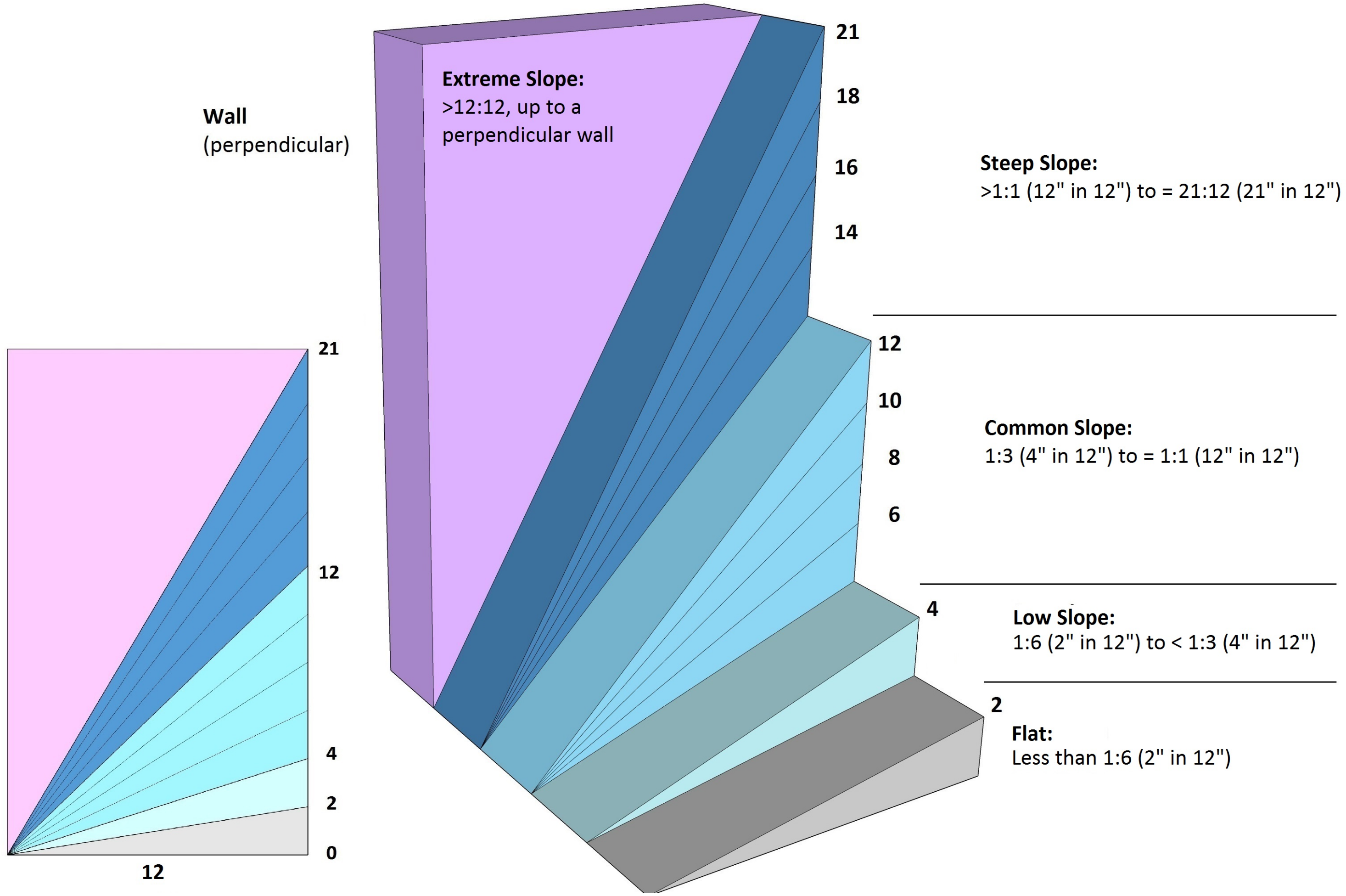
☆ Water-shedding roofs

- rely on gravity to move water away from the building.
- slope is greater than 1:6.
- Do not resist hydrostatic pressures.

Cedar roof (Pacific Wildlife Centre, Delta)

The British Columbia Building Code and Wind

☆ How the RGC defines slope (from the Roofing Practices Manual)



The British Columbia Building Code and Wind

- Both waterproofing and water-shedding roofs can be used on “Part 3” and “Part 9” buildings.
- Most “Part 3” buildings are constructed with membrane roofs. So are some “Part 9” structures.
- Requirements for membrane roofs used on both “Part 3” and “Part 9” buildings intersect in Division B, Part 5 (Environmental Separation).

The British Columbia Building Code and Wind

- ☆ To design a roof that will resist wind, begin with the end in mind.

The British Columbia Building Code and Wind

- The primary function of a roof is to…keep the weather outside.
- Division B has nine Parts, and Part 5 addresses….Environmental Separation (keeping the weather outside…)

The British Columbia Building Code and Wind

- Division B, Part 5 (Environmental Separation) has ten Sections, plus the Notes (Notes replace the Appendices in the 2012 BC Building Code and are frankly easier to use):
  - Section 5.1 – General
  - Section 5.2 – Loads and Procedures
  - Section 5.3 – Heat Transfer
  - Section 5.4 – Air Leakage
  - Section 5.5 – Vapour Diffusion
  - Section 5.6 – Precipitation
  - Section 5.7 – Surface and Ground Water
  - Section 5.8 – Sound Transmission
  - Section 5.9 – Standards
  - Section 5.10 – Objectives and Functional Statements

The British Columbia Building Code and Wind

☆ Section 5.6 seems to be the natural place to look ("Precipitation" is a weather term, and we want to find out how to keep weather out of the building):

- Section 5.1 – General
- Section 5.2 – Loads and Procedures
- Section 5.3 – Heat Transfer
- Section 5.4 – Air Leakage
- Section 5.5 – Vapour Diffusion
- Section 5.6 – Precipitation
- Section 5.7 – Surface and Ground Water
- Section 5.8 – Sound Transmission
- Section 5.9 – Standards
- Section 5.10 – Objectives and Functional Statements

The British Columbia Building Code and Wind

- ☆ But…Section 5.6 is rather underwhelming:
  - ✓When a building is exposed to precipitation (which building isn’t?), precipitation must be kept outside (my paraphrase but, yes, it actually says that).
  - ✓Protective materials installed to achieve the first requirement should do their job.
  - ✓When water is collected or diverted as a consequence of doing the first two things, it has to be drained away.

And that’s pretty much it in a nutshell.

The British Columbia Building Code and Wind

- Direction for membrane roofs <u>and wind resistance</u> is **not** in Section 5.6 Instead, it begins in Section 5.1 General, specifically in **Article 5.1.4.1. Structural and Environmental Loads** (red text is mine, for emphasis):
  - ✓Sentence (1)(b) provides the first hints about roofing: "*Building* materials, components and assemblies that separate dissimilar environments or are exposed to the exterior shall have sufficient capacity and integrity to resist or accommodate..(b) all structural loads, and effect of those loads, that may reasonably be expected."
  - ✓Sentence (4) then says this: "Compliance with Clause (1)(b) shall be demonstrated by design complying with Subsection 5.2.2., and construction conforming to that design, with regard to…c) wind up-lift imposed on roofing…"

The British Columbia Building Code and Wind

- ☆ So, we turn to Section 5.2. Loads and Procedures, and it is there that we find further direction, specifically in **Article 5.2.2.2 Determination of Wind Loads**:
  - ✓The focus in the Article is on systems
    - (a) "that separate dissimilar environments or are exposed to the exterior" and
    - (b) which may be "subject to wind load, and …[are] required to be designed to resist wind load."

The British Columbia Building Code and Wind

5.2.2.2. Determination of Wind Load

(See Note A-5.2.2.2.)

1) This Article applies to the determination of wind load to be used in the design of materials, components and assemblies, including their connections, that separate dissimilar environments or are exposed to the exterior, where these are
   a) Subject to wind load, and
   b) Required to be designed to resist wind load.
2) Except as provided in Sentence (3), the wind load referred to in Sentence (1) shall be 100% of the specified wind load determined in accordance with Article 4.1.7.1.
3) Where it can be shown by test or analysis that a material, component, assembly or connection referred to in Sentence (1) will be subject to less than 100% of the specified wind load, the wind load referred to in Sentence (1) shall not be less than the load determined by test or analysis.
4) Except as provided in Sentence (5), the wind uplift resistance of membrane roofing assemblies shall be determined in accordance with the requirements of CAN/CSA-A123.21, "Dynamic Wind Uplift Resistance of Membrane-Roofing Systems." (See Note A-5.2.2.2.(4).)
5) Membrane roofing assemblies with proven past performance for the anticipated wind loads need not comply with Sentence (4). (See Note A-5.1.4.1.(5).)

The British Columbia Building Code and Wind

- ☆ Note that **Article 5.2.2.2.** is not only about roofs – it applies to any material, component, assembly, or their connections. This includes cladding. On walls.

Why is this statement in the Code? Because when “environmental separators” (roofs and walls) cease to keep the outside “outside” (because of a failure or breach under wind loads), the roof

- ✓fails to meet the Objectives of the Code (for example, *Objective OH1 Indoor Conditions*; Division A, Part 2, Section 2.2. Objectives).
- ✓no longer satisfies the Acceptable Solutions in Division B, Part 5, Section 5.6 Precipitation.

The British Columbia Building Code and Wind

Which is another way of saying that a poorly designed roof that leaks is non-compliant.

The British Columbia Building Code and Wind

Or, to frame it just a little differently…*

Let's consider another metaphor: the Reese's Peanut Butter Cup…

keep the peanut butter on the inside by surrounding it with a well-formed chocolate exterior strong enough to resist failure†.

* today is *I Love Reese's Day*, according to the Daily Calendar

† Of course, the metaphor breaks down at this point because if the Reese's Peanut Butter Cup could resist "expected loads" it would be inedible.

The British Columbia Building Code and Wind

- **Article 5.2.2.2.** is not new, but it has changed:
  - In the 2012 British Columbia Building Code, **Article 5.2.2.2.** was called *<Determination of> Wind Load*, and it was brief. It referred the reader to Appendix A (now called the Notes to Part 5), and the Article read, quite simply

1) This Article applies to the determination of wind load to be used in the design of materials, components and assemblies, including their connections, that separate dissimilar environments or are exposed to the exterior, where these are

   a) subject to wind load, and

   b) required to be designed to resist wind load.

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The British Columbia Building Code and Wind

- To summarize, **Article 5.2.2.2** in the 2012 Code required:
  - The calculation of wind loads according to Division B, Part 4, **Article 4.1.7.1.**
  - The roof design must be capable of resisting 100% of those loads, unless it can be shown that the loads will in fact be less than the calculations.

And that was it. No direction. No hints on how to do that. The *Design Authority* was essentially left to his or her own wits to find a meaningful Acceptable Solution for this directive.

The British Columbia Building Code and Wind

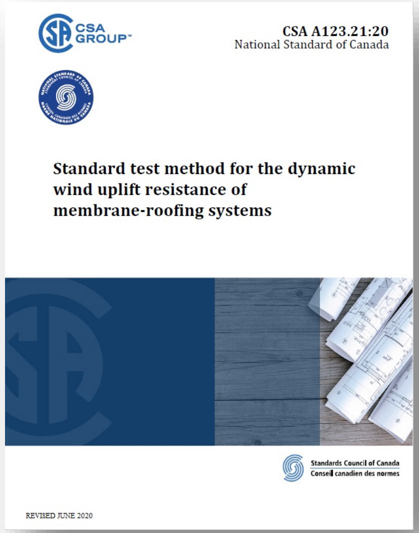
- A similar situation existed in Division B, Part 4. In fact, the entire Subsection 4.1.7. Wind Load changed so much in 2018 that the two are hardly recognizable when placed side-by-side
- The 2012 Code recognized that 'suction' forces on roofs are 'a thing' (this is not a new concept), but the methods for calculating them were less refined than they are in the 2018 iteration.

The British Columbia Building Code and Wind

- Design Authorities had to figure out how to design roofs to comply with the Code, so they turned to whatever resources they could find. Typically, they turned south to the large underwriting giant…

The British Columbia Building Code and Wind

- ☆ Old habits die hard. FM Global isn't a recognized solution for complying with the requirements in Division B, Part 5, **Article 5.2.2.2.**


CSA GROUP
CSA A123.21:20
National Standard of Canada
Standard test method for the dynamic wind uplift resistance of membrane-roofing systems
Standards Council of Canada
Conseil canadien des normes
REVISED JUNE 2020

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The British Columbia Building Code and Wind

☆ Back to the 2018 Code:

- **Membrane roofs have a structural function**: roof systems are more than a separator or an architectural feature. They are a structural element of the building. This is made clear by the intimate connection between Part 5 and Part 4.
- **How to build a wind-resistant membrane roof**: there is new guidance in **Article 5.2.2.2.** that provides pathways for compliance. They can be found in Sentences (4) and (5):

4) Except as provided in Sentence (5), the wind uplift resistance of membrane roofing assemblies shall be determined in accordance with the requirements of CAN/CSA-A123.21, "Dynamic Wind Uplift Resistance of Membrane-Roofing Systems." (See Note A-5.2.2.2.(4).)

5) Membrane roofing assemblies with proven past performance for the anticipated wind loads need not comply with Sentence (4). (See Note A-5.1.4.1.(5).)

The British Columbia Building Code and Wind

☆ To summarize what **Article 5.2.2.2.** means:

- Because a membrane roof is a structural element of the building and is subject to negative wind loads, those loads must be calculated using the guidance in Division B, Part 4 (Structural Design), **Article 4.1.7.1. Determination of Wind Loads**.
- To build a wind-resistant membrane roof, the designer has three permissible options to choose from.

The British Columbia Building Code and Wind

☆ What are Specified Wind Loads?

- Division B, Part 4, Subsection 4.1.7 Wind Load
  - Pages and pages of new material (blue text) devoted to the calculation of Specified Wind Loads on roofs.
  - Helpful graphics (if you're a structural engineer) to understand the formulae for different roof configurations.
  - Generally, wind loads must be calculated and then increased by a safety factor of 1.5, to allow for variables such as gusts and strong wind events (NOTE: the methodology for determining safe working loads has changed with the latest edition of the CSA test method, but the results for design will remain the same).

The British Columbia Building Code and Wind

☆ Selections from Division B, Part 4, Subsection 4.1.7 Wind Load

Division B: *Acceptable Solutions* **Part 4 –** *Structural Design*

4.1.7. Wind Load

4.1.7.1. Specified Wind Load

1) The specified wind loads for a building and its components shall be determined using the Static, Dynamic or Wind Tunnel Procedure as stated in Sentences (2) to (5).

2) For the design of *buildings* that are not dynamically sensitive, as defined in Sentence 4.1.7.2.(1), one of the following procedures shall be used to determine the specified wind loads:

a) the Static Procedure described in Article 4.1.7.3.,

b) the Dynamic Procedure described in Article 4.1.7.8., or

c) the Wind Tunnel Procedure described in Article 4.1.7.12.

3) For the design of *buildings* that are dynamically sensitive, as defined in Sentence 4.1.7.2.(2), one of the following procedures shall be used to determine the specified wind loads:

a) the Dynamic Procedure described in Article 4.1.7.8., or

b) the Wind Tunnel Procedure described in Article 4.1.7.12.

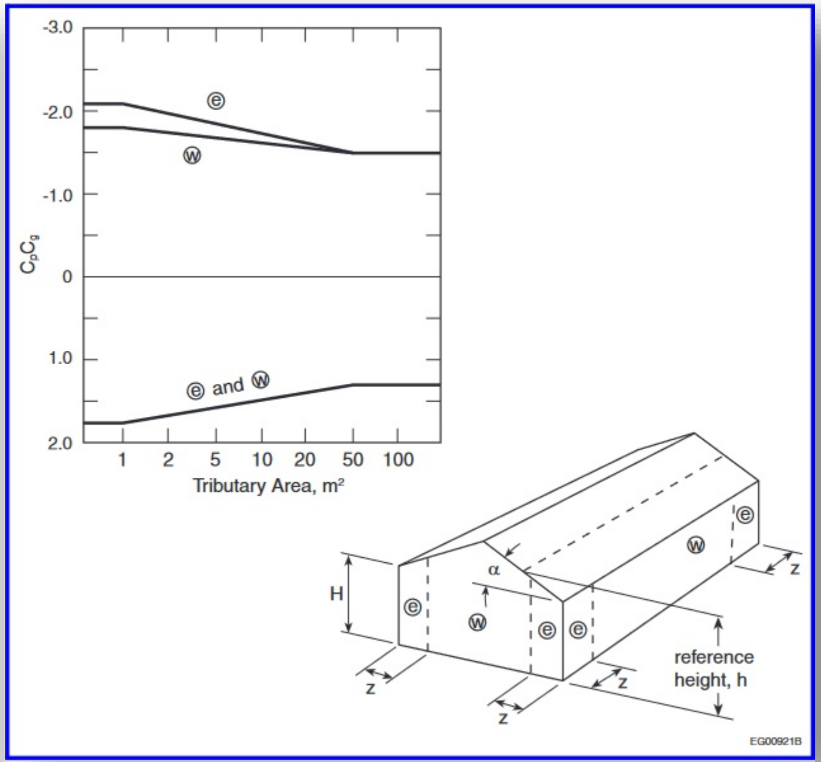
4) For the design of *buildings* that may be subject to wake buffeting or channelling effects from nearby *buildings*, or that are very dynamically sensitive, as defined in Sentence 4.1.7.2.(3), the Wind Tunnel Procedure described in Article 4.1.7.12., shall be used to determine the specified wind loads.

5) For the design of cladding and secondary structural members, one of the following procedures shall be used to determine the specified wind loads:

a) the Static Procedure described in Article 4.1.7.3., or

b) the Wind Tunnel Procedure described in Article 4.1.7.12.

6) Computational fluid dynamics shall not be used to determine the specified wind loads for a *building* and its components. (See Note A-4.1.7.1.(6).)



The British Columbia Building Code and Wind

☆ **Calculating the *Specified Wind Loads*:** no matter how large or small a roof is, the loads are not negotiable and are determined by

- ✓ **Exposure** (open or protected by trees or other structures).
- ✓ **Proximity** to other buildings.
- ✓ **Openings** (few or many, open or mostly closed).
- ✓ **Geometry** (building height, width, and length).
- ✓ **Parapets** (small or none, or over 1m high).

If the desirable roof design can't handle the loads, simply design a different roof.

The British Columbia Building Code and Wind

☆ Calculating the *Specified Wind Loads*:

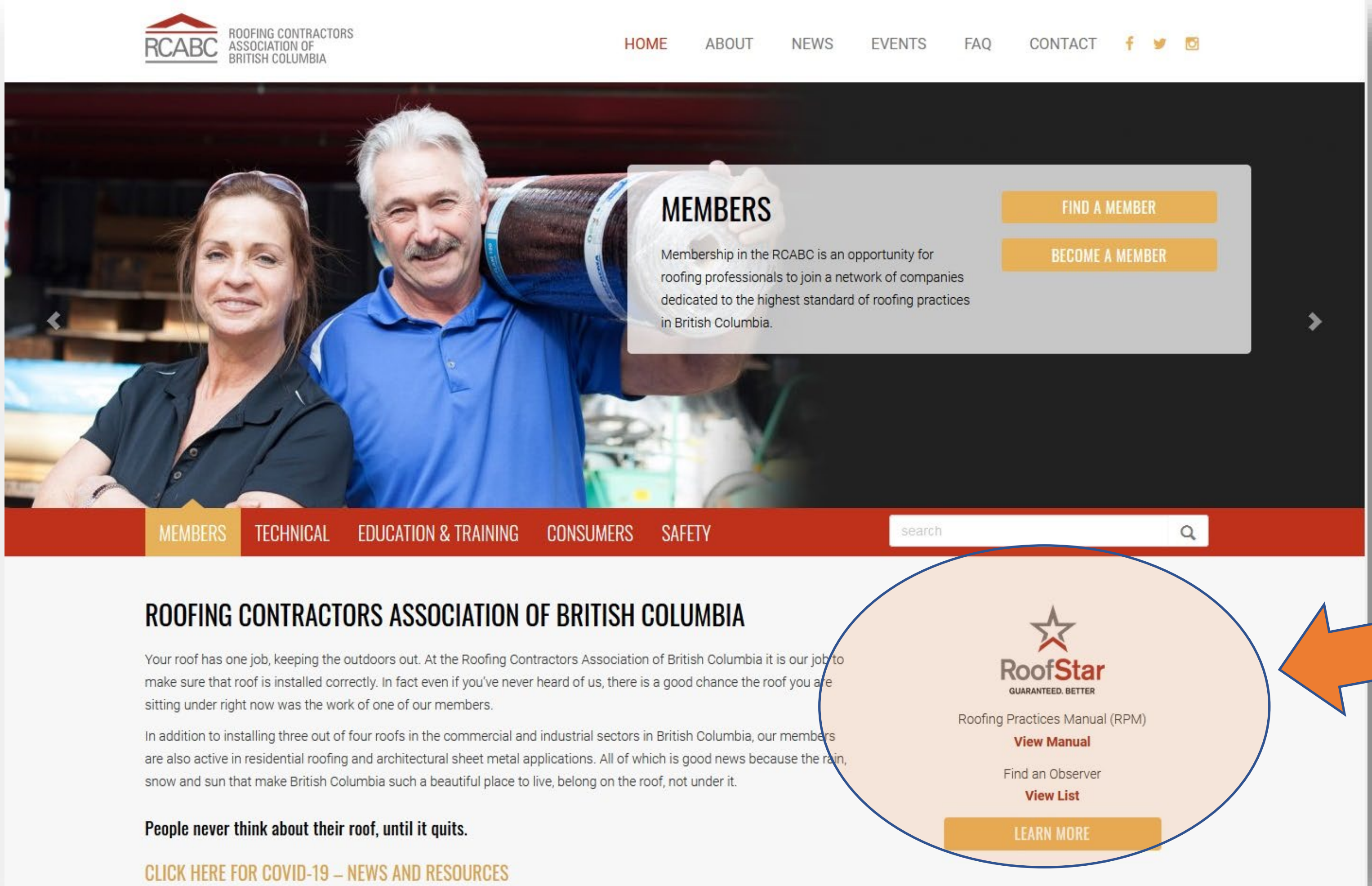
- Have a *registered professional* do it (more on this later), using the wonderful resources in Part 4

OR

- Use the handy online tool developed and published by the NRC, the Wind-RCI calculator, and have the calculations reviewed by a *registered professional*.

You can find the calculator easily by looking for it in the RCABC Roofing Practices Manual…

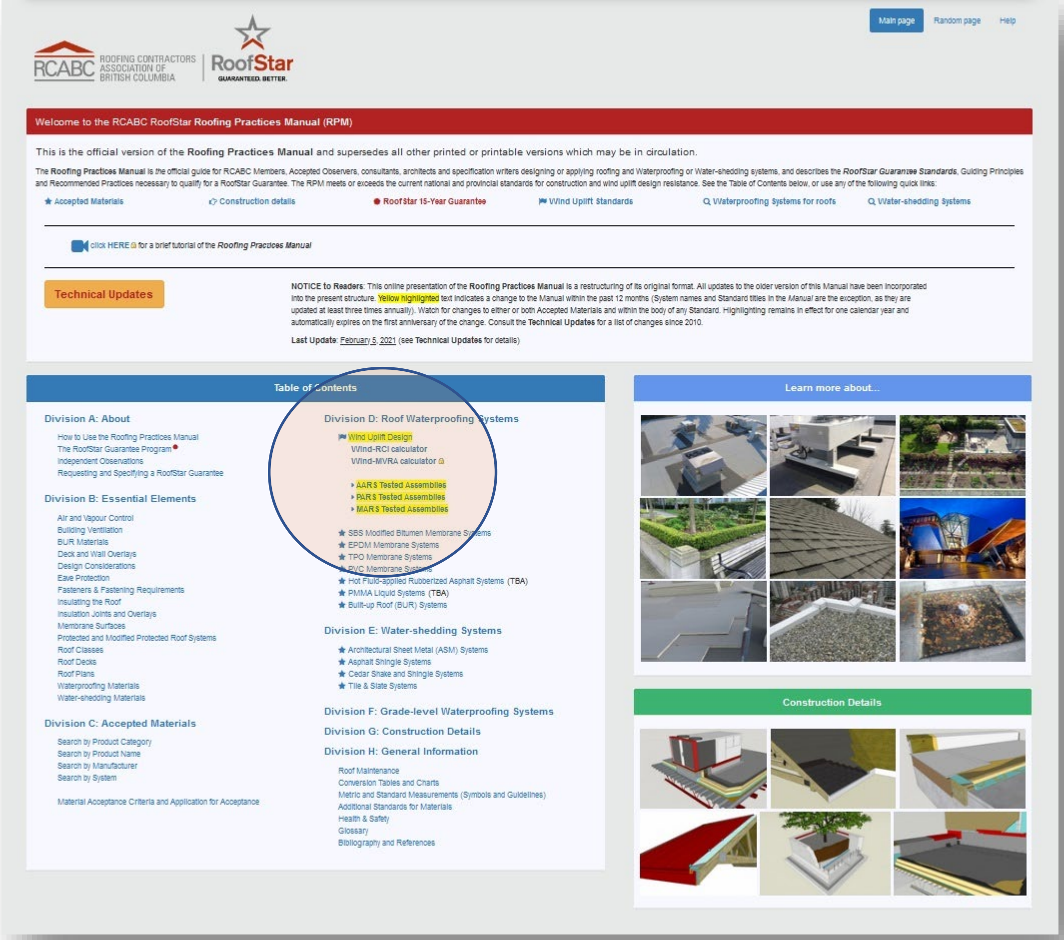
The British Columbia Building Code and Wind

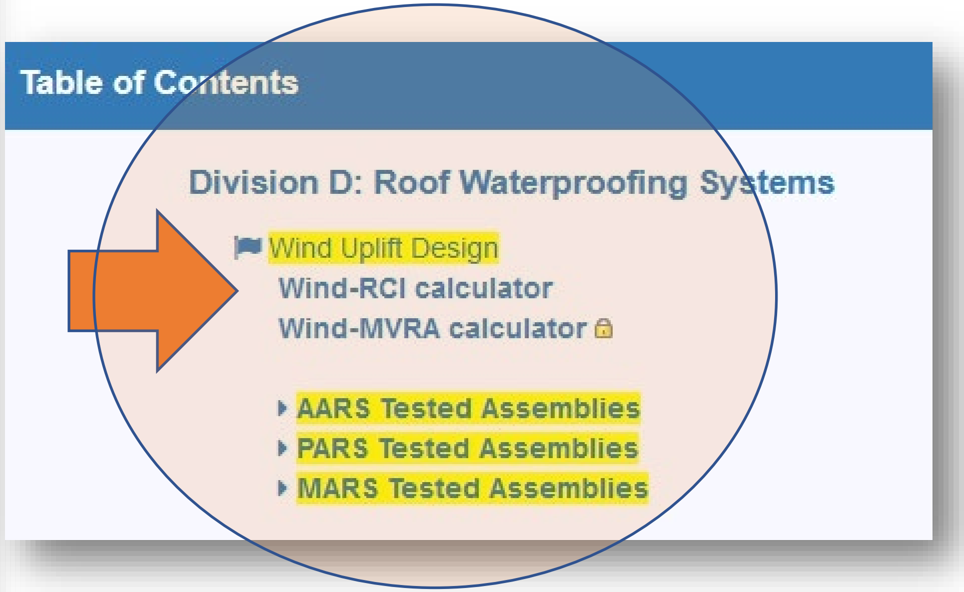


Link to RPM

The British Columbia Building Code and Wind

☆ Roofing Practices Manual (RPM)





The British Columbia Building Code and Wind

- ☆ About Wind-RCI:
  - ✓ Developed by the NRC to facilitate simplicity in design
  - ✓ Uses the calculations in Division B, Part 4 for *most* building types (has some limitations).
  - ✓ A simplified approach but may not capture all the variables in a design.
  - ✓ Read the disclaimer on the user agreement page.

The British Columbia Building Code and Wind

- Getting back to **Article 5.2.2.2**…the Code offers three design Code-compliant roof design options (all performance-based):
  1. Tested roof assembly
  2. Assembly with Proven Past Performance
  3. Custom-engineered (what I refer to as the ‘third way’)

The British Columbia Building Code and Wind

- Read the Notes!
  - Formerly the Appendices in the 2012 Code
  - Notes always have a prefix “A-” and are specific to a sentence, e.g. A-5.2.2.2.(4)
  - Notes provide a fuller explanation of the requirements in **Article 5.2.2.2.**
  - Sentence (4) in **Article 5.2.2.2.** is supported by…Note A-5.2.2.2.(4).

The British Columbia Building Code and Wind

☆ Note A-5.2.2.2.(4)

A-5.2.2.2.(4) Membrane Roofing Systems. Wind loads for membrane roofing systems must be calculated in accordance with Part 4. The tested uplift resistance and factored load should satisfy the requirements of the Commentary entitled Limit States Design in the "User's Guide – NBC 2015, Structural Commentaries (Part 4 of Division B)."

The test method described in CAN/CSA-A123.21, "Dynamic Wind Uplift Resistance of Membrane-Roofing Systems," applies only to membrane roofing systems whose components' resistance to wind uplift is achieved by fasteners or adhesives. It does not apply to roofing systems that use ballasts, such as gravel or pavers, to secure the membrane against wind uplift.

In the case of membrane roofing systems in which the waterproof membrane is attached to the structural deck using mechanical fasteners, the wind-induced forces and the roofing system's response are time- and space-dependent and, thus, dynamic in nature. Further information on the design and evaluation of such systems can be found in "A Guide for the Wind Design of Mechanically Attached Flexible Membrane Roofs," published by NRC.

The wind uplift resistance obtained from the test method in CAN/CSA-A123.21 is limited to configurations with specific fastener or adhesive patterns. To extrapolate the test data to non-tested configurations, refer to ANSI/SPRI WD-1, "Wind Design Standard Practice for Roofing Assemblies," for a rational calculation procedure. However, in using this extrapolation procedure, wind loads should be calculated in accordance with the BCBC. NRC's guide for wind design referenced above provides further guidance and examples of wind load calculations.

Note: The "Third Way" (later)

The British Columbia Building Code and Wind

☆ Key observations from Note A-5.2.2.2.(4):

- Blue text means it is new language in the Code (since 2018).
- Membrane roof systems must be designed as a structural component of a building (note the connection to Division B, Part 4).
- Limited scope of the CSA test method:
  - ✓ Membrane roofs that are adhered or mechanically fastened.
  - ✓ Does not apply to ballasted roofs (where ballast is the securement mechanism)*.

* We'll touch on this later in the presentation

The British Columbia Building Code and Wind

☆ **Option 1:** Tested Roof Assembly – a membrane roof assembly* that has been tested

- In laboratory conditions
- By an NRC-qualified facility
- Using CSA test method CSA-A123.21 *Dynamic Wind Uplift Resistance of Membrane Roofing Systems*

The nature and application of a Tested Assembly is developed in the Notes to Part 5.

* The term “assembly” includes the roof system and the deck which supports it.

The British Columbia Building Code and Wind

☆ The Dynamic Roof Testing Facility, Drummondville, QC

The British Columbia Building Code and Wind

- ☆ Dynamic assembly tests:
  - ✓ Calculate the highest loads at which the assembly will successfully resist predictable wind loads
  - ✓ Results are reduced by a resistance factor (formerly called a “safety factor”)
  - ✓ Reduce values allow for variables such as
    - Higher-than-average gusts
    - Unusually strong wind days
    - Real-world factors: contractor experience, scheduling, weather constraints

The British Columbia Building Code and Wind

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The British Columbia Building Code and Wind

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  - **MARS** (Mechanically Attached Roof Systems) – systems (assemblies) in which the membrane is secured through the entire system with screw fasteners and plates.

The British Columbia Building Code and Wind

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  - **AARS** (Adhesive Applied Roof Systems) – systems (assemblies) in which the entire system is adhered (components adhered to each other and to the supporting deck)

The British Columbia Building Code and Wind

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  - **AARS** (Adhesive Applied Roof Systems) – systems (assemblies) in which the entire system is adhered (components adhered to each other and to the supporting deck)
  - **PARS** (Partially Adhered Roof Systems) – systems (assemblies) in which a *hybrid* approach to securement is used (some screws, some adhesive).

The British Columbia Building Code and Wind

☆ Finding "Tested Assembly" reports

- Most manufacturers publish them online (not always easy to find).
- The RCABC uploads reports into the RPM library (more on this later).

Main page Random page Help

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AARS Tested Roof Assemblies

Using the Tables | Additional Notes | SBS Membrane Assemblies | EPDM Membrane Assemblies | TPO Membrane Assemblies | PVC Membrane Assemblies | BUR Assemblies

NOTICE to READER

Before you use these tables, make sure you know the wind load requirements for the roof under design or construction. You can find guidance in **Part 3** **SECURING the ROOF ASSEMBLY** of the membrane system that is specified. *Specified Wind Loads* for the three principal roof zones may be calculated either by using the formulae in the *British Columbia Building Code*, 4.1.7 Wind Loads, or by using the National Research Council's online tool, **Wind-RCI online wind calculator**.

Table Structure and Organization

The tables on the adjacent tabs display data drawn from, and links to, **Tested Assembly Reports** listed by the membrane type shown on the tab heading. All test reports are downloadable from the "Test Report" column, and are catalogued under a RoofStar numbering system that may differ from the number designation on the report. Dynamic Wind Uplift (DUR) values are shown in columns near the left side of the tables. Only the DUR and Manufacturer columns are sortable; to sort a column, click the column heading. **Click on any drop-down button to try the demo table below.**

Tested Assembly Report Data					RoofStar Guarantee	Primary Materials			Other System Materials & Deck			
Manufacturer ⬍	Dynamic Uplift Resistance		Roof Assembly Summary	Test Report	Term†	Cap Membrane	Base Membrane	Plies	Insulation Overlay	Insulation	Deck Overlay	Deck Type
	kPa ⬍	Psf ⬍										
Manufacturer	-1.9	-40	View summary	Report link 1-A	5, 10	View options	View options	1, 2 or 3	View options	View options	View options	Deck type

Each row displays one test for a particular system of securement. That means that the DUR derived for that test is based on a particular pattern of fasteners or adhesive application. Most assemblies were tested with one system of securement, but some were tested with as many as four. When this is the case, the same report number will be displayed with test report names such as **[Manufacturer X] MARS 1-A** and **[Manufacturer X] MARS 1-B**. Read the test report details to see what was changed in the securement system that affected the DUR for the assembly.

Every table displays Tested Assembly report data in easy-to-read rows with drop-down buttons that display key information for each assembly (see the working example above). When the Tested Assembly uses a membrane with 2 or more plies, each membrane and its options is listed in separate columns.

Note that some tests were conducted without one or more of these constituent components and may list those materials as "optional". When a material category such as "insulation overlay" is absent from the test, the drop-down menu will indicate its absence with "N/A" or as "optional". Occasionally, a missing material poses a conflict with the ***RoofStar Guarantee Standards***. When the conflict is obvious, the Roof Assembly Summary will normally flag this with a note at the bottom of the list. Notwithstanding these notes, the reader is responsible to understand and apply the ***RoofStar Guarantee Standards*** regardless of the Tested Assembly report (see below under **Tested Assemblies and RoofStar Guarantee Standards**).

The British Columbia Building Code and Wind

☆ **Option 2:** Assembly with Proven Past Performance

- The term *Proven Past Performance* is not explained directly in Section 5.2 Loads and Procedures,
- An explanation is provided in the Notes (Note A-5.1.4.1.(5) Past Performance as Basis for Compliance with Respect to Structural Loads).
- Can be summarized this way:
  - ✓ When an assembly exists that has a proven record of resisting the specified wind loads, that assembly may be used to comply with the Code.

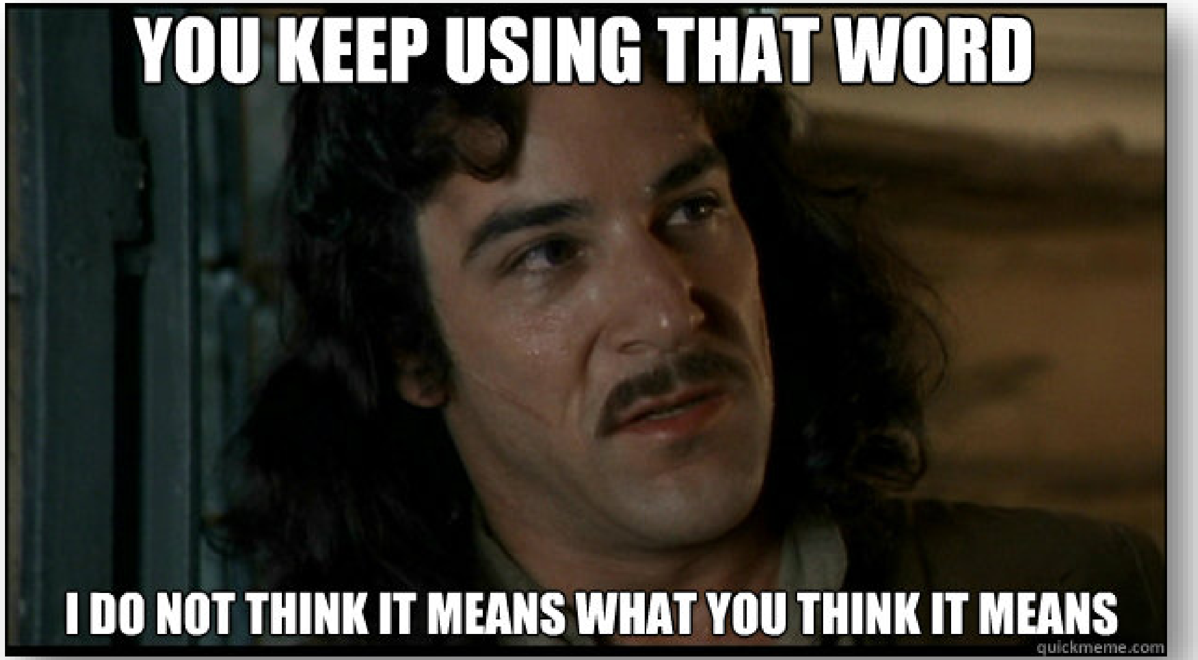
A-5.1.4.1.(5) Past Performance as Basis for Compliance with Respect to Structural Loads. As discussed in Note A-5.1.4.1., a range of structural loads and effects can be imposed on materials, components and assemblies in environmental separators and assemblies exposed to the exterior. In many instances, compliance with Sentence 5.1.4.1.(1) for structural loads must be determined based on the loads and calculation methods described in Part 4 as specified in Sentence 5.1.4.1.(3) and the referenced Subsection 5.2.2., e.g. for cladding. In practice, compliance for some materials, components or assemblies of environmental separators and assemblies exposed to the exterior is determined by relying on provisions governing the use of alternative solutions (such as Clause 1.2.1.1.(1)(b) of Division A).

For some very common building elements and installations, however, there is a very large body of evidence of proven performance over a long period of time. In these cases, imposing the degree of analysis, or documentation of performance, required by Part 4 or

The British Columbia Building Code and Wind

☆ **Caution:**

- Looks like a convenient escape hatch from the apparent onerous requirement to use a Tested Assembly
- “Proven” doesn’t necessarily mean what many think it means…



The British Columbia Building Code and Wind

- "Proven" means the new roof assembly
  - life expectancy must be supported by a model roof assembly with at least as much history (i.e. if the new roof is expected to last 25 years, the model roof must have an equivalent record).
  - must possess properties that are "identical or superior to those of the…assembly used as a reference."
  - Must be modeled after an assembly that was used on a similar building to the building under design – this includes the ability to survive the dynamic loads caused by proximity to other structures because of funneling or building harmonics.

The British Columbia Building Code and Wind

When explained this way, the *Proven Past Performance* option has less appeal than Option 1.

The British Columbia Building Code and Wind

☆ **Option 3:** the "Third Way"

- When Option 1 and Option 2 don't seem viable, the Code provides an actual escape hatch, called ANSI-SPRI WD-1 *Wind Design Standard Practice for Roofing Assemblies*.

ANSI/SPRI WD-1

Wind Design Standard Practice for Roofing Assemblies

Approved November 17, 2014

Table of Contents

465 Waverley Oaks Road
Suite 421
Waltham, MA 02452
www.spri.org

Disclaimer
This standard is for use by architects, engineers, roofing contractors and owners of low slope roofing systems. SPRI, its members and employees do not warrant that this standard is proper and applicable under all conditions.

The British Columbia Building Code and Wind

☆ ANSI-SPRI WD-1 is one 'custom engineering' approach, but it has limitations:

- It extrapolates from existing securement patterns based on calculated load requirements.
- It is limited to mechanically fastened systems (it was developed for the single-ply membrane industry).

So…

When the building is too tall for the Wind-RCI online calculator to work (it works for buildings up to 150 feet tall), or the Tested Assembly offers only one securement system and you want options for the different roof zones (more on this a little later), it's time to call…

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…the *registered professional*, of course.

(you thought I was going to say Ghostbusters, didn't you?)

The British Columbia Building Code and Wind

☆ And finally, responses to a few questions you're going to ask anyway:

Question: Do the Part 4/Part 5 requirements apply to <u>all</u> "Part 3" buildings?

Response: "Most" is probably the best answer.

In Division A, Section 1.3 ("Divisions A, B and C of this Code"), the Code states that "Parts 3, 4, 5, and 6 of Division B apply to all *buildings* described in Article 1.1.1.1. and" are classified as *post-disaster buildings* or are used for select *major occupancies*. Division A is your friend for this question.

The British Columbia Building Code and Wind

Question: What wind design requirements apply to Part 9 buildings?

Response: This is an interesting question.

The best answer I can find begins in Division B, Part 9, **Article 9.4.1.1. General**. There, it states (paraphrased) that unless otherwise stated in Part 9, “structural members and their connections shall…be designed according to Part 4 using the loads and deflection and vibration limits specified in…Part 9 or…Part 4.”

Further on in Section 9.26 Roofing, Part 9 roofs must conform to “the remainder” of Subsection 9.26.1 General, or to Part 5. Since membrane roofs are not addressed in “the remainder” of Subsection 9.26.1 (the “remainder” is **Article 9.26.1.3.** which deals with asphalt shingle installation), it stands to reason that they are governed by Part 5.

Who’s in charge here?

Who's in charge here?

☆ In this presentation we use the term "Design Authority". Who is that?

- Anyone who takes responsibility for designing a roof assembly, referred to by the Code as the "coordinating registered professional":
  - ✓Architects
  - ✓Roofing or Envelope consultants
  - ✓Roofing contractors
  - ✓Building Owners

Who's in charge here?

☆ Summarizing what we know so far (sticking with "Part 3" buildings):

- The roof is a structural component of the building. This is clear from the language in **Article 5.2.2.2.** which is linked to **Article 4.1.7.1 Specified Wind Loads** (red text is mine, for emphasis):

  > "The specified wind loads for a building and its components shall be determined using the Static, Dynamic or Wind Tunnel Procedure as states in Sentences (2) to (5)."

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- Because the roof plays a structural role in the building, the *Design Authority* must calculate the *Specified Wind Loads* for the roof using Part 4, Subsection 4.1.7 Wind Load.

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- Because the roof plays a structural role in the building, the *Design Authority* must calculate the *Specified Wind Loads* for the roof using Part 4, Subsection 4.1.7 Wind Load.
- To build a roof capable of resisting the calculated loads, the *Design Authority* must select from the options provided in Part 5, **Article 5.2.2.2.** (Tested Assembly, Proven Past Performance or the “third way”).

Who's in charge here?

Membrane roofs:

+

Structural
Part 4

Environmental Separation
Part 5

Who's in charge here?

- ☆ The word "components" used in **Article 4.1.7.1.** means, in its plainest sense, a building's constituent parts, such as doors, windows, wall cladding and…the roof.
- ☆ When these "components" (like the roof) are subjected to loads induced by the wind (pushing or pulling/sucking), the loads must be calculated along with all the other loads prescribed in Division B, Part 4.
- ☆ Part 4, then, brings the entire subject full-circle:
  - The roof must capably separate the outside environment from the interior conditioned space (Part 5), and to that that
  - the roof must remain where it is built (Part 4).

Designing the roof, then, begins with the overall structural design of the building.

Who's in charge here?

☆ So, who undertakes the design of the roof?

- This question has not been answered consistently by anyone.
- Some assign the Part 4 calculations to the roofing contractor. Others assign the Part 5 requirements.
- Assigned or delegated design to constructors is common practice.

Is assigned or delegated *structural design* permissible under the Code?

Who’s in charge here?

Division C (Administrative Provisions) provides much needed guidance.

- Part 2, **Article 2.2.1.2. Structural Design** states:

  “for design work carried out in accordance with Part 4 of Division B, the designer shall be a *registered professional* skilled in the work concerned (See Note A-2.2.1.2.(1).).”

- The Note to **Article 2.2.1.2.**, Sentence (1) states:

  “[it is] the assumption that structural design will be carried out by a *registered professional* who is qualified to perform such design. Sentence 2.2.1.2.(1) is not intended to imply that a registered professional may not also be required in the application of requirements in other Parts of the British Columbia Building Code.” (Note A-2.2.1.2.(1))

Who's in charge here?

- Neither the Article or its parallel Note indicates if the *registered professional* must be the "coordinating registered professional" or even an RP who is part of the design team. However, in Note *A-2.2.7 Professional Design and Review*, the Code states:

  "The responsibility for code compliance of the design remains with the original registered professional who undertook the design."

- Further on, in Note A-2.2.7.2.(1)(a) Coordinating Registered Professional, the Code states:

  "The coordinating registered professional is responsible to ascertain that all Code related aspects which are relevant to the project are clearly identified by each of the registered professionals in the collection of Schedules B."

Who’s in charge here?

- All of this would remain ambiguous and leave plenty of room for the assignment of design to someone else (the roofing contractor, for example), but for what is said in Division C, Part 2, **Article 2.2.2.1. General Information Required**.

[Next slide. Blue text is normal and indicates new text in 2018; red text is used only for emphasis]

Who's in charge here?

1) Sufficient information shall be provided to show that the proposed work will conform to this Code and whether or not it may affect adjacent property.
2) Plans shall be drawn to scale and shall indicate
   a) the nature and extent of the work or proposed occupancy in sufficient detail to establish that, when completed, the work and the proposed occupancy will conform to this Code,
   b) the applicable edition of the Code,
   c) whether the building is designed under Part 3 or Part 9,
   d) the major occupancy classifications of the building,
   e) the building area and building height,
   f) the number of streets the building faces,
   g) the accessible entrances, work areas and washrooms,
   h) the accessible facilities particular to the occupancies, and
   i) the energy compliance path to which the building conforms, and, where a building conforms to Subsection 9.36.6. or 10.2.3. of Division B, the Step to which it conforms.
3) When proposed work is changed during construction, information on the changes shall comply with the requirements of this Section for proposed work.

Who's in charge here?

- The word "sufficient" is left ambiguous, but it is clarified by **Article 2.2.4.3. Information Required on Structural Drawings** (red text is for emphasis):

  1) Structural drawings and related documents submitted with the application to build shall indicate, in addition to those items specified in Article 2.2.4.6. and in Part 4 of Division B applicable to the specific material,

     a) the name and address of the person responsible for the structural design,

     b) the date of issue of the Code and standards to which the design conforms,

     c) the dimensions, location and size of all structural members in sufficient detail to enable the design to be checked,

     d) sufficient detail to enable the dead loads to be determined, and

     e) all effects and loads, other than dead loads, used for the design of the structural members and exterior cladding.

Who's in charge here?

- Now consider Subsection 2.2.5. Drawings and Specifications for Environmental Separators and Other Assemblies Exposed to the Exterior, specifically **Article 2.2.5.1.**:

  "This Subsection applies to building materials, components and assemblies to which Part 5 of Division B applies."

Who’s in charge here?

- In that Subsection, Article **2.2.5.2. Information Required on Drawings** states the following (again, red text is for emphasis):

  1) Information shown on drawings and in specifications shall be clear and legible, and shall contain sufficient details to demonstrate conformance with this Code. (See Note A-2.2.6.2.(1).)

Who’s in charge here?

- Take-aways

Who's in charge here?

- Take-aways
  - The person designing the roof assembly (the *Design Authority*) is responsible for ensuring that the assembly design (Part 5) capably resists the loads calculated in Part 4. This is true regardless of the *Design Authority's* profession.

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  - Calculating the *Specified Wind Loads* (a Division B, Part 4 requirement) must be undertaken or at least reviewed by a *registered professional* skilled in the work concerned. This person does not have to be the “coordinating registered professional” (read *Design Authority)*, but that person is ultimately responsible to comply with the Code.

Who's in charge here?

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- ❖ Because of the inter-relatedness of Division B, Part 4 and Part 5 with respect to the design of the roof, compliance with Part 5 logically falls to the "coordinating registered professional", since the design of a load-resistant roof falls under Division B, Part 5.

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- ❖ Drawings and specifications for the “proposed work” must be complete by the time the building design is “submitted with the application to build” (that is, before anyone bids on a scope of work).

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- ❖ Drawings and specifications must include sufficient details to build the roof system/assembly to resist those loads.
- ❖ Drawings and specifications for the "proposed work" must be complete by the time the building design is "submitted with the application to build" (that is, before anyone bids on a scope of work).
- ❖ The design of the membrane roof assembly should identify the *Specified Wind Loads*, and ought to provide clear instructions for how the roof, as part of the building enclosure that provides environmental separation, must be constructed to resist those loads.

Who’s in charge here?

- Take-aways
  - ✓ Although the *Specified Wind Loads* are calculated in Part 4, the roof design needs to be provided as a normal part of an [architectural] specification.
  - ✓ None of the take-aways precludes the *Design Authority* from assigning to the constructor the task of selecting a suitable roofing system using the options in Division B, Part 5, **Article 5.2.2.2.**

    However, assigning system selection does not necessarily achieve the interests of the *Design Authority*. More on this later.

Who's in charge here?

Will everyone agree with this interpretation of the Code and responsibility for structural design?

Probably not.

And we welcome discussion.

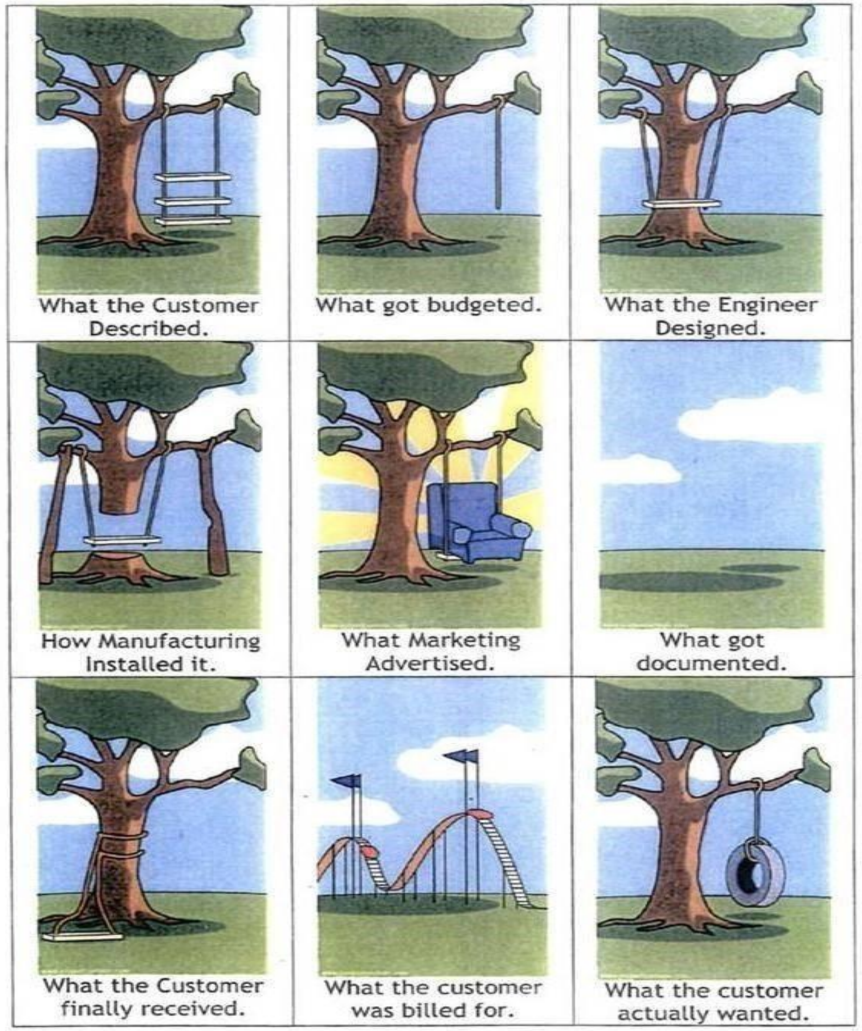
But here's a sobering question:

Who’s in charge here?

Who wants this on their resumé?

Credit: Tony Delessio

Using the tools: from Code to actual design



Using the tools: from Code to actual design

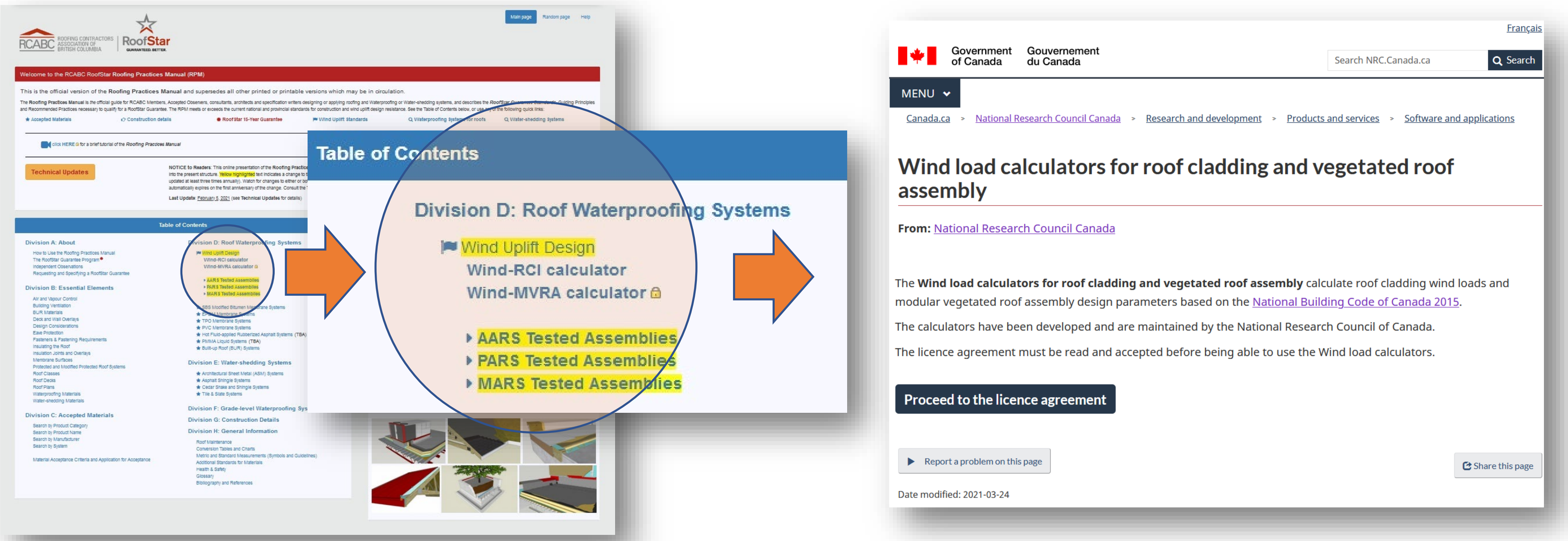
- How do we use what we've learned about Code requirements and responsibility for design, to practically design a roof?

To answer that, we'll focus the last part of this presentation on the application of Tested Assemblies, for new construction projects.

Using the tools: from Code to actual design

☆ **Step 1:** Begin by calculating *Specified Wind Loads*

- Use the freely available online Wind-RCI calculator or (as discussed earlier) retain a *registered professional* in structural engineering to do it for you.

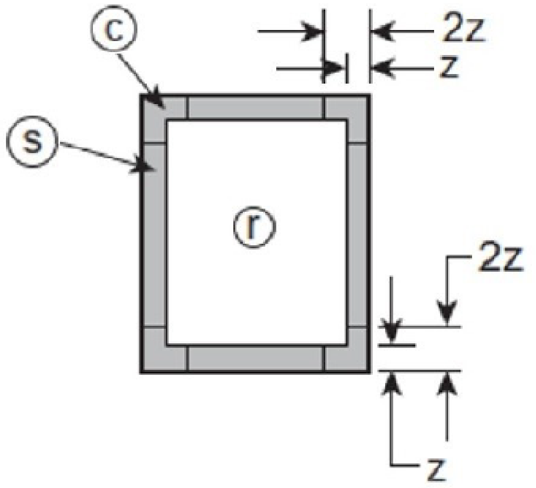


Using the tools: from Code to actual design

- ☆ The report (when using Wind-RCI) will provide data for three roof zones
  - **Scenario**: at right is a sample report on a fictitious structure):
    - **Corner**
    - **Edge**
    - **Field**

Note that the report also specifies an End Zone Width
(we'll come back to that shortly)

Roof area	Wind load
End zone width, Z☐	15 ft
Corner ©	-112 psf
Edge Ⓢ	-73 psf
Field ⓡ	-48 psf



(NBCC Figure A-4.1.7.5.(4))

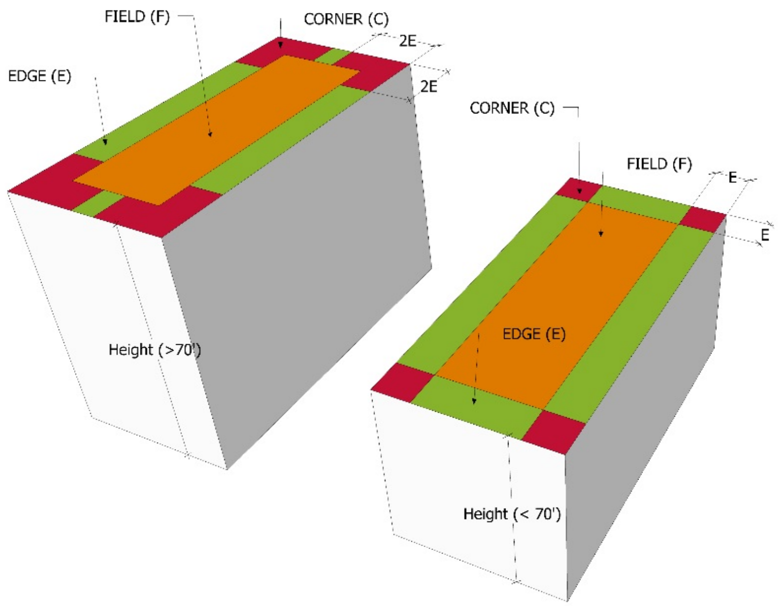
(Conversion Unit: 1 ft = 0.3048 m, 1 psf = 47.88 Pa, 1lb/ft^2 = 4.8824 kg/m^2)

Using the tools: from Code to actual design

☆ The roof, then, will experience a high load of 112 psf (negative pressure) in the Corner Zone (high loads are always in the corners). The rest of the *Specified Wind Loads* follow in descending values*:

- Corner: -112 psf
- Edge: - 73 psf
- Field: - 48 psf
- End Zone Width: 15 feet

NOTE: End Zone Width is a function of building height†



Three roof zones:
- Field
- Edge
- Corners

The Corner dimensions are always a function of the Edge width.

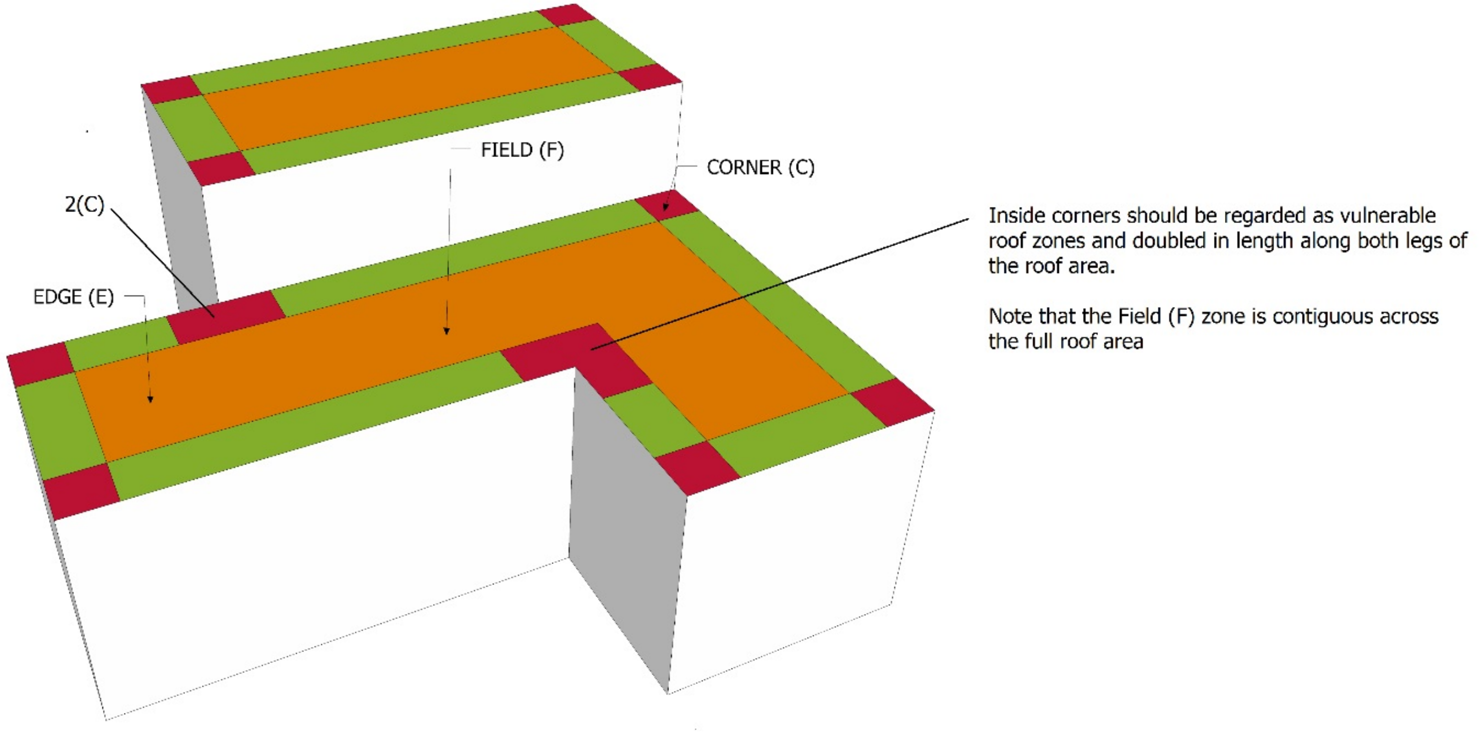
When structures exceed 21.3 m (70') in height, Corners double in size (2E).

* Imperial units used. Metric can be selected when launching the Wind-RCI tool

† Image from Part 3, Standard for EPDM Membrane Systems (RCABC Roofing Practices Manual)

Using the tools: from Code to actual design

Side Note: What do you do with multiple roof areas, or adjoining roofs? We've addressed that in our Guarantee requirements for membrane roof systems, under Part 3 of each Standard (we're more conservative than the Code):



Using the tools: from Code to actual design

☆ **Step 2:** Know what you want to build.

- This sounds elementary, but you need to consider a few key elements before going further:
  - **Deck type** – if it's steel or wood, you can consider assemblies that use mechanical fasteners. Concrete decks are more amenable to adhered materials, but pinning isn't out of the question.
  - **Type of covering** (membrane) – roof assemblies are tested with specific membranes, so you may want to make your work easier by deciding what type of membrane suits your design requirements.
  - **Type of insulation** – not all assemblies are tested with the same combinations of materials, and there are some types of insulation that are rarely if ever tested.

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- **Scenario**: the fictitious building we ran a report for is a modest high-rise* in Victoria, BC described as follows:
  - **Height:** 70 feet high (21.5 m)
  - **Width:** 110 feet (33.8 m)
  - **Length:** 150 feet (46.2 m)
  - **Exposure:** Open
  - **Openings:** Category 1
  - **Importance:** Normal

* 70 feet is the dividing line between Low Rise and High-rise buildings in the Wind-RCI calculator.

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- We've decided, for various reasons, to specify an insulated 2-ply SBS-modified bituminous membrane system.

Using the tools: from Code to actual design

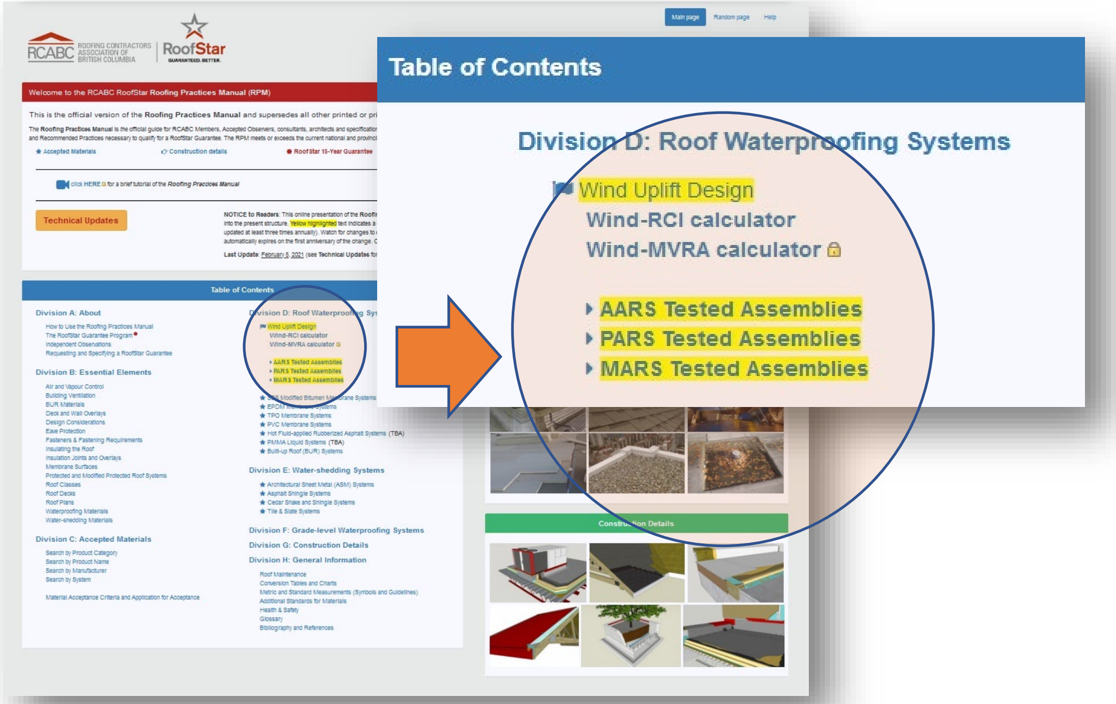
☆ **Step 2:** (continued)

- We've decided, for various reasons, to specify an insulated 2-ply SBS-modified bituminous membrane system.
- Ideally, we want it to have a hybrid securement system, and we want to utilize polyisocyanurate insulation.

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- We've decided, for various reasons, to specify an insulated 2-ply SBS-modified bituminous membrane system.
- Ideally, we want it to have a hybrid securement system, and we want to utilize polyisocyanurate insulation.
- With the highest *Specified Wind Loads* in mind (-112 psf), we turn to the tables in the Roofing Practices Manual to find a suitable assembly…



RCABC ROOFING CONTRACTORS ASSOCIATION OF BRITISH COLUMBIA | RoofStar GUARANTEED. BETTER.

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- After selecting the PARS page link in the RPM Table of Contents, we get this:

PARS Tested Roof Assemblies

Using the Tables | Additional Notes | SBS Membrane Assemblies | EPDM Membrane Assemblies | TPO Membrane Assemblies | PVC Membrane Assemblies | BUR Assemblies

N[illegible]EADER

Before [illegible] these tables, make sure you know the wind load requirements for the roof under design or construction. You can find guidance in **Part 3** **SECURING the ROOF ASSEMBLY** of the membrane system that is specified. *Specified Wind Loads* for the three principal roof zones may b[illegible]ed either by using the formulae in the *British Columbia Building Code*, 4.1.7 Wind Loads, or by using the National Research Council's online tool, **Wind-RCI online wind calculator**.

Table Structure and Organization

The tables on the adjacent tabs display data drawn from, and links to, **Tested Assembly Reports** listed by the membrane type shown on the tab heading. All test reports are downloadable from the "Test Report" column, and are catalogued under a RoofStar numbering system that may differ from the number designation on the report. Dynamic Wind Uplift (DUR) values are shown in columns near the left side of the tables. Only the DUR and Manufacturer columns are sortable; to sort a column, click the column heading. **Click on any drop-down button to try the demo table below.**

Tested Assembly Report Data					RoofStar Guarantee	Primary Materials			Other System Materials & Deck			
Manufacturer ⬍	Dynamic Uplift Resistance kPa ⬍	Dynamic Uplift Resistance Psf ⬍	Roof Assembly Summary	Test Report	Term†	Cap Membrane	Base Membrane	Plies	Insulation Overlay	Insulation	Deck Overlay	Deck Type
Manufacturer	-1.9	-40	View summary	Report link 1-A	5, 10	View options	View options	1, 2 or 3	View options	View options	View options	Deck type

Each row displays one test for a particular system of securement. That means that the DUR derived for that test is based on a particular pattern of fasteners or adhesive application. Most assemblies were tested with one system of securement, but some were tested with as many as four. When this is the case, the same report number will be displayed with test report names such as **[Manufacturer X] MARS 1-A** and **[Manufacturer X] MARS 1-B**. Read the test report details to see what was changed in the securement system that affected the DUR for the assembly.

Every table displays Tested Assembly report data in easy-to-read rows with drop-down buttons that display key information for each assembly (see the working example above). When the Tested Assembly uses a membrane with 2 or more plies, each membrane and its options is listed in separate columns.

Note that some tests were conducted without one or more of these constituent components and may list those materials as "optional". When a material category such as "insulation overlay" is absent from the test, the drop-down menu will indicate its absence with "N/A" or as "optional". Occasionally, a missing material poses a conflict with the ***RoofStar Guarantee Standards***. When the conflict is obvious, the Roof Assembly Summary will normally flag this with a note at the bottom of the list. Notwithstanding these notes, the reader is responsible to understand and apply the ***RoofStar Guarantee Standards*** regardless of the Tested Assembly report (see below under **Tested Assemblies and RoofStar Guarantee Standards**).

The Roof Assembly Summary provides a quick overview of how the roof assembly is secured. This feature of the tables will be especially helpful when searching for a suitable PARS assembly, because the placement of mechanical fasteners within an assembly can vary widely. Note, however, that the summaries do not list sizes, types or spacing of specific adhesives or fasteners; these details must be obtained from a careful reading of the Tested Assembly report.

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- Don't neglect the important stuff like the Additional Notes.

PARS Tested Roof Assemblies

Using the Tables | Additional Notes | SBS Membrane Assemblies | EPDM Membrane Assemblies | TPO Membrane Assemblies | PVC Membrane Assemblies | BUR Assemblies

NOTICE to READE[illegible]

Before you use these tables, [illegible] you know the wind load requirements for the roof under design or construction. You can find guidance in **Part 3** SECURING the ROOF ASSEMBLY of the membrane system that is specified. *Specified Wind Loads* for the three principal roof zones may be calculated either by u[illegible]rmulae in the *British Columbia Building Code*, 4.1.7 Wind Loads, or by using the National Research Council's online tool, **Wind-RCI online wind calculator**.

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Tested Assembly Report Data					RoofStar Guarantee	Primary Materials			Other System Materials & Deck			
Manufacturer ⇕	Dynamic Uplift Resistance kPa ⇕	Dynamic Uplift Resistance Psf ⇕	Roof Assembly Summary	Test Report	Term†	Cap Membrane	Base Membrane	Plies	Insulation Overlay	Insulation	Deck Overlay	Deck Type
Manufacturer	-1.9	-40	View summary ▾	Report link 1-A	5, 10	View options ▾	View options ▾	1, 2 or 3	View options ▾	View options ▾	View options ▾	Deck type

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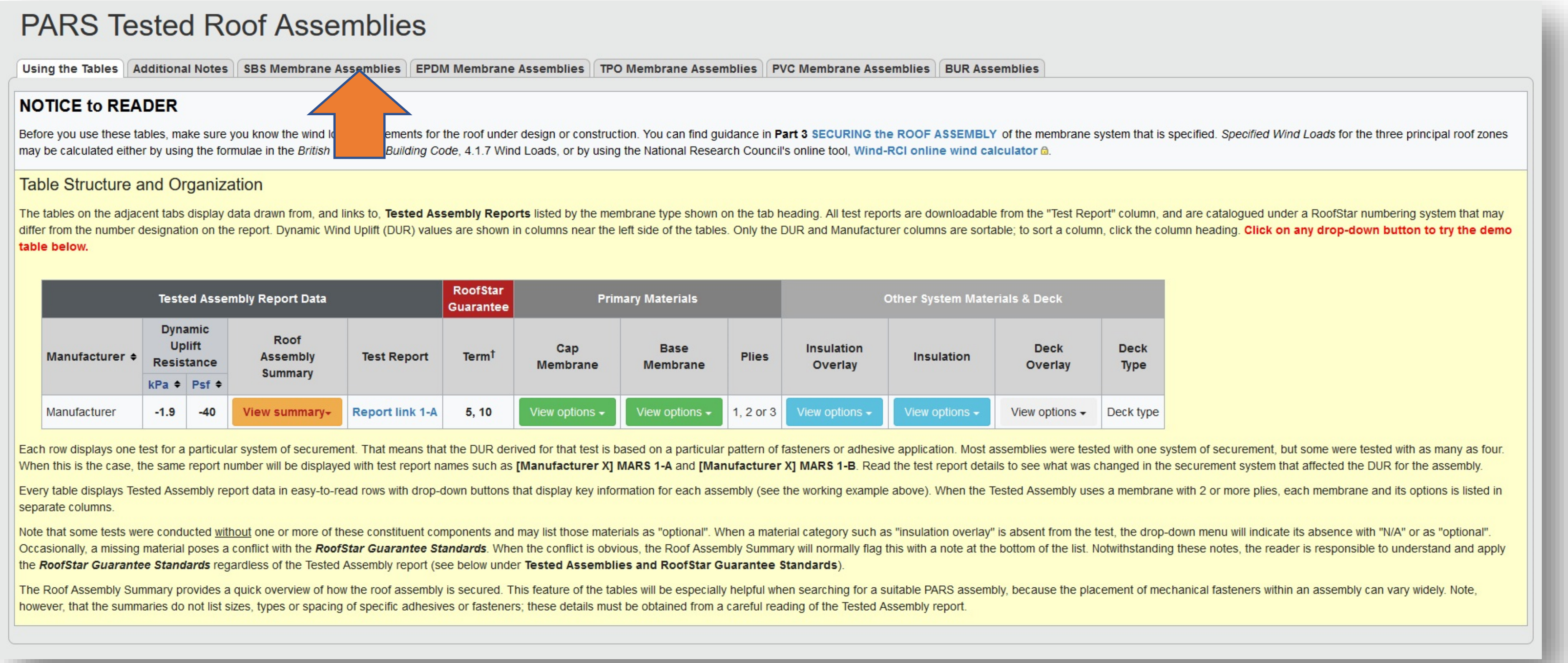
Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- Select the SBS Membrane tab and click.



PARS Tested Roof Assemblies

Using the Tables | Additional Notes | SBS Membrane Assemblies | EPDM Membrane Assemblies | TPO Membrane Assemblies | PVC Membrane Assemblies | BUR Assemblies

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Manufacturer ⬍	Dynamic Uplift Resistance		Roof Assembly Summary	Test Report	Term†	Cap Membrane	Base Membrane	Plies	Insulation Overlay	Insulation	Deck Overlay	Deck Type
	kPa ⬍	Psf ⬍										
Manufacturer	-1.9	-40	View summary	Report link 1-A	5, 10	View options	View options	1, 2 or 3	View options	View options	View options	Deck type

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Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- Select the SBS Membrane tab and click.

PARS Tested Roof Assemblies

Using the Tables | Additional Notes | SBS Membrane Assemblies | EPDM Membrane Assemblies | TPO Membrane Assemblies | PVC Membrane Assemblies | BUR Assemblies

Tested Assembly Report Data					RoofStar Guarantee	Primary Materials			Other System Materials & Deck			
Manufacturer	Dynamic Uplift Resistance kPa	Dynamic Uplift Resistance Psf	Roof Assembly Summary	Test Report	Term†	Cap Membrane	Base Membrane	Plies	Insulation Overlay	Insulation	Deck Overlay	Deck Type
IKO Industries Ltd.	-2.4	-50	View summary▾	IKO PARS 9-A	5, 10	View options ▾	View options ▾	2	View options ▾	View options ▾	View options ▾	Steel
IKO Industries Ltd.	-2.2	-47	View summary▾	IKO PARS 13-A	5, 10	View options ▾	View options ▾	2	View options ▾	View options ▾	View options ▾	Steel
IKO Industries Ltd.	-4.2	-80	View summary▾	IKO PARS 14-A	5, 10	View options ▾	View options ▾	2	View options ▾	View options ▾	View options ▾	Steel
IKO Industries Ltd.	-1.9	-40	View summary▾	IKO PARS 15-A	5, 10	View options ▾	View options ▾	2	View options ▾	View options ▾	View options ▾	Steel
IKO Industries Ltd.	-1.9	-40	View summary▾	IKO PARS 16-A	5, 10	View options ▾	View options ▾	2	View options ▾	View options ▾	View options ▾	Steel
IKO Industries Ltd.	-6.7	-140	View summary▾	IKO PARS 17-A	5, 10	View options ▾	View options ▾	2	View options ▾	View options ▾	View options ▾	Steel
Polyglass USA, Inc.	-3.1	-64	V			s ▾	View options ▾	2 or 3	View options ▾	View options ▾	View options ▾	Steel
Polyglass USA, Inc.	-3.1	-64	V			s ▾	View options ▾	2 or 3	View options ▾	View options ▾	View options ▾	Steel
Polyglass USA, Inc.	-3.1	-64	V			s ▾	View options ▾	2 or 3	View options ▾	View options ▾	View options ▾	Steel
Polyglass USA, Inc.	-3.1	-64	V			s ▾	View options ▾	2 or 3	View options ▾	View options ▾	View options ▾	Steel
Polyglass USA, Inc.	-3.1	-64	V			s ▾	View options ▾	2 or 3	View options ▾	View options ▾	View options ▾	Steel
Polyglass USA, Inc.	-3.1	-64	View summary▾	POL PARS 6-A	5, 10	View options ▾	View options ▾	2 or 3	View options ▾	View options ▾	View options ▾	Steel
Polyglass USA, Inc.	-3.1	-64	View summary▾	POL PARS 7-A	5, 10	View options ▾	View options ▾	2 or 3	View options ▾	View options ▾	View options ▾	Steel

Cap membrane: torch-applied
Base membrane: torch-applied (optional)
Insulation overlay: mechanically fastened (composite overlay)
Insulation (top layer): avarious securement options
Insulation (bottom layer): various securement options
Air/Vapour control layer: self-adhered on primer
Deck overlay (thermal barrier): various securement options
Roof deck

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- We can quickly survey the contents of an Assembly before downloading the report.

PARS Tested Roof Assemblies

Using the Tables | Additional Notes | SBS Membrane Assemblies | EPDM Membrane Assemblies | TPO Membrane Assemblies | PVC Membrane Assemblies | BUR Assemblies

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IKO Industries Ltd.	-2.4	-50	View summary	IKO PARS 9-A	5, 10	View options	View options	2	View options	View options	View options	Steel
IKO Industries Ltd.	-2.2	-47	View summary	IKO PARS 13-A	5, 10	View options	View options	2	View options	View options	View options	Steel
IKO Industries Ltd.	-4.2	-80	View summary	IKO PARS 14-A	5, 10	View options	View options	2	View options	View options	View options	Steel
IKO Industries Ltd.	-1.9	-40	View summary	IKO PARS 15-A	5, 10	View options	View options	2	View options	View options	View options	Steel
IKO Industries Ltd.	-1.9	-40	View summary	IKO PARS 16-A	5, 10	View options	View options	2	View options	View options	View options	Steel
IKO Industries Ltd.	-6.7	-140	View summary	IKO PARS 17-A	5, 10	View options	View options	2	View options	View options	View options	Steel
Polyglass USA, Inc.	-3.1	-64	View summary	POL PARS 1-A	5, 10	V		2 or 3	View options	View options	View options	Steel
Polyglass USA, Inc.	-3.1	-64	View summary	POL PARS 2-A	5, 10	V		2 or 3	View options	View options	View options	Steel
Polyglass USA, Inc.	-3.1	-64	View summary	POL PARS 3-A	5, 10	V		2 or 3	View options	View options	View options	Steel
Polyglass USA, Inc.	-3.1	-64	View summary	POL PARS 4-A	5, 10	V		2 or 3	View options	View options	View options	Steel
Polyglass USA, Inc.	-3.1	-64	View summary	POL PARS 5-A	5, 10	V		2 or 3	View options	View options	View options	Steel
Polyglass USA, Inc.	-3.1	-64	View summary	POL PARS 6-A	5, 10	V		2 or 3	View options	View options	View options	Steel
Polyglass USA, Inc.	-3.1	-64	View summary	POL PARS 7-A	5, 10	V		2 or 3	View options	View options	View options	Steel

- Torchflex TP-250
- Torchflex TP-HD
- Torchflex TP-250 5 mm
- Torchflex TP-180
- Prevent TP-250
- Prevent Premium TP-250
- Prevent TP-HD
- Carrara Armourcool HD
- Prevent Armourcool HD Cap
- Modiflex MP-180 Cap

Using the tools: from Code to actual design

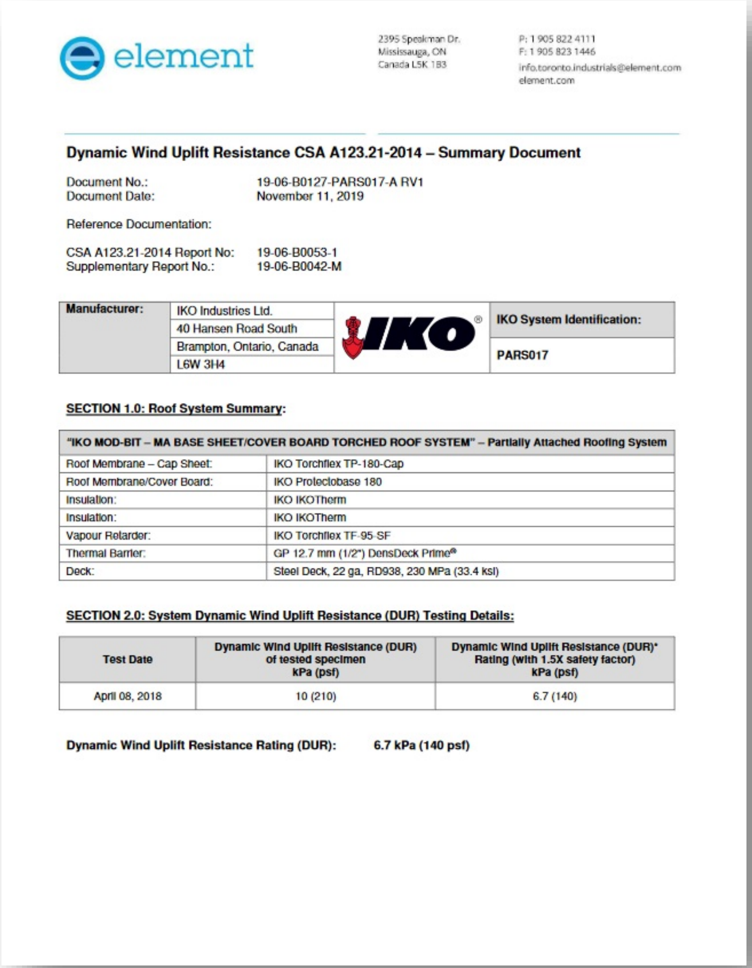
☆ **Step 2:** (continued)

- Since the assembly looks promising (the DUR is higher than the loads we expect for the Corner Zone*), we can download the report for more detail.

A few observations about the report:

- There is one system of securement test, and it produced a DUR (Dynamic Uplift Resistance) of -140 psf (adjusted for the safety factor required by the previous methods used in CSA-A123.21)
- The complete assembly profile is shown in a summary table on the front of the report

*Always look for a DUR that is higher than the Specified Wind Loads



element

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F: 1 905 823 1446
info.toronto.industrials@element.com
element.com

Dynamic Wind Uplift Resistance CSA A123.21-2014 – Summary Document

Document No.: 19-06-B0127-PARS017-A RV1
Document Date: November 11, 2019

Reference Documentation:

CSA A123.21-2014 Report No: 19-06-B0053-1
Supplementary Report No.: 19-06-B0042-M

Manufacturer:	IKO Industries Ltd. 40 Hansen Road South Brampton, Ontario, Canada L6W 3H4	IKO	**IKO System Identification:** **PARS017**

SECTION 1.0: Roof System Summary:

"IKO MOD-BIT – MA BASE SHEET/COVER BOARD TORCHED ROOF SYSTEM" – Partially Attached Roofing System	
Roof Membrane – Cap Sheet:	IKO Torchflex TP-180-Cap
Roof Membrane/Cover Board:	IKO Protectobase 180
Insulation:	IKO IKOTherm
Insulation:	IKO IKOTherm
Vapour Retarder:	IKO Torchflex TF-95-SF
Thermal Barrier:	GP 12.7 mm (1/2") DensDeck Prime®
Deck:	Steel Deck, 22 ga, RD938, 230 MPa (33.4 ksi)

SECTION 2.0: System Dynamic Wind Uplift Resistance (DUR) Testing Details:

Test Date	Dynamic Wind Uplift Resistance (DUR) of tested specimen kPa (psf)	Dynamic Wind Uplift Resistance (DUR)* Rating (with 1.5X safety factor) kPa (psf)
April 08, 2018	10 (210)	6.7 (140)

Dynamic Wind Uplift Resistance Rating (DUR): 6.7 kPa (140 psf)

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- An examination of the rest of the report shows critical detail:
  - Which layers in the assembly are mechanically fastened, and which are adhered (in this case, the base membrane is factory-bonded to an insulation overlay, which is mechanically fastened).
  - Size of mechanical fasteners (critical, because size does matter – see the last page of the report for fastener size)
  - Optional materials (not necessarily tested, but engineered as equivalents for the same uplift resistance performance)

SECTION 3.0: Tested Product and Substitutable Products:

Roof Membrane (Cap Sheet)			
Tested Product	IKO Torchflex TP-180-Cap		
Product Size	Roll Width: 1 m (36.9"), roll Length 8 m (26')		
Attachment Method	Heat Welded		
Substitutable Product(s)			
Manufacturer	**Product Identification**		
IKO Industries Ltd.	Torchflex TP-HD-Cap	Torchflex TP-250-Cap	Torchflex TP-250-Cap (5 mm)
	PrevENt TP-250-Cap	PrevENt TP-HD-Cap	PrevENt Premium TP-250-Cap
	ArmourCool Granular TP-HD	PrevENt ArmourCool Granular TP	PrevENt ArmourCool HD Cap
	Carrara ArmourCool HD		
IKO Industries Ltd.	Modiflex MP-180-cap	Modiflex MP-250-cap	Modiflex MP-HD-cap
	PrevENt MP-250-cap	PrevENt MP-HD-cap	
	Torchflex TP-HD-Cap	Torchflex TP-250-Cap	Torchflex TP-250-Cap (5 mm)

Roof Membrane Base Sheet/Cover Board	
Tested Product	IKO Protectobase 180
Product Size	5.4 x 914 x 2440 mm (1/8" x 3' x 8')
Attachment Method	Mechanically attached
Fastening Rate	305 mm (12") o.c. fastener spacing row spacing in-seam and two mid-seam rows 102 (4") either side of centre
Substitutable Product(s)	
Manufacturer	**Product Identification**
IKO Industries Ltd	Shieldbase 180
	Protectoboard with Torchflex TP-180-FF-Base

Insulation (Top Layer)			
Tested Product	IKO IKOTherm		
Product Size	38 x 1220 x 2440 mm (1.5" x 4' x 8')		
Attachment Method	Loose laid, pre-secured or adhered		
Fastening Rate	n/a		
Substitutable Product(s)			
Manufacturer	**Product Identification**		
IKO Industries Ltd.	IKOTherm III	IKOTherm 25 psi	IKOTherm III 25 psi
	IKOTherm Tapered	IKOTherm III Tapered	IKOTherm 25 psi Tapered

Using the tools: from Code to actual design

☆ **Step 2:** (continued)

- Fastener size does matter:
  - **Trufast #14 screws** have a published pull-out resistance (18-Gauge steel decks) that ranges from 675 ksi to 985 ksi*
  - **Trufast #12 screws** (for the same deck specifications) will resist 540 to 800 ksi.

#12

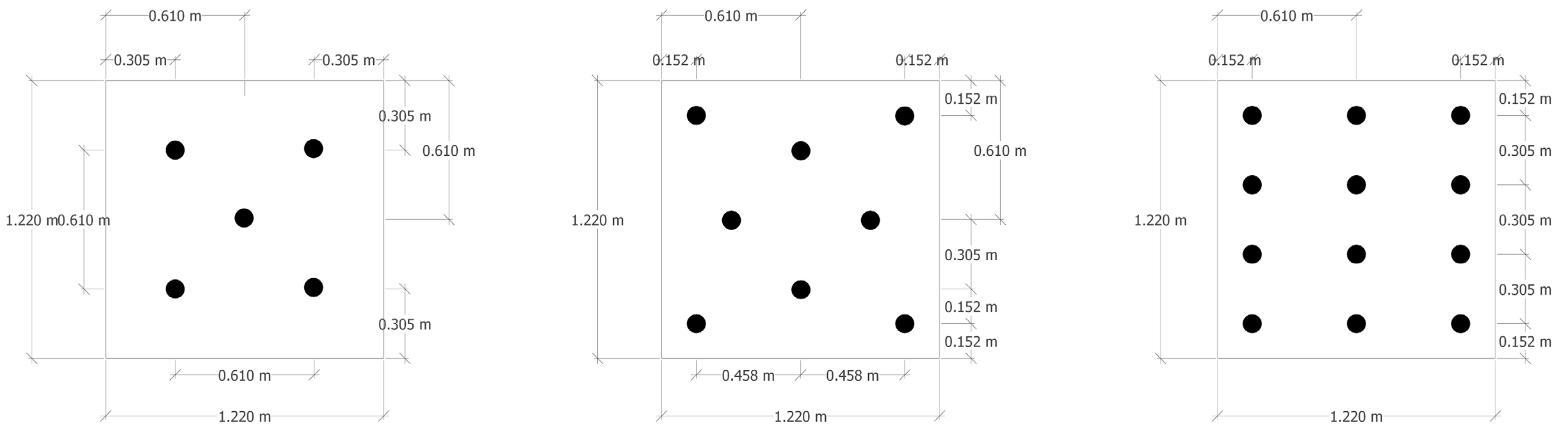
#14

* Kilopounds per square inch

Using the tools: from Code to actual design

☆ **Step 3:** Use the desirable Tested Assembly in your specification (more on this soon):

- Provide the *Specified Wind Loads* so that the constructors know what to work with.
- Embed (or attach as an Appendix) a copy of the report.



Fastening patterns from a published Tested Assembly report, illustrating three securement systems

Using the tools: from Code to actual design

☆ **Step 3:** What about the zones?

- In the scenario, the assembly test showed only one system of securement which generated only one DUR value for the entire roof area. When this is the case, you have options:
    1. Use the same system of securement for the entire roof, as if it were all the Corner Zone.
    2. Have a *registered professional* (engineer) extrapolate the securement requirements for the Edge and Field Zones by using the ANSI/SPRI WD-1 methodologies.

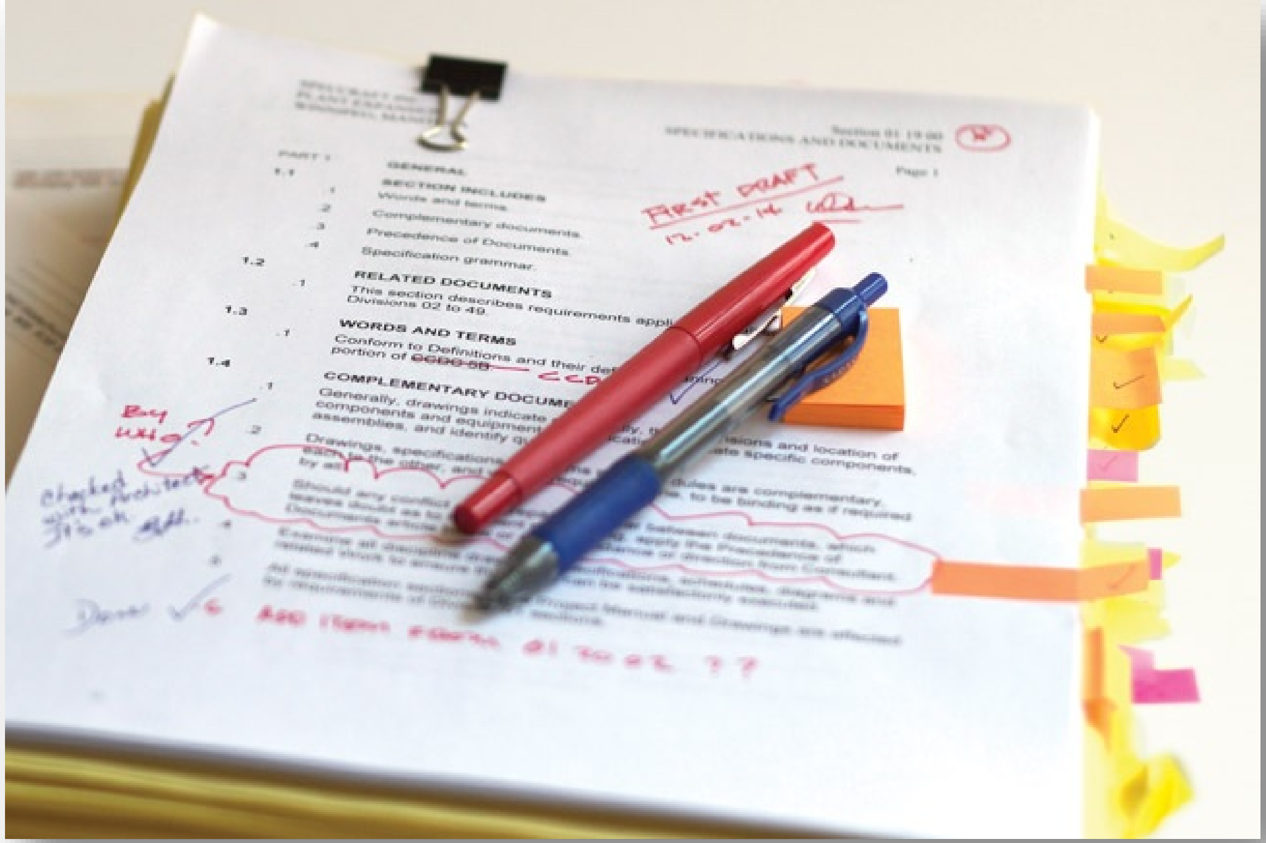
Using the tools: from Code to actual design

☆ **Step 3:** What about the zones?

- Not all tests are limited to one securement system. Some roof assemblies are tested with different securement systems; a report will then publish the various results. When that is the case, it may be possible to use one test report and the multiple results to design securement for separate roof zones (example below).

System Designation	Measured Value	Computed Value (To Include 1.5 Experimental Factor)	
A	-3,2 kPa (-67 psf)	-2,2 kPa (-45 psf)	FIELD
B	-5,4 kPa (-112 psf)	-3,6 kPa (-75 psf)	EDGE
C	-7,5 kPa (-157 psf)	-5,0 kPa (-105 psf)	CORNER

Specifying a Code-compliant Roof



Specifying a Code-compliant Roof

- ☆ How do you specify a Code-compliant roof?
  - ✓ No matter who you are as the *Design Authority,* a good roof depends upon the clear articulation of needs, obligations and methods.
  - ✓ To specify a Code-compliant roof, consider the following ideas, which come from years of working with various designers.

Specifying a Code-compliant Roof

✓ **Be clear about what you want.**

It doesn't help constructors if a specification uses a statement like, "All membrane roofing systems installed shall conform to CSA A123.21…". If the intent of the design is to use a Tested Assembly, the specifications should say that the roof must be constructed using a Tested Assembly (remember that "Tested Assembly" is one compliance pathway).

As an aside, remember that the CSA test method is just that – a test method. conforming to the CSA test method isn't a thing. The roof system must conform to the Code.

Specifying a Code-compliant Roof

✓ **Avoid conflicting requirements**.

Any reference to "FM" has no place in a Code-compliant specification. As a test method, its approach is radically different from the CSA test method and isn't recognized by the Code.

- FM uses a static test with a 60-second duration, reproduced 6 times.
- The CSA test method is dynamic in nature, uses fluctuating cycles of winds (gusts), and can last up to 5 hours.

Specifying a Code-compliant Roof

✓ **Indicate what kind of securement to use**.

Some design specifications leave the reader to guess, which doesn't help anyone.

Be clear and concise.

Furthermore, wind-resistant membrane roof design has its own 'lingo' like PARS and *Specified Wind Loads*, so use it to your advantage. Manufacturers "speak it" and the knowledgeable roofing contractors who bid on the job will thank you for the clarity.

Specifying a Code-compliant Roof

✓ **Provide relevant data**.

If the roof is going to be constructed using a Tested Assembly, but you want the roofing contractor to choose the assembly based on the *Specified Wind Loads*, include those load values and a diagram showing the associated roof zones so that the contractor can make informed choices.

The same holds true for using a system with *proven past performance*; the proven system data needs to be included in the specification.

Specifying a Code-compliant Roof

✓ **Make sure the materials you specify match available options for compliance**.

If you're design follows the Tested Assembly path for Code compliance, make sure you list the materials that have been tested. Substitutions aren't always an option (more on this shortly), and RFI's for alternates can delay projects unnecessarily.

Specifying a Code-compliant Roof

✓ **Let the Tested Assembly report do the work for you**.

Instead of prescribing application methods and rates ("Apply insulation to vapour retarder or to adjoining board with specified adhesive applied in 2 cm. wide bands every 33 cm. ..."), simply refer to the requirements of the assembly test. It's all there. The proper application rates are listed in the report and specified by the manufacturer who arranged for the test.

Specifying a Code-compliant Roof

So much for general principles.

You've got questions. We've got some answers.

Specifying a Code-compliant Roof

☆ **Question**: Can't I simply use what I know and feel comfortable with?

Using the tools: from Code to actual design

☆ **Answer**: It depends.

Specifications traditionally prescribe the materials to be used, and list suitable alternatives. As you now know, the current Building Code says that a membrane roof must be designed with a *Tested Assembly*, an assembly with *Proven Past Performance*, or (though not expressly stated), an assembly with custom-engineered securement (excepting ANSI/SPRI WD-1).

Many materials have been tested, but not all of them. And not all of them will provide the kind of performance (wind resistance) the Code now requires.

Using the tools: from Code to actual design

☆ **Question**: Can I assign the selection of a roof system to the roofing contractor?

Using the tools: from Code to actual design

☆ **Answer**: Sure, as I've already alluded to. But understand that you may lose some control over the project.

For example, you could provide the *Specified Wind Loads* in a specification but leave the system choice to the constructor. However, what the constructor chooses won't necessarily be what you imagined, so consider narrowing the field of options:

- Identify the type of covering (membrane)
- Identify how you want the system secured.
- Identify the manufacturer of the membrane you want.

Using the tools: from Code to actual design

Further thought: the more specific you can be (provide an actual *Tested Assembly* as the basis of the design), the more certainty you will have around

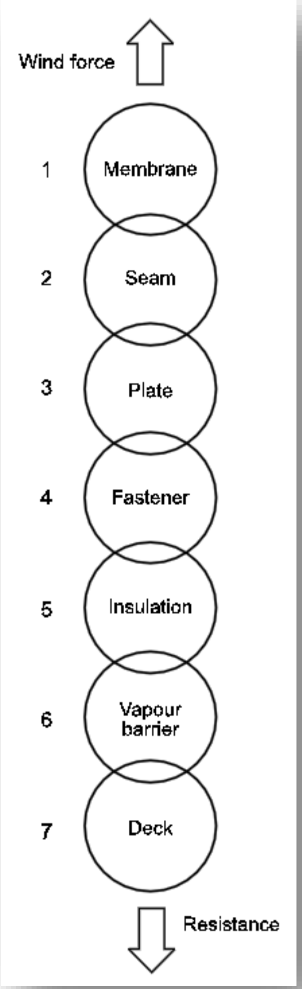
- cost
- performance
- roof system aesthetics and longevity

Using the tools: from Code to actual design

☆ **Question**: Can I substitute a material in a Tested Assembly?

Using the tools: from Code to actual design

- **Answer**: It's possible, but not necessarily advisable. Why? Because of the Chain of Connectivity…



Using the tools: from Code to actual design

- Material properties affect the way each constituent layer in a roof assembly behave under loads. Consider the humble apple pie as a metaphor…

Using the tools: from Code to actual design

- When membrane assemblies are tested to CSA-A123.21, most test failures do not occur between materials (an *adhesive* issue) – they occur within the material, usually between its facer and the core (a *cohesive* issue).

Using the tools: from Code to actual design

- When membrane assemblies are tested to CSA-A123.21, most test failures do not occur between materials (an *adhesive* issue) – they occur within the material, usually between its facer and the core (a *cohesive* issue).
- CSA-A123.21 offers some guidance for material swapping in Annex F, but it is informative only, not mandatory. Furthermore, the principles are different for MARS, PARS and AARS assemblies so there is no one governing principle that can be broadly applied to the issue.

However, a few broad concepts are pertinent:

Using the tools: from Code to actual design

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However, a few broad concepts are pertinent:

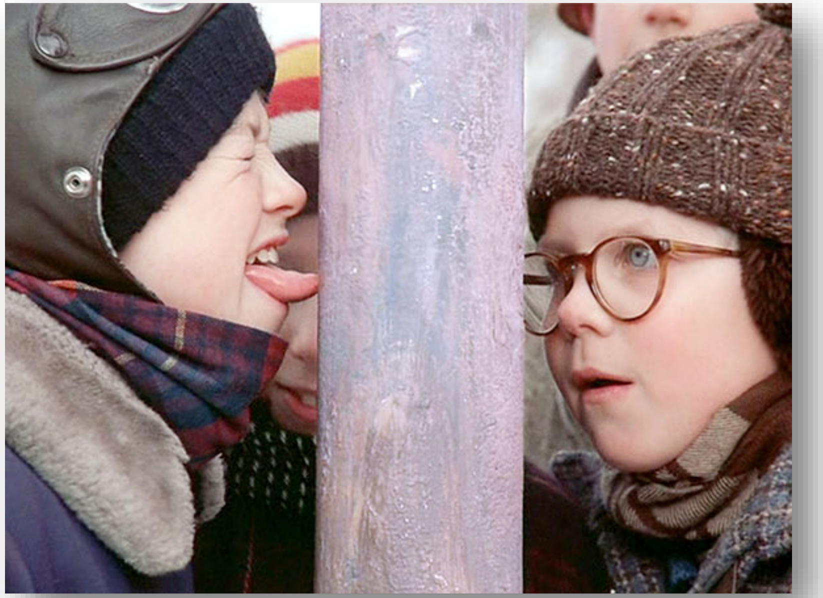
- ✓ Use **CAUTION**.
- ✓ It’s complicated with AARS and PARS, less complicated with MARS.
- ✓ Swap in a new material only if is necessary (to conform to RGC requirements, for example*), and then only if the material’s relevant properties (i.e. compressive strength) are greater than those for the tested material you want to replace.
- ✓ Limit swapping to one component in a Tested Assembly. Changing more than one component generally requires a new test.

*Generally, this isn’t necessary given the breadth of RoofStar-accepted materials but check the Tested Assembly against the list of materials in the RPM.

Using the tools: from Code to actual design

☆ **Remember**: not everything sticks together, or to another material, the same as the next one, so if you want to swap a material where <u>adhesion</u> matters (AARS or PARS assemblies), first check

- with the manufacturer and obtain an approval in writing.
- with the RCABC (if you're specifying a Guarantee, the optional materials must be Accepted).



Using the tools: from Code to actual design

☆ **Question**: What about complete roof replacements?

Using the tools: from Code to actual design

- **Answer**: Definitely! Approach a full system replacement as if it were new construction.

NOTE: Calculating *Specified Wind Loads* is still required (by Code, and by RoofStar Guarantee Standards).

Using the tools: from Code to actual design

☆ **Question**: What about partial roof replacements?

Using the tools: from Code to actual design

- **Answer**: Complying with the Code for partial roof replacements is difficult and not necessarily achievable.

Remember, the key word in the Code is *alteration*, and the key principle is the *alteration* of a structural element in a building, so…

Using the tools: from Code to actual design

1. Calculate the *Specified Wind Loads*
2. Design the securement for the new system to resist those loads:
   - Consider mechanically-fastened (PARS or MARS) systems.
   - If adhering new materials is desirable, try to mechanically secure the first overlay as a platform to which all other new materials can be adhered. Be cautious when tempted to rely on the adhesive properties of existing materials.
   - Consider using a system with *Proven Past Performance*.

Using the tools: from Code to actual design

☆ **Question**: What are the requirements for ballasted roofs?

Using the tools: from Code to actual design

- **Answer**: The Code doesn't say, although ballasted roofs are mentioned in the Notes for **Article 5.2.2.2.** ("[the CSA test method] does not apply to roofing systems that use ballasts, such as gravel or pavers, to secure the membrane against wind uplift"). Nevertheless, do the following:

Using the tools: from Code to actual design

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  1. Calculate the *Specified Wind Loads* for the roof (this is still required by Code, even if the Code provides no direction for how to secure the roof. RCABC Standards also require this).

Using the tools: from Code to actual design

- **Answer**: The Code doesn't say, although ballasted roofs are mentioned in the Notes for **Article 5.2.2.2.** ("[the CSA test method] does not apply to roofing systems that use ballasts, such as gravel or pavers, to secure the membrane against wind uplift"). Nevertheless, do the following:
  1. Calculate the *Specified Wind Loads* for the roof (this is still required by Code, even if the Code provides no direction for how to secure the roof. RCABC Standards also require this).
  2. The Protected Membrane Roof (PMR) must be secured against wind uplift. To do that, you may refer to Part 3 of the RGC Standard for the membrane type you want to use, and leverage the helpful design guidance in the Dupont Tech Solutions 508.2 Ballast Design Guide for PMR Systems. The Dupont guide is downloadable from Part 3 (RoofStar Guarantee Standards).

  (NOTE: In a PMR ("inverted") system, the membrane is already secured (adhered) to the roof deck or a suitable substrate. Securement of the remainder of the assembly requires ballast (depth and weight) dictated by the *Specified Wind Loads*)

Wrapping it up

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Wrapping it up

- Understanding the British Columbia Building Code requires careful reading and an attentiveness to each Division and the Notes for each Part.
- Good roof design plays a key role in the structural engineering of a building.
- Wind can cause a lot of damage to a roof system that is poorly designed and inadequately secured to the building.
- When a design clearly indicates loads and solutions for the contractor, everyone comes out a winner.

Wrapping it up

A friendly reminder…

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Wrapping it up

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