ENERGY DESIGN
conference & expo

Wingnut Testing: How PSA tapes, liquid sealants, basement waterproofing systems, and roof venting really work

Dave Gauthier, WTF CEO

Peter Yost, Chief Wingnut

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code /1 hour energy** continuing education requirements."

For additional continuing education approvals, please see your credit tracking card.

WTF?

It all started innocently enough…

Bird's-Eye View | Key Materials | Builder Tips

ADHESIVE/SEALANT
Low-VOC construction adhesive + more

BRICK VENEER
Brick is like a big hard sponge — let it dry, and everything is OK
+ more

RIGID INSULATION FOR WALLS
Types of rigid insulation + more

SHEATHING DRAINAGE MAT
Alternatives to sheathing drainage mat + more

SILL SEALERS
Thicker sill sealers are better + more

SILL SEALER
Sill sealer keeps sills or bottom plates away from concrete + more

CONTINUOUS BEAD OF SEALANT
Which caulks and sealants works best, and where? + more

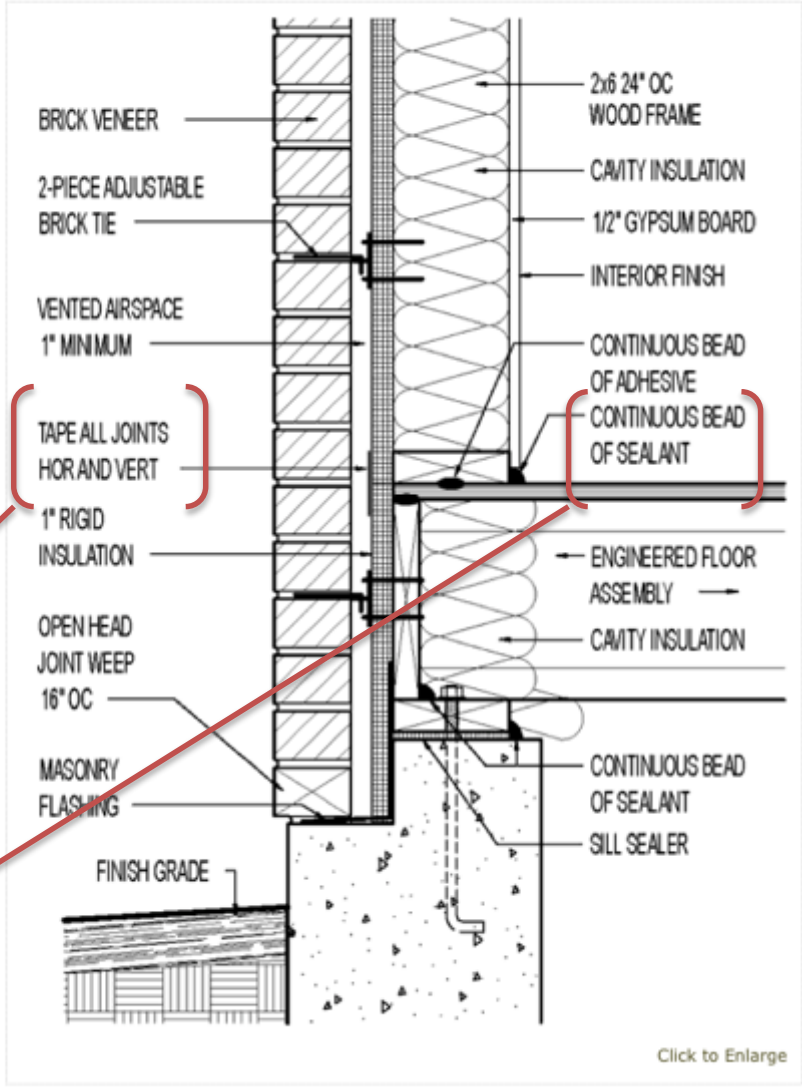
CAVITY INSULATION
Which insulation is greenest? + more

1/2" GYPSUM BOARD
Greener choices exist + more

INTERIOR FINISH
Let interior finishes let the walls dry + more

2-PIECE ADJUSTABLE MASONRY TIE
Two-piece ties hold better; stainless steel lasts longer + more

DRAWING DETAIL — Download: PDF | DWG



"TAPE ALL JOINTS HOR AND VERT"

"CONTINUOUS BEAD OF SEALANT"

Test Methods

Test methods adhesives

Adhesives ASTM Standard test methods	Method
Resistance of Adhesive Bonds to Chemical Reagents	D896-97
Tensile Properties of Adhesive Bonds	D897-95a
Applied Weight Per Unit Area of Dried Adhesive Solids	D898-96
Peel or Stripping Strength of Adhesive Bonds	D903-98
Exposure of Adhesive Specimens to Artificial Light	D904-99
Strength Properties of Adhesive Bonds in Shear by Compression Loading	D905-98
Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading	D906-98
Standard Terminology of Adhesives	D907-99
Impact Strength of Adhesive Bonds	D950-98
Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)	D1002-99
Cleavage Strength of Metal-to-Metal Adhesive Bonds	D1062-96e1
Standard Test Methods for Viscosity of Adhesives	D1084-97
Determining Strength Development of Adhesive Bonds	D1144-99
Effect of Moisture and Temperature on Adhesive Bonds	D1151-90
Resistance of Adhesives to Cyclic Laboratory Aging Conditions	D1183-96e1
Flexural Strength of Adhesive Bonded Laminated Assemblies	D1184-98
Storage Life of Adhesives by Consistency and Bond Strength	D1337-96
Working Life of Liquid or Paste Adhesives by Consistency and Bond Strength	D1338-99
Standard Specification for Adhesive for Acoustical Materials	D1779-98
Conducting Creep Tests of Metal-to-Metal Adhesives	D1780-99
Climbing Drum Peel for Adhesives	D1781-98
Atmospheric Exposure of Adhesive-Bonded Joints and Structures	D1828-96
Peel Resistance of Adhesives (T-Peel Test)	D1876-95
Preparation of Surfaces of Plastics Prior to Adhesive Bonding	D2093-97
Preparation of Bar and Rod Specimens for Adhesion Tests	D2094-91
Tensile Strength of Adhesives by Means of Bar and Rod Specimens	D2095-96e1
Creep Properties of Adhesives in Shear by Compression Loading (Metal-to-Metal)	D2293-96
Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)	D2294-96
Strength Properties of Adhesives in Shear by Tension Loading at Elevated Temperatures (Metal-to-Metal)	D2295-96
Standard Guide for Preparation of Metal Surfaces for Adhesive Bonding	D2651-90
Durability Assessment of Adhesive Joints Stressed in Peel	D2918-99
Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading	D2919-95

Lab Test Conditions

- Stainless steel substrate
- Clean substrate
- Warm (70 F)
- Dry (including 50% RH)

Clean trimmed fingernails

Surgical scissors instead of utility knife?

Bare soft hands

Job site conditions

- Cold
- Dirty
- Wet

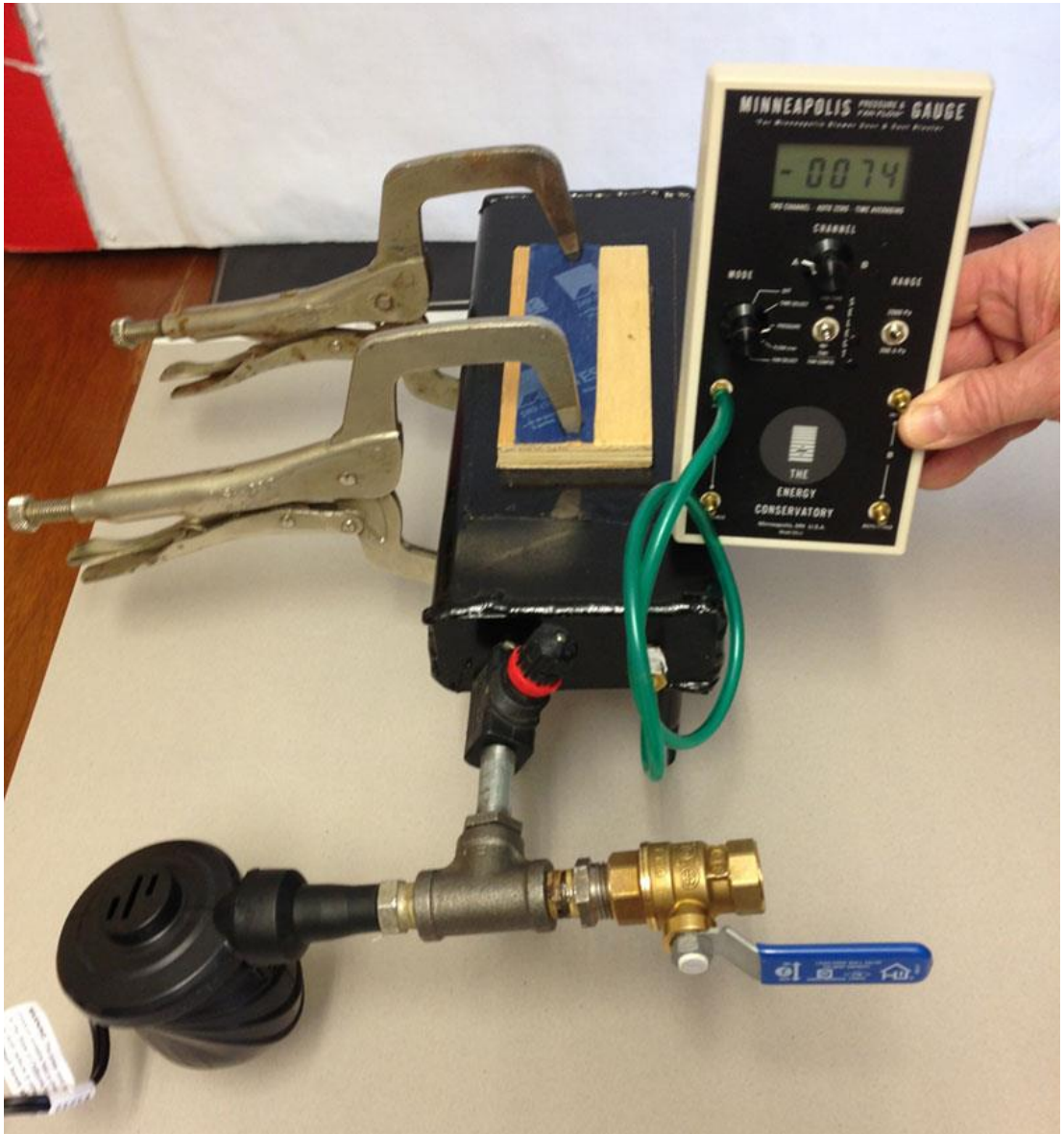
Context - Caveats

- We are, after all…wingnuts
- Sample sizes of two are anecdotal, not statistically significant
- Our results are contextual and we ask that you not generalize them…
- We do our best to involve manufacturers
- Our mission statement: cajole adult supervision…

WTF work to-date

- PSA tapes
- Negative-side waterproofing
- Roof venting
- Bit of range hood testing

GBA: PSA tape


MINNEAPOLIS GAUGE
-0074
CHANNEL
MODE
RANGE
THE
ENERGY
CONSERVATORY

GBA: NSW

GBA: Roof Venting

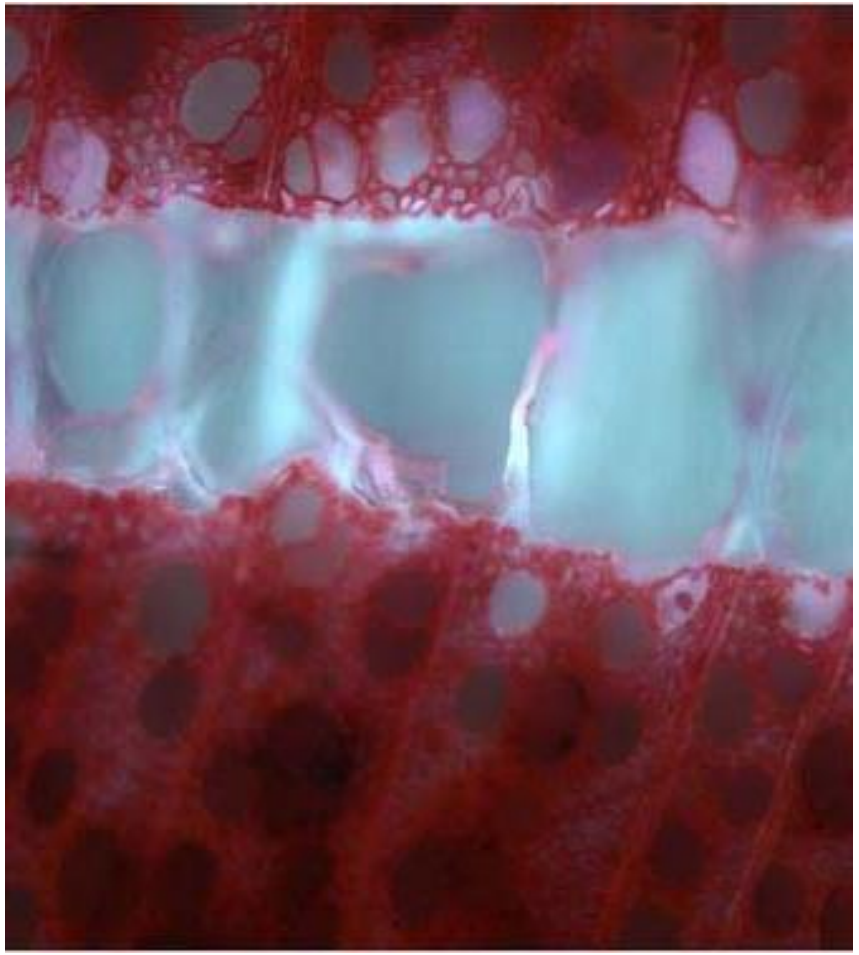
GBA: Range hoods

Liquid sealants and adhesive tapes

Why are some things “sticky?”

Why are some things “sticky?”

- Physical bonding (both substances stay the same)
  - Polymers (big chains of repeated content) that can “wet”
  - “Favorable thermodynamic surface energies”
  - Molecular mobility



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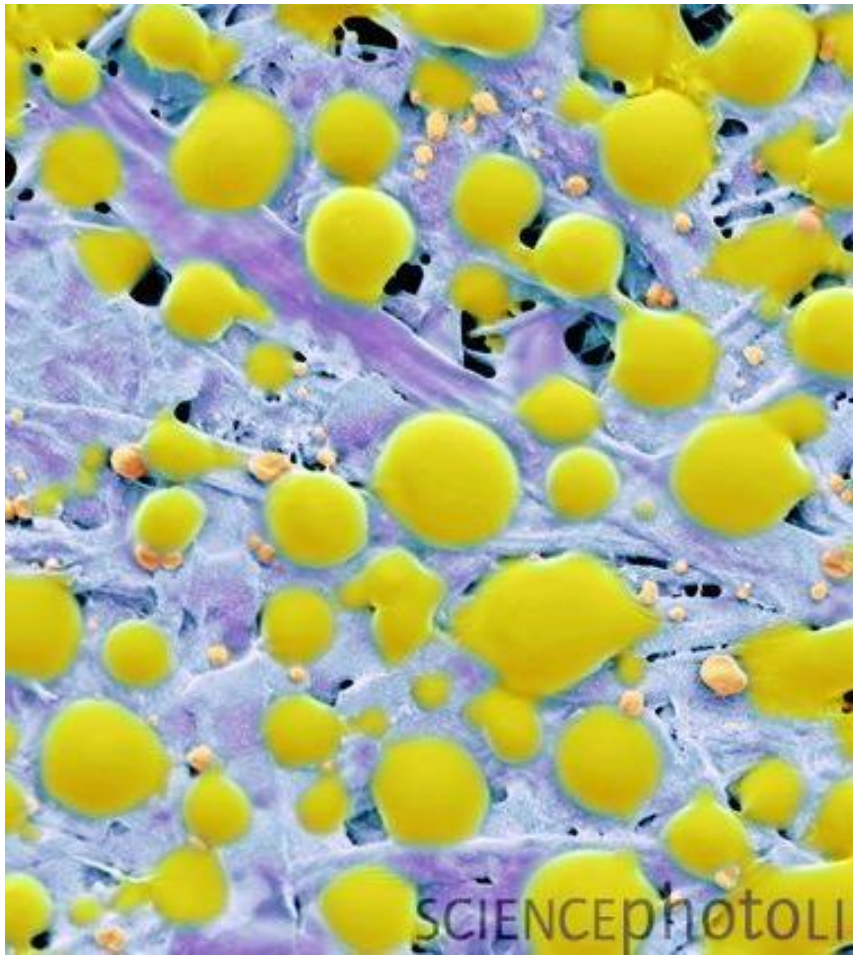
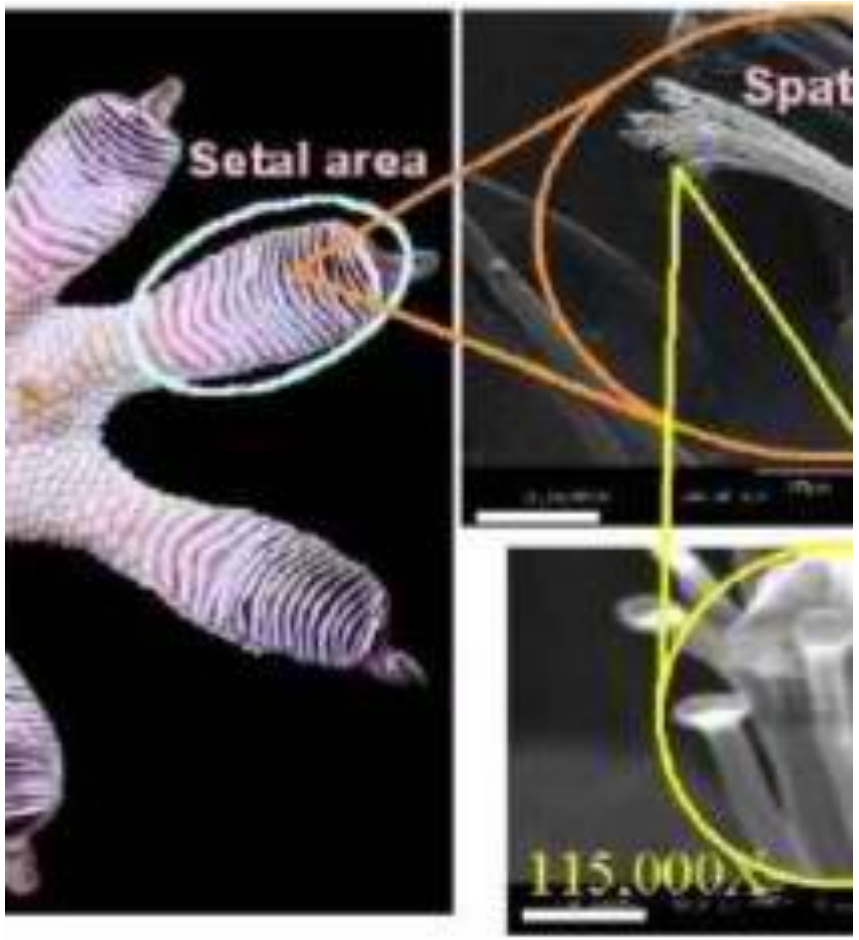


Why are some things “sticky?”

- Maybe think of it as atomic level velcro…
- It takes energy to pull the materials apart



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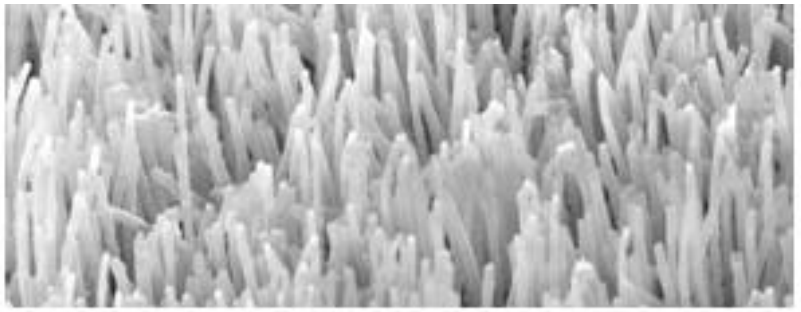
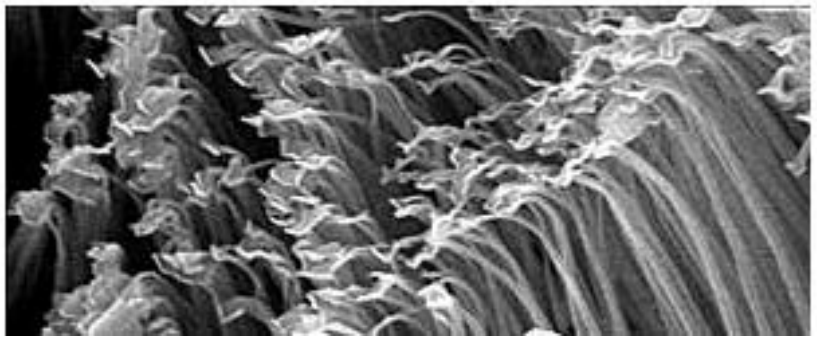


A pair of scanning electron micrographs show similarities between synthetic polymer fibers creat by UC Berkeley researchers (above) and the setae from an Anolis lizard. (Photo below of Kellar Autumn, Lewis & Clark College)



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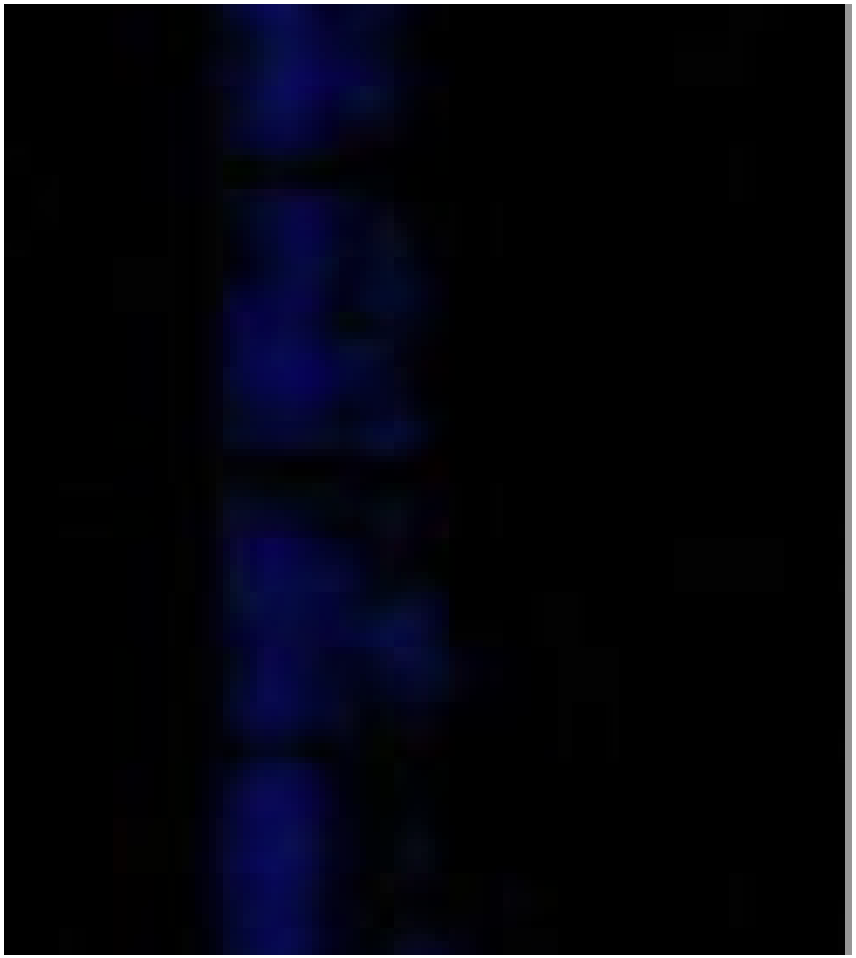
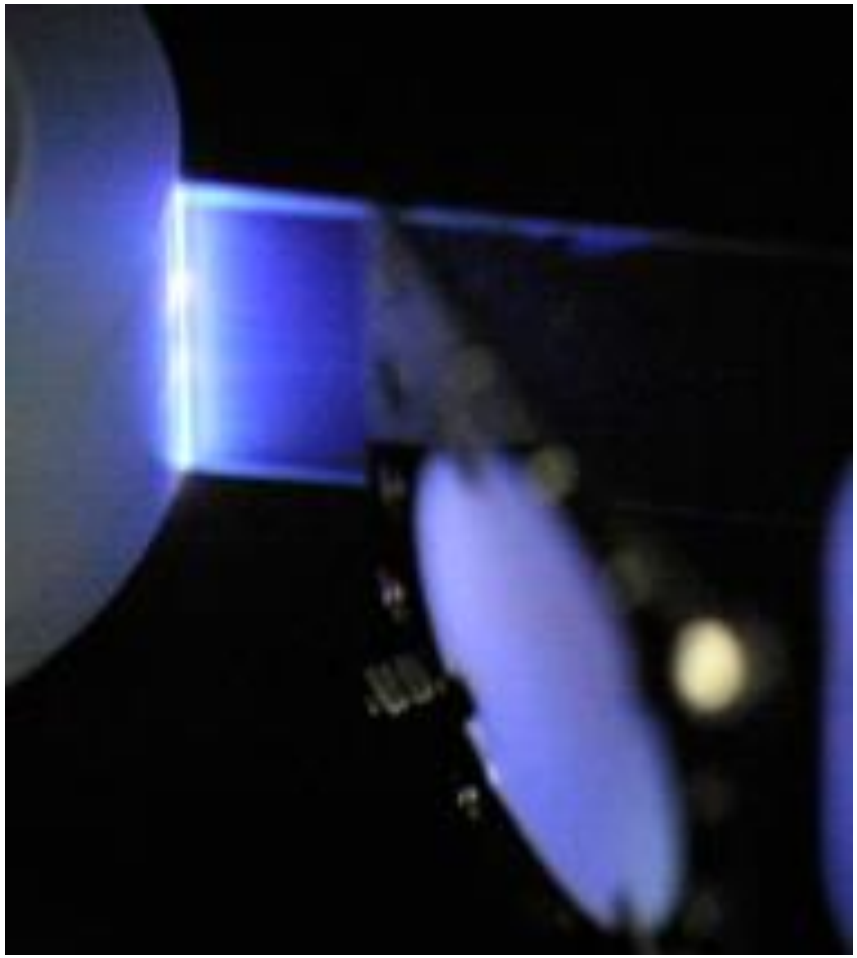




We’re not completely sure…but cool stuff like triboluminescence!

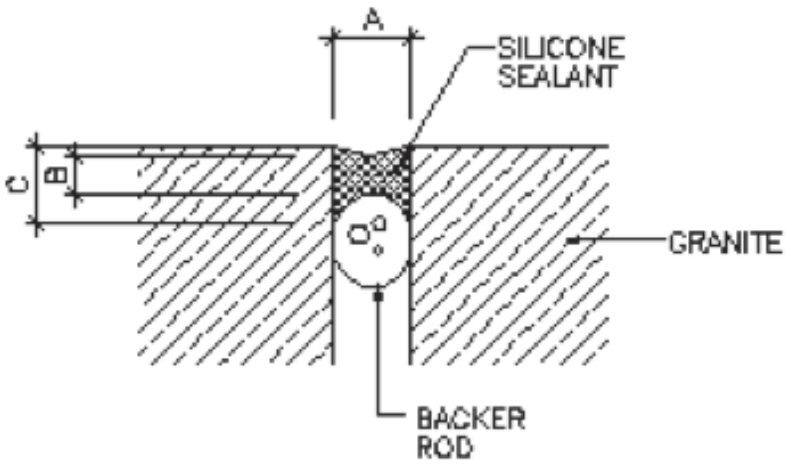
Liquid Sealants

- Sticky
- Flexible
- Non-compressible
- Adhered to two surfaces only
- Bond break with support

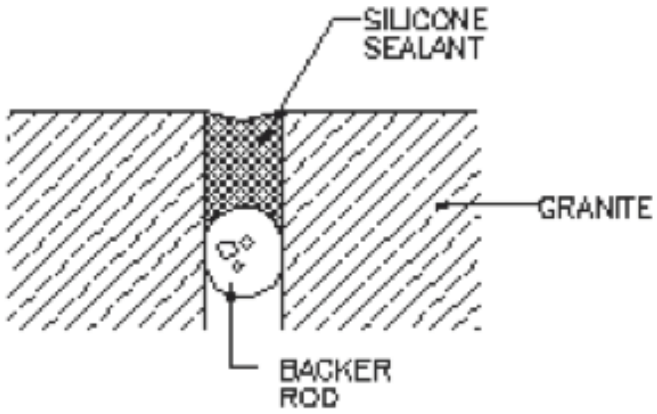
Liquid Sealants

CONVENTIONAL MOVING WEATHERSEAL

GOOD JOINT DESIGN



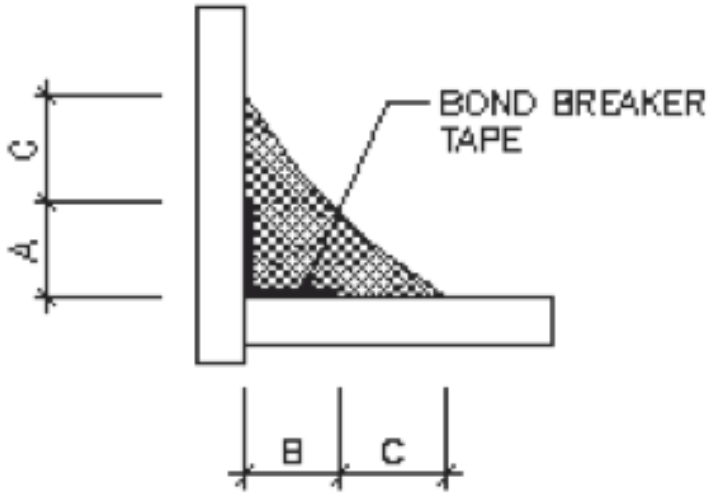
POOR JOINT DESIGN



Liquid Sealants

MOVING CORNER JOINT

GOOD JOINT DESIGN



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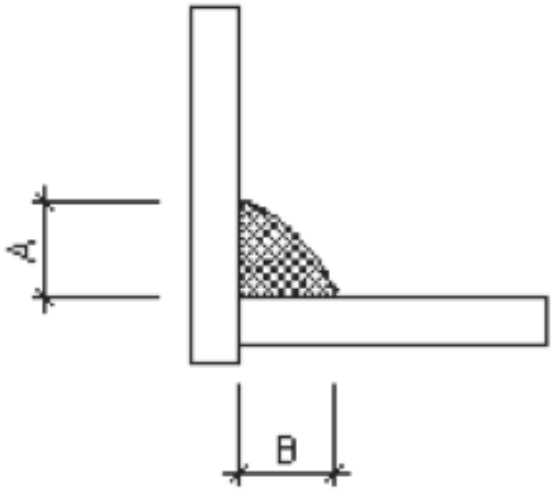
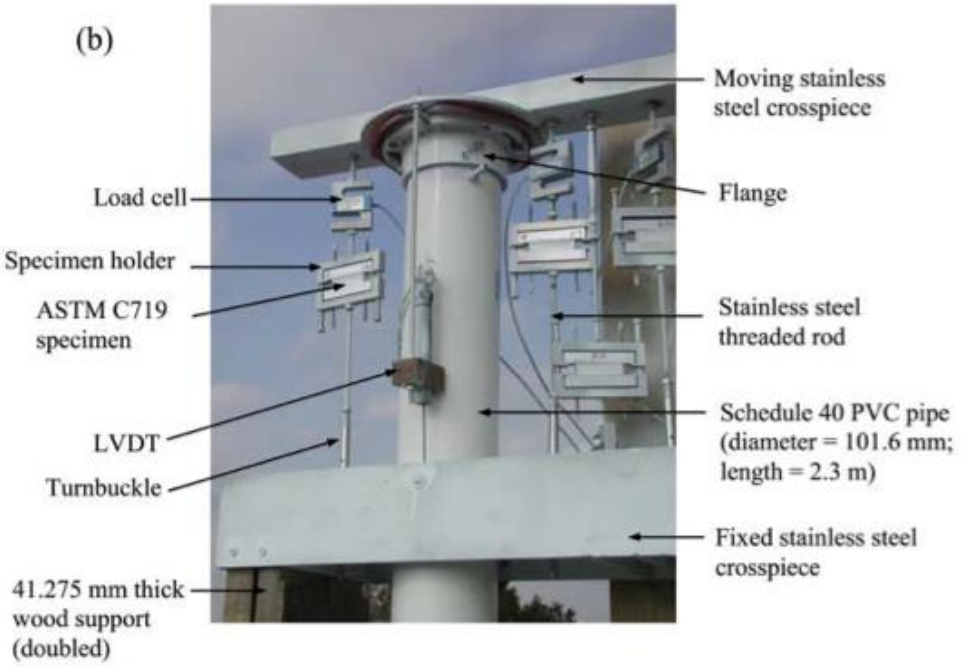


Durability – service life prediction

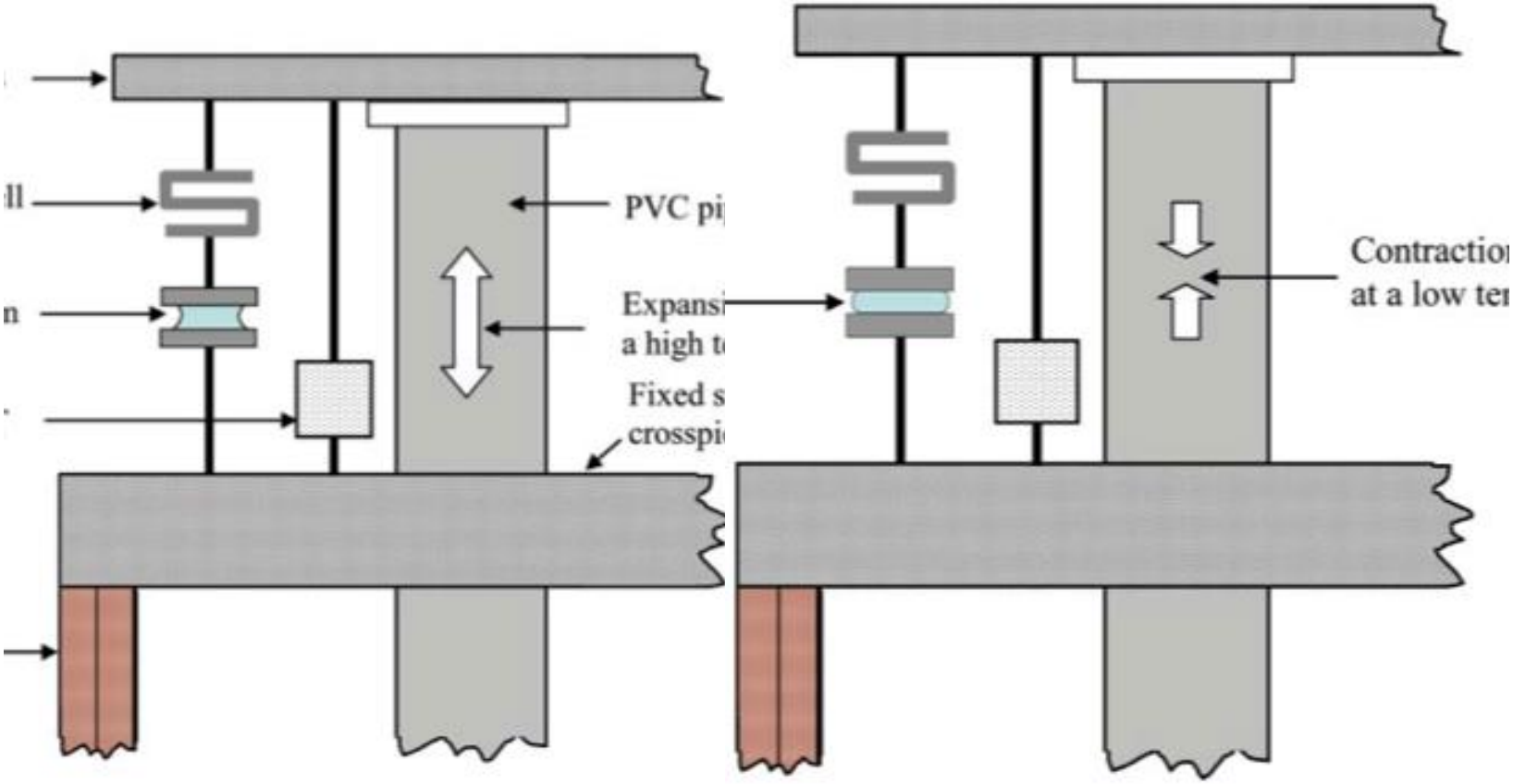
- NIST – National Institute of Standards & Tech
- Started service life prediction research in about 2001
- ASTM standards 2011
- Field test for service life prediction of sealants: ASTM C1589

Christopher White - NIST

Field Test Rig



Field Test Rig



ASTM C1735 - 11 Standard Test Method for Measuring the Time Dependent Modulus of Sealants Using Stress Relaxation

Demo – PSA “Lab” testing

Wingnut Test Facility (WTF)
“real world” testing

Modes of failure

- Adhesive
- Backer
- Substrate

Round Two
ASTM D3654 – Method A

What forces do tapes really “see?”

What forces do tapes really “see?”

“Bellowing” - WTF Pressure Pig

“Bellowing” - WTF Pressure Pig

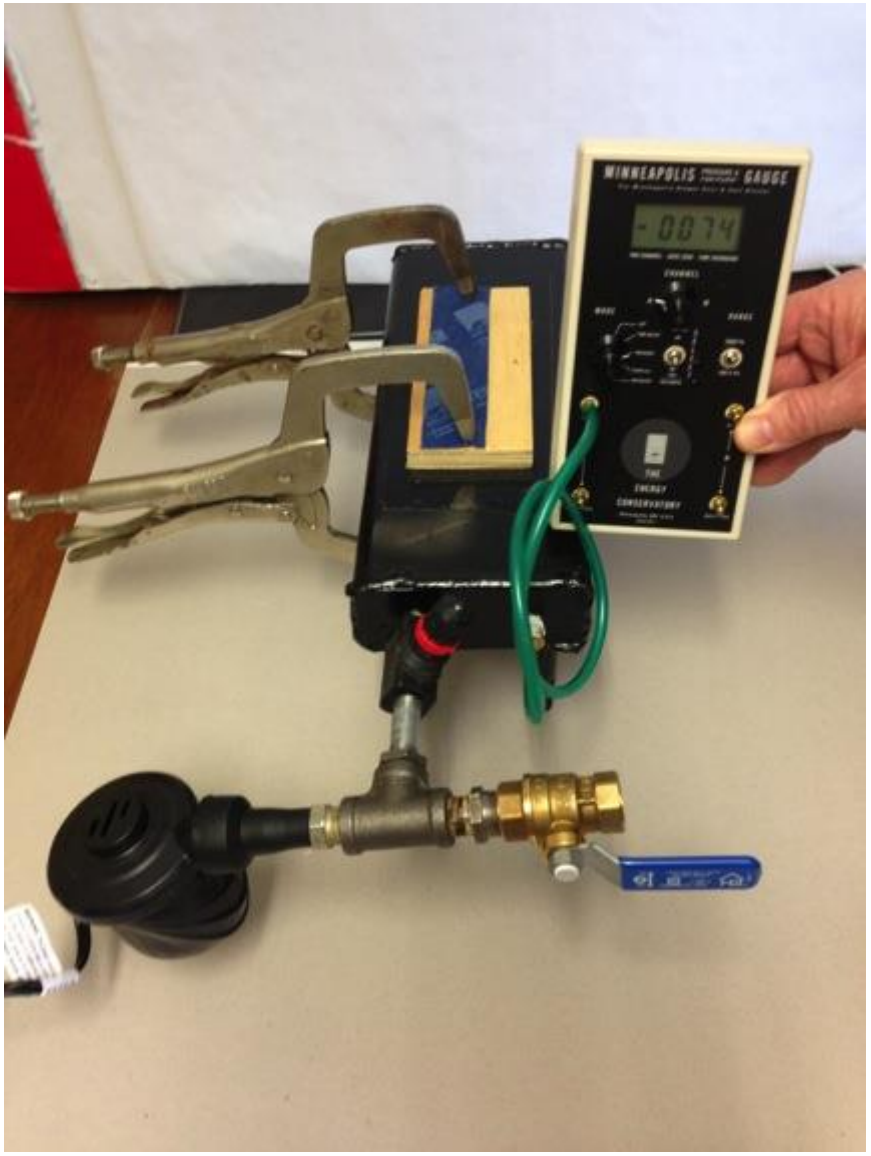
Earth air pressure extremes

- Difference between “normal” and extreme (hurricane and tornado) is about 3 psi
- Tape failure on WTF “pressure pig” was about 3 psi
- WTF Conclusion? Tapes will fail in hurricanes and tornados
- PSI vs Pascals?
- Real world?

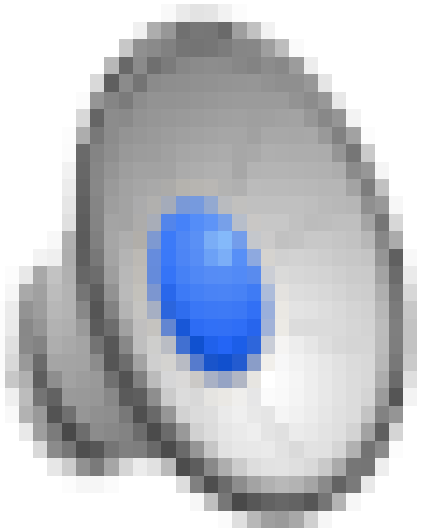
Pressure relationships

- Pressure = Force divided by area
- 1 Newton = 1 Pascal per square meter
- 1 psi = 6895 Pa
- 70 mph wind = (about) 450 Pa

“Bellowing” - WTF Pressure Pig



“Bellowing” & the WTF “Pressure Pig”



Show pressure pig demo video…

A New Wingnut PSA tape test

Wingnut Math and Physics

- Since 1 Pascal = 1 Newton per square meter, then
- 75 Newtons/sq m = 16.8 lbs.
- Tape sample is 2.25 inches by 6 inches = 13.5 sq in.
- 13.5 sq in = .009 sq m
- 16.8 lbs * .009 sq m = 0.15 lbs
- 1 lb on 13.5 sq in is about 6 times greater than 75 Pa…

New testing protocol circulated to key manufacturers for their review…

- Huber ZIP Wall
- Siga
- Pro Clima
- ZIP tape manufacturer

Show protocol pdf…


Coca
Sprite
Schweppes


D3
E3
F3

WingNut Test Facility

Tape Test 3

As of	11/24/15								
		Primed Vana	Vana	Zip	Wigluv	Pella	IPG	Typar/Typar	Zip/Zip
Flange		A	B	C	D	E	F	G	H
Vinyl	1	11/25/15	11/23/15		11/24/15	11/22/15	11/22/15	11/23/15	
Metal	2	11/23/15	11/24/15		11/25/15	11/22/15	11/23/15	11/23/15	
Metal	3		11/23/15		11/23/15	11/22/15	11/22/15	X	X
Vinyl	4	11/24/15	11/22/15		11/24/15	11/23/15	11/23/15	X	X


A2
B2
C2
D2
E2
F2


B2
C2


B1

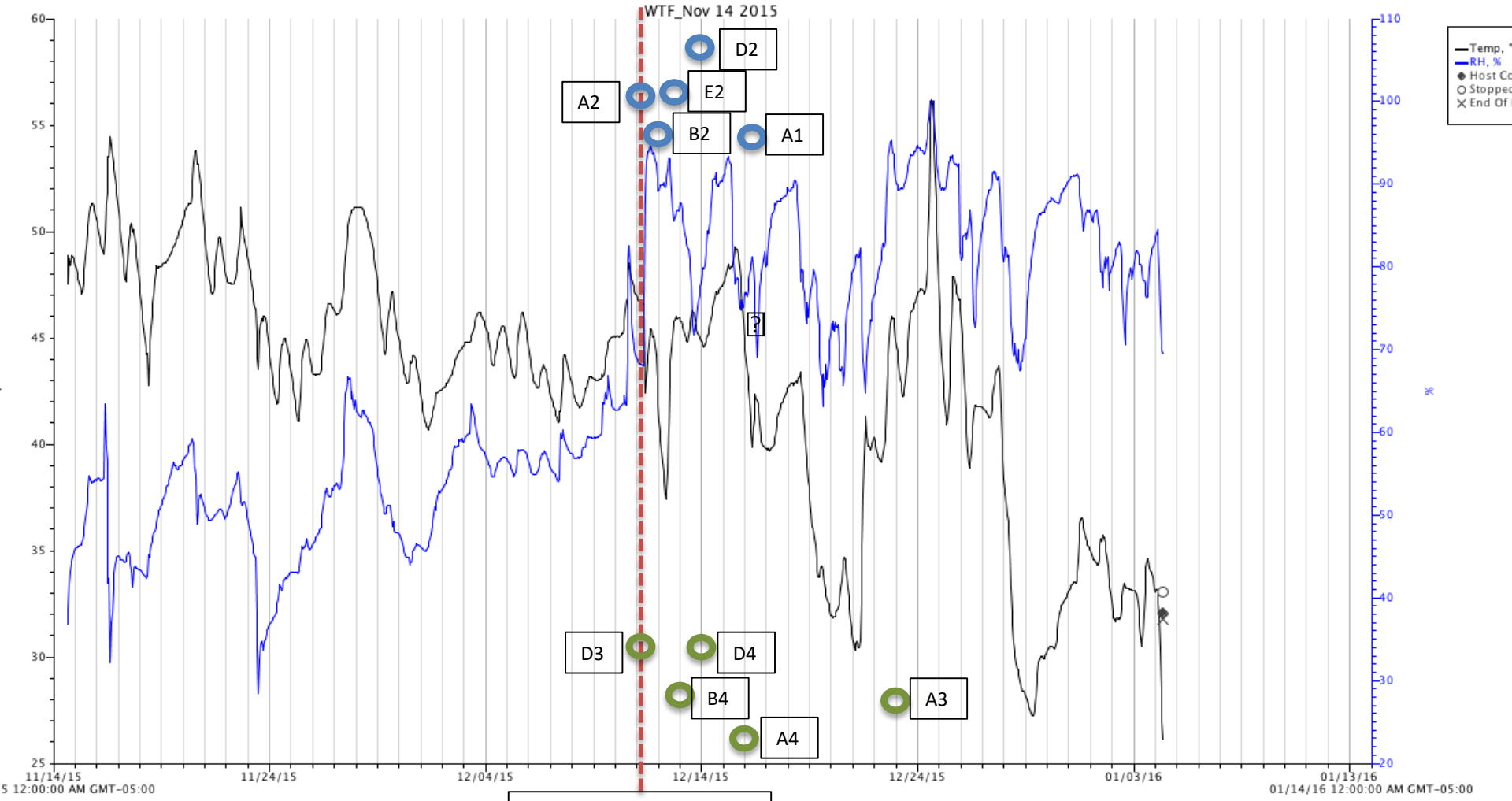
onset
43.22
°F
MEMORY
81.6
%RH
LOGGING
HOBO temp/RH logger

WingNut Test Facility

Tape Test 4

As of	1/22/16							
		Primed Vana	Wigluv	Zip	Primed Vana	Wigluv	Zip	Test Condition
Flange		A	B	C	D	E	F	
Vinyl	1	12/17/15			1/22/16			WETTED
Metal	2	12/11/15	12/12/15		12/14/15	12/13/15		WETTED
Vinyl	3	12/23/15			12/11/15			DRY
Metal	4	12/16/15	12/13/15		12/14/15	12/13/15		DRY

High Performance Acrylic Tapes



12-11: Moved to shed

= dry drop

= wet drop

2s/4s= metal flange

1s/3s= PVC flange

Latest drop (3-6): B4 Siga on PVC flange

What have we learned

- This test has passed muster with major manufacturers
- Butyl tapes we tested don’t like low temps or “tougher” substrates
- Off the shelf “high performance” tapes did not make the cut
- Only one tape has held regardless of substrate and wetting (so far…)

WTF has been “admired”

Prof. David NiCastro University of Texas – Austin
Construction Durability Lab
(JJ Pickle Center)

http://mattrisinger.com/fluid-applied-wrb-testing/

From Matt Reisinger's blog…

http://mattrisinger.com/fluid-applied-wrb-testing/

http://mattrisinger.com/fluid-applied-wrb-testing/

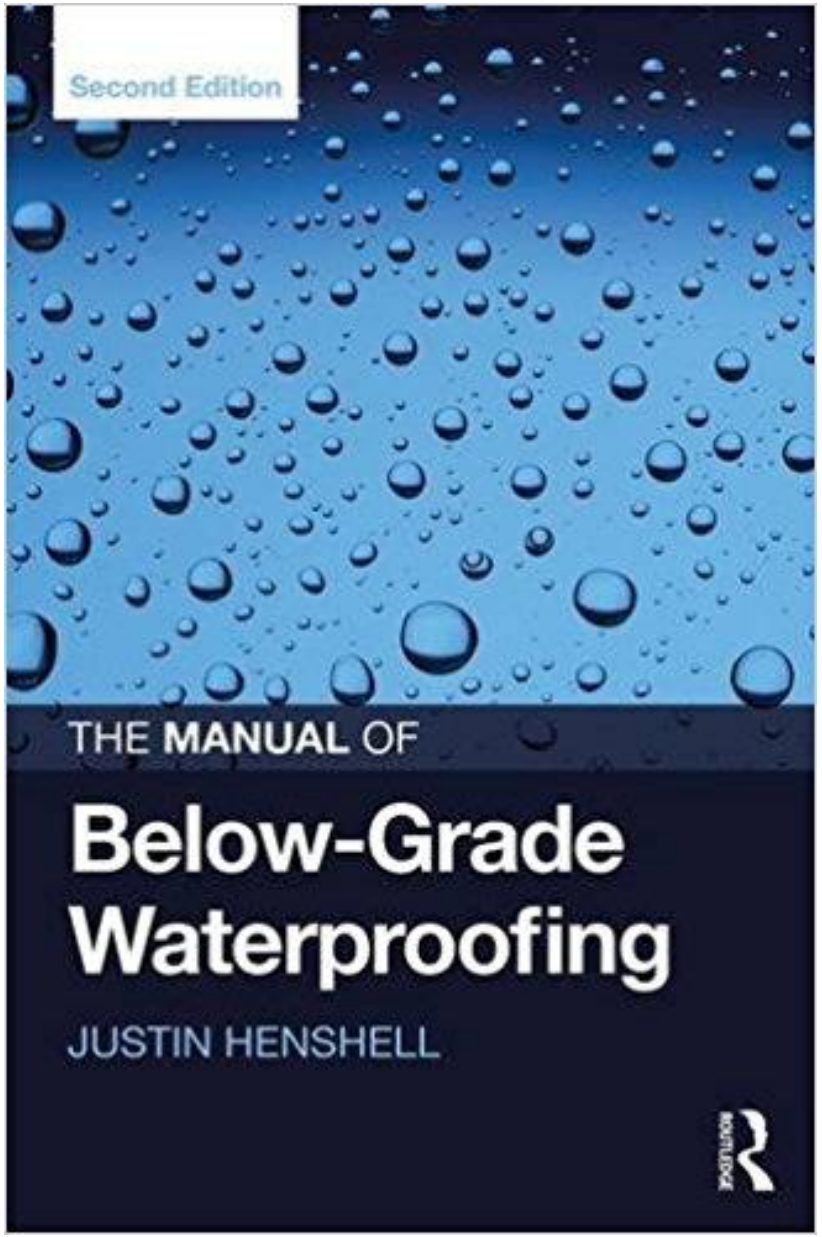
So, what's next for WTF?

- Run current tests through at least a full summer plus this past winter
- Look at negative side basement waterproofing
- Simple test for PI dependent R-value?
- Siloxane testing?

So what is next? WTF 2.0?

Waterproofing,
Especially From the Interior

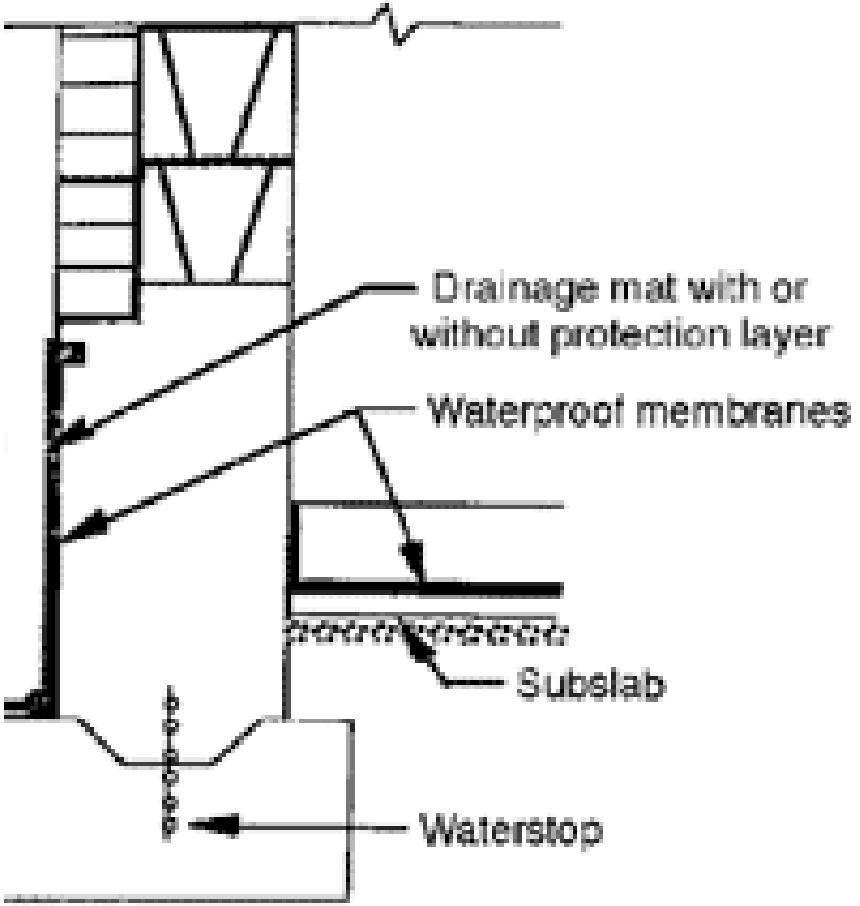
Primary Info Source

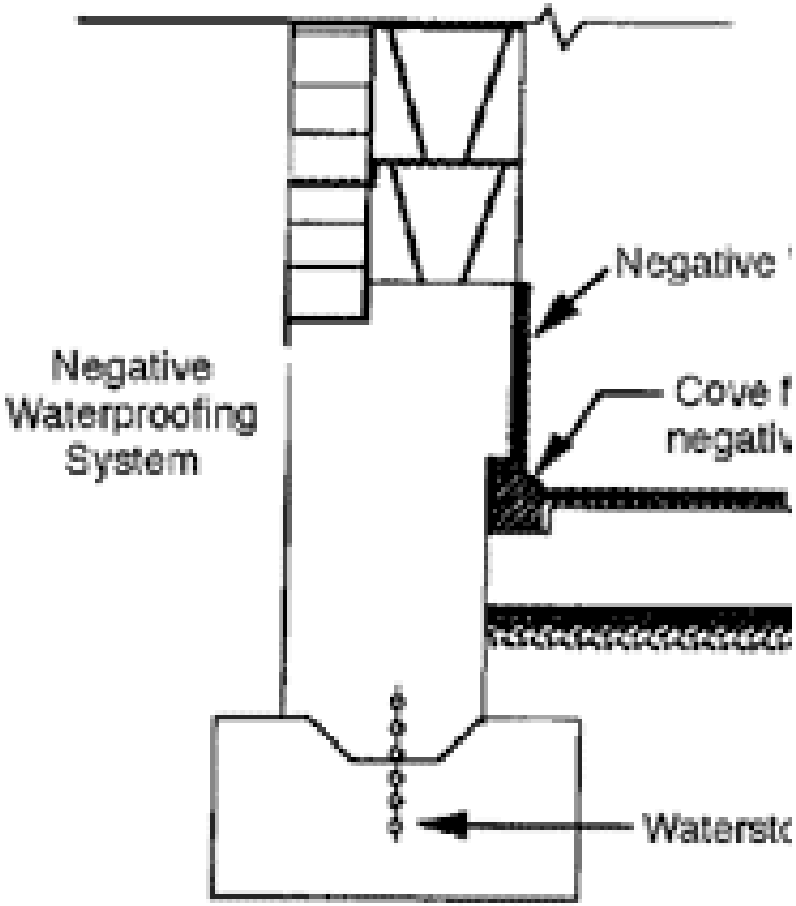


Dampproofing vs. Waterproofing

- Crack-bridging ability
- Resistance to both soil moisture and liquid water: hydrostatic pressure
- “Cost”

Negative Side Waterproofing





The Builder's Engineer – Tim Garrison

Waterstops….

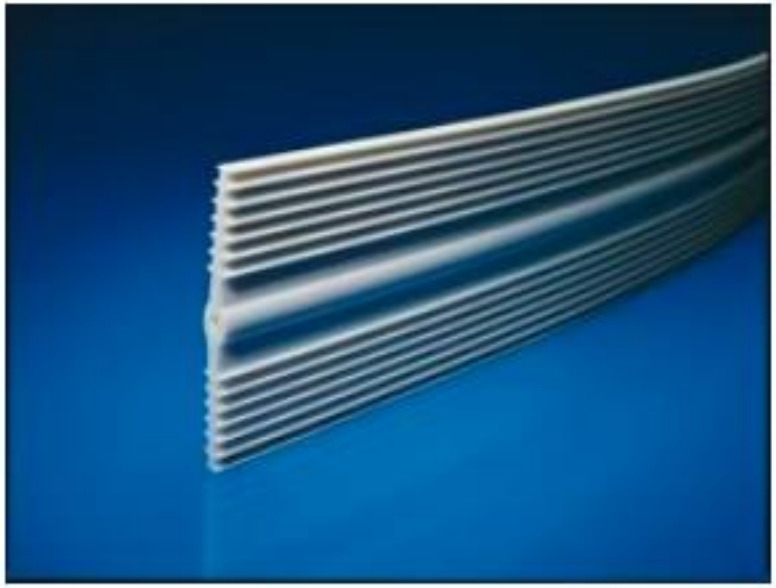
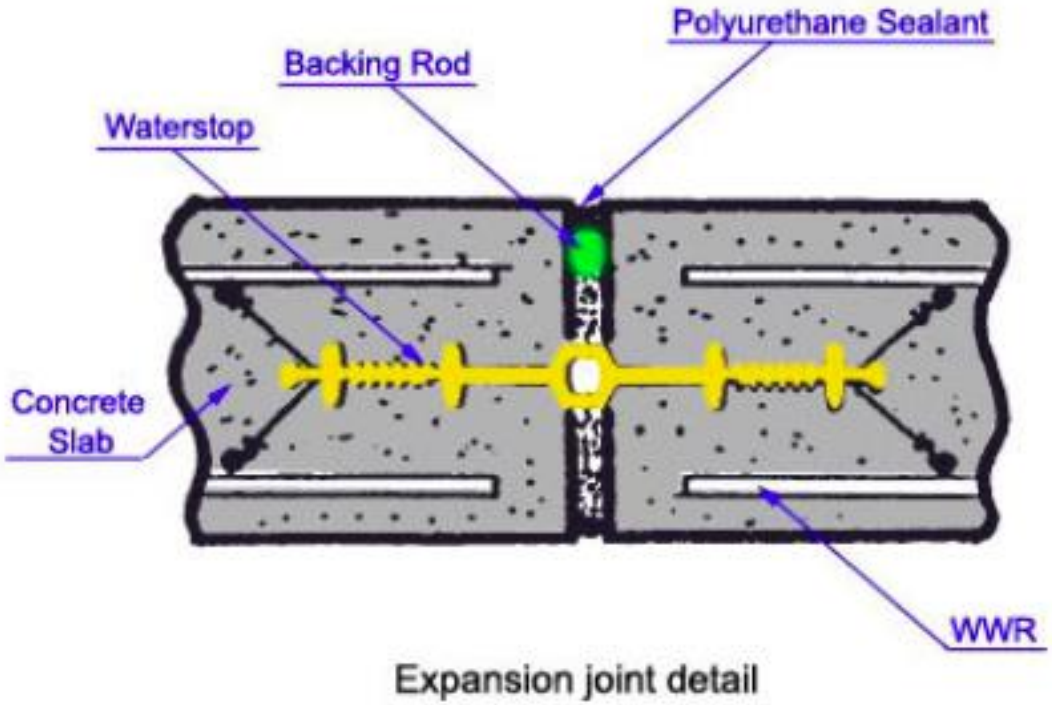


Image Credit: GreenStreak | Waterproof Magazine



Expansion joint detail

From: Engineering 360

BEST PRACTICES MANUAL

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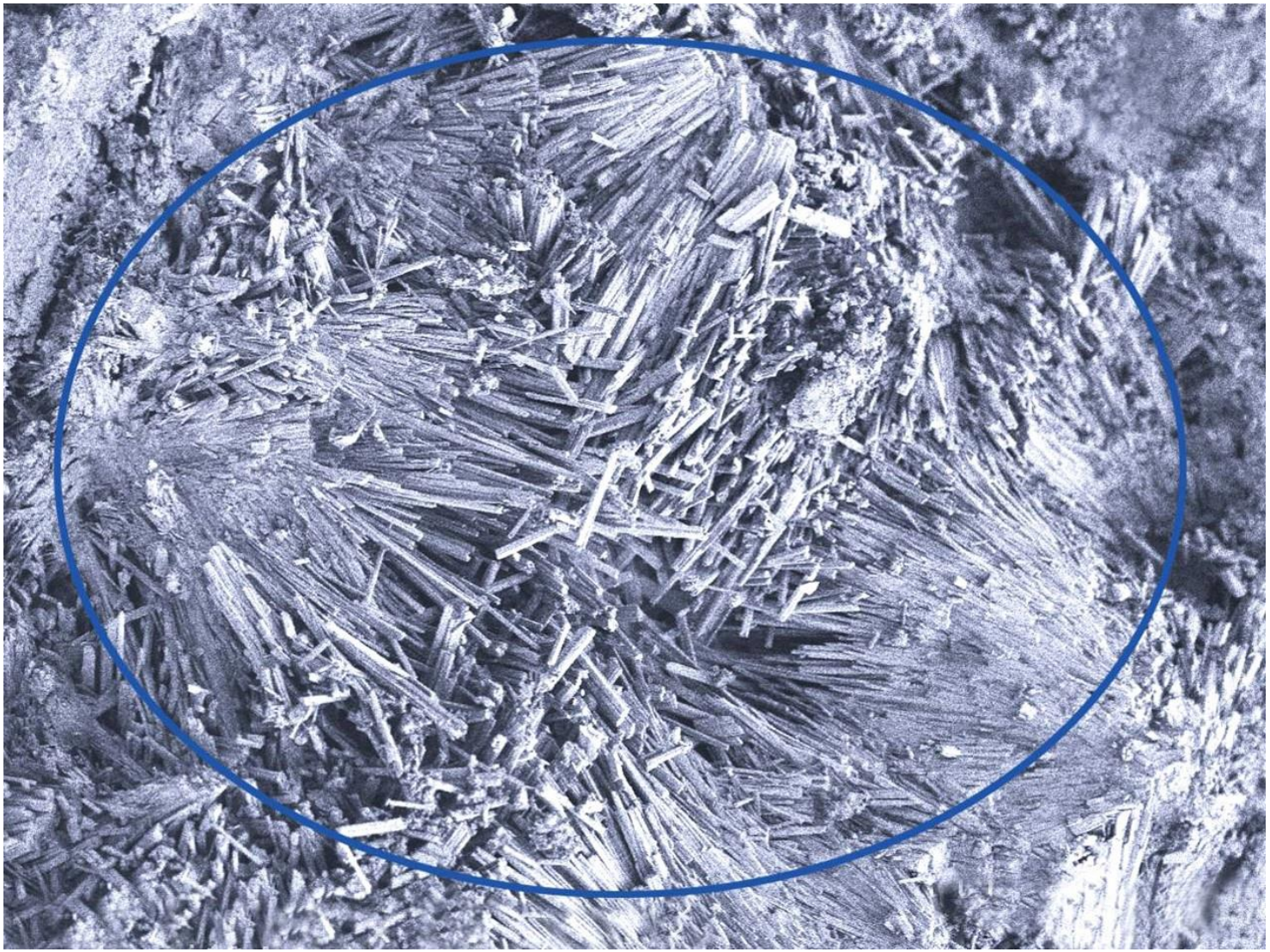
TABLE OF CONTENTS

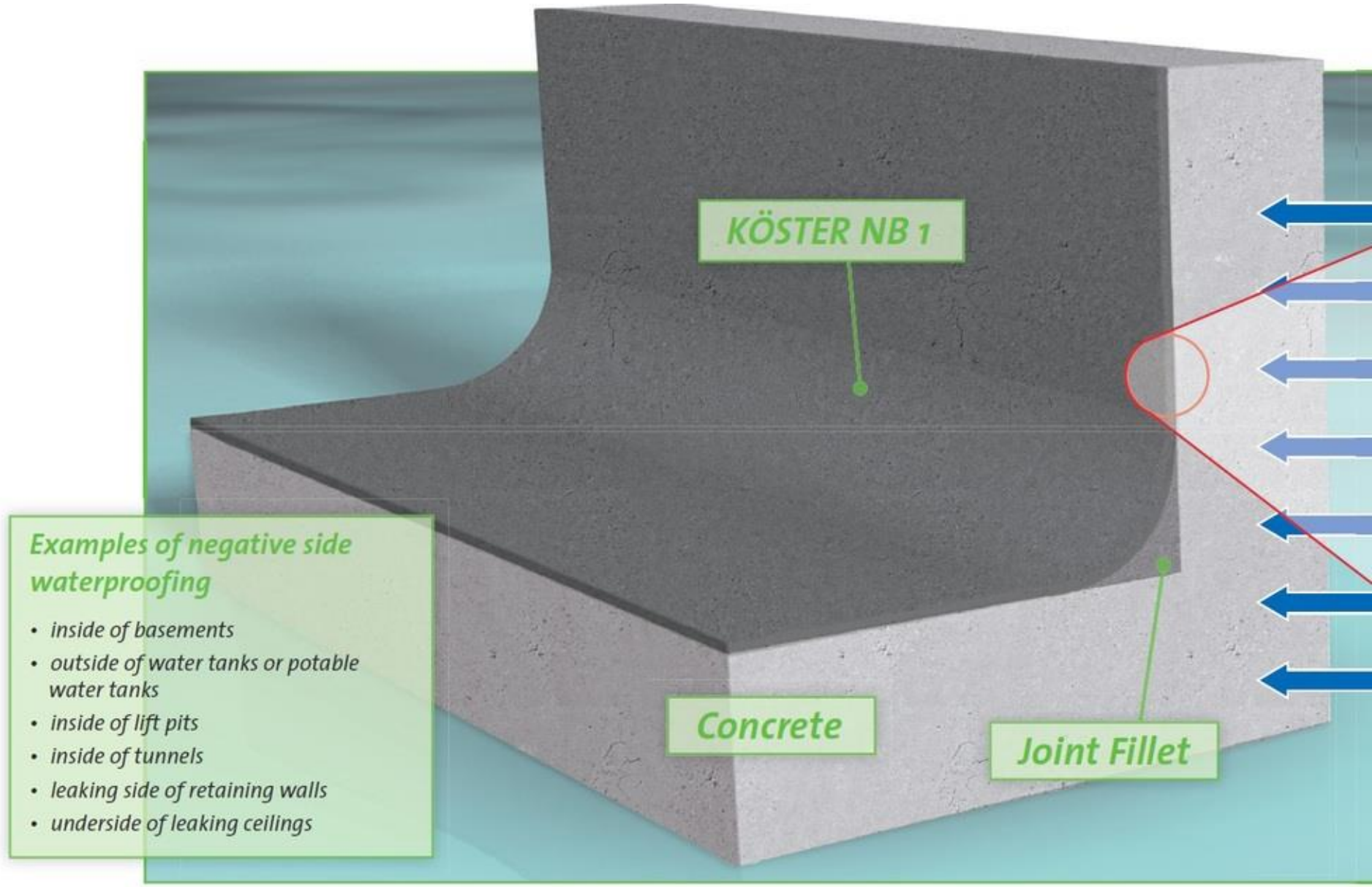
7.4 BASEMENTS: RETROFIT

https://hammerandhand.com/best-practices/manual/7-basements/7-4-basement-retrofit/

Henshell: Only NSW crystalline coatings work



Xypex

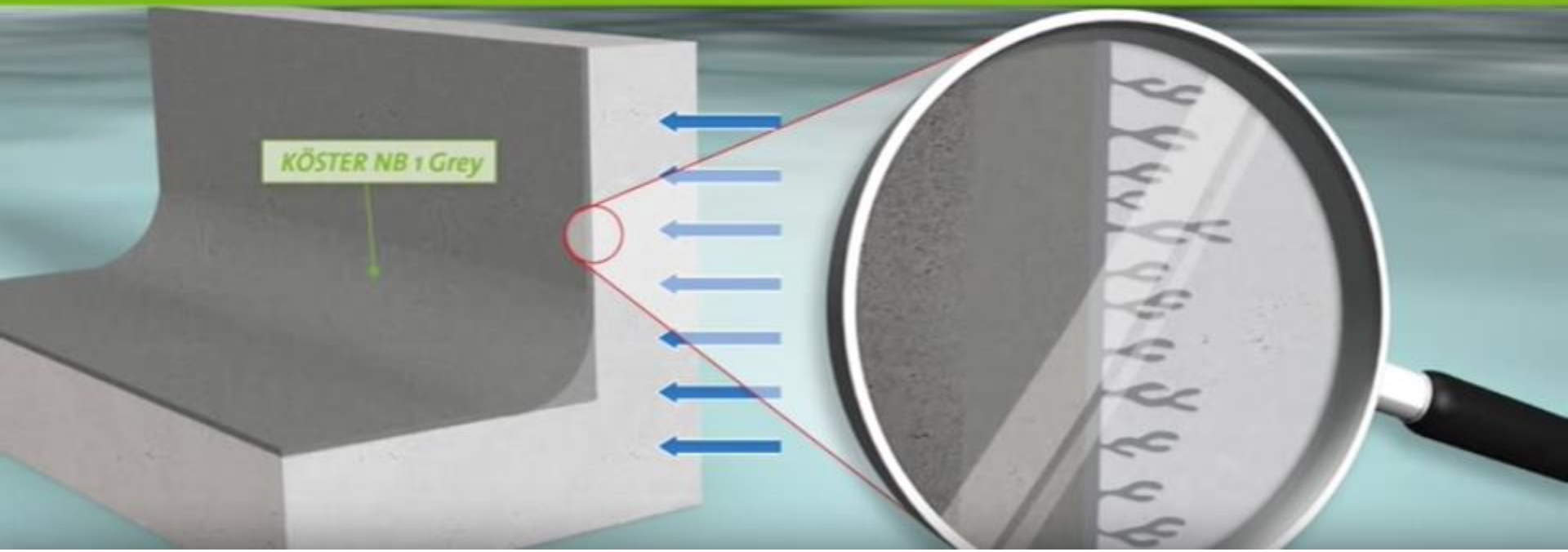


Examples of negative side waterproofing

- inside of basements
- outside of water tanks or potable water tanks
- inside of lift pits
- inside of tunnels
- leaking side of retaining walls
- underside of leaking ceilings

The solution: negativ side waterproofing with KÖSTER NB 1 Grey

- suited for all mineral substrates
- becomes an integral part of the structure



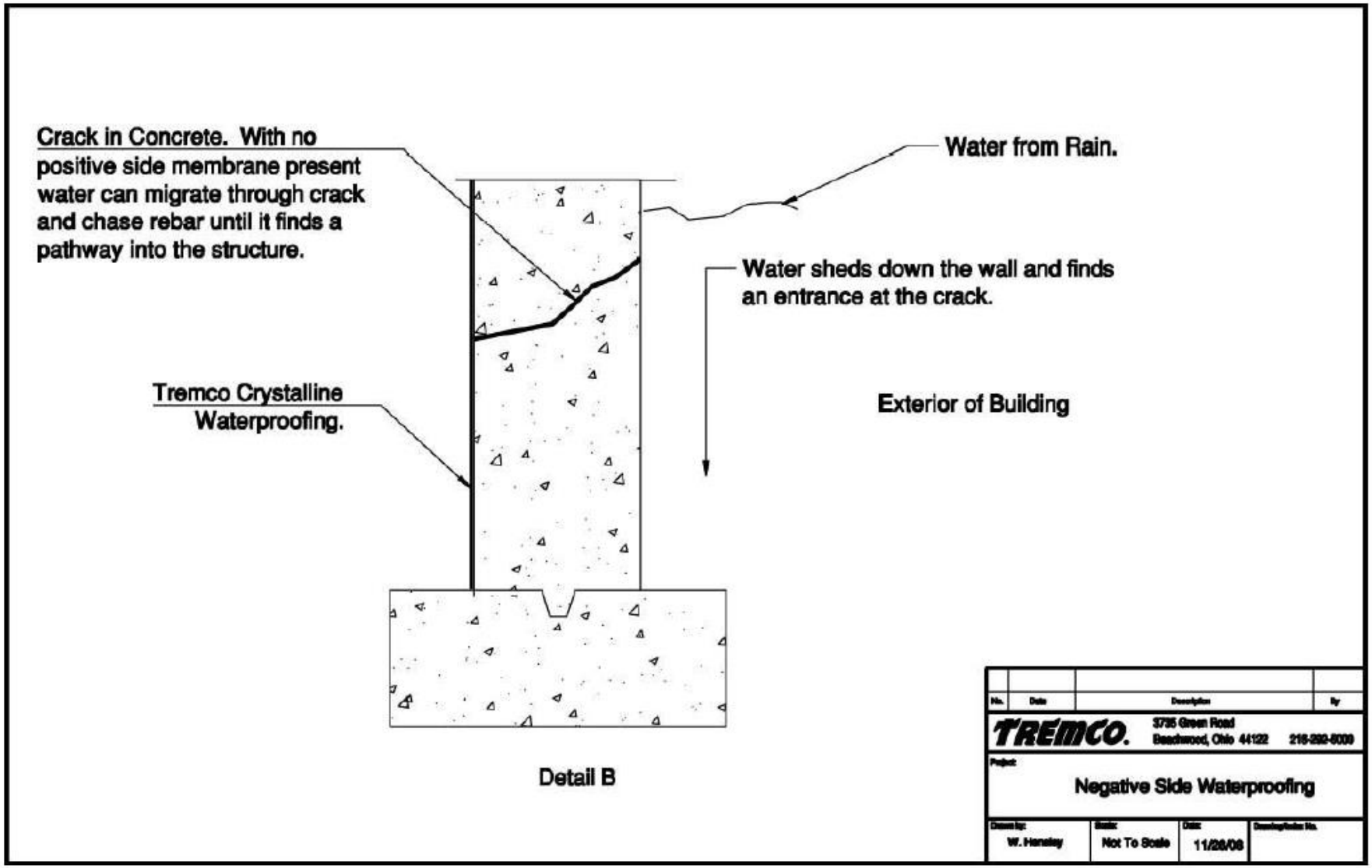
Plugging flowing water, even

Koster YouTube

Plugging flowing water, even

https://www.youtube.com/watch?v=qRFi84y5gy4

So, magic, right?



TREMCO Tech Bulletin S-08-31

Testing to 200 psi: USACE C-48-92

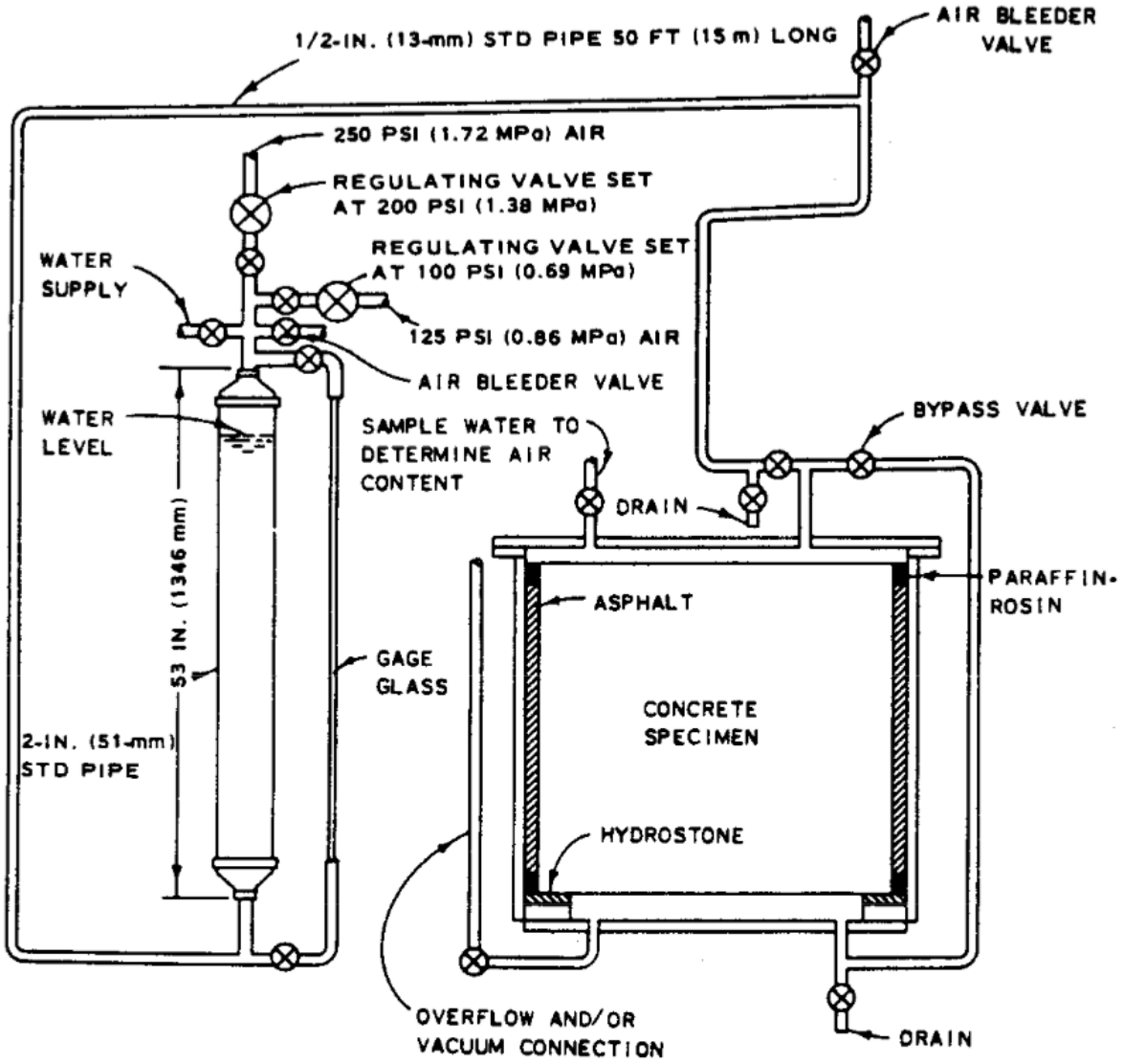


Fig. 1. Permeability test assembly (schematic)

NSW WTF-style

ProtectionPLUS website


Tropicana

1CR


QuartzLock2
SUPERIOR


QuartzLock

Cost

- DryLok
  - Extreme (1 gallon): $30
  - Fast Plug (10 lb): $14.25
- Xypex
  - Concentrate (50 lb): $0.44 per coat
  - Patch-n-Plug (60 lb): $86 (0.64 cf)
- Koster

Product Name	Packaging	Consumption	Price
KOSTER NB 1 Grey	55 lb bag	Approx. 110 SqFt/Bag	$51.48
KOSTER Polysil TG 500	2.56 gal jug	330-420 SqFt/Gal	$107.75
KOSTER SB Bonding Emulsion	2.5 gal jug	As required	$121.46
KOSTER KD2 Blitz	33 lb bucket	Approx. 80-160 SqFt/bucket	$50.94

Key Takeaways (Incl. Henshell)

- Reduce first…
- Membranes don’t work…
- Most common NSW are crystalline…
- There actually is a standard test—USACE CRD C48-73
- Crystalline coatings work because they penetrate
- NSW systems are typically vapor permeable
- Crystalline systems can bridge cracks to .012 inches and can reactivate but can’t reseal new ruptures

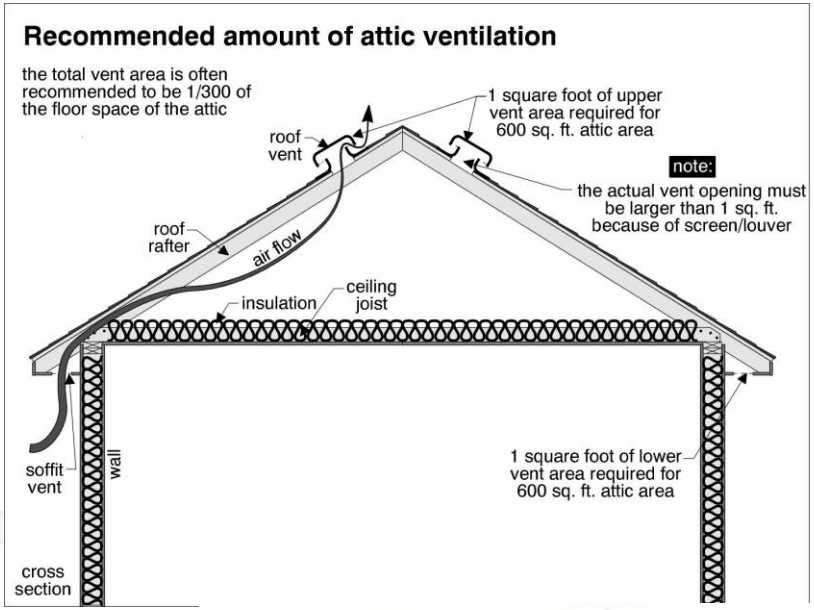
Conclusions - Summary

- Crystalline NSW can work
- Substrates matter (concrete, CMU, brick, etc.)
- Must maintain inspection and likely repair
- Foolproof approach is the Hammer & Hand
- Foolproof approach is curtain wall injection
- And if you have the opportunity because it's new construction:
  WATERPROOFING, not damproofing…

Venting Cathedral Roof Assemblies

- Section R806 – Roof Ventilation
- Screening to prevent “creature” entry
- Net free ventilating area: 1/150
- Or 1/300 if: high-low (primarily soffit-to-ridge)
- 1-inch vent depth minimum
- Ventilator installation per manufacturer

The power of arrows…



roofvents.com

Products Shop Articles Resources

Attic Ventilation – Flat Roof

Products

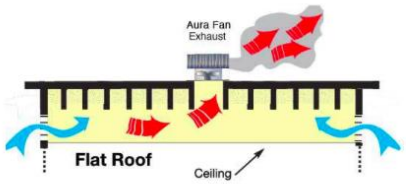
- 1. Roof Vents – Exhaust
- 2. Roof Vents – Intake
- 3. AC Powered Attic Fans
- 4. Solar Powered Attic Fans
- 5. R Panel Roof Vents
- 6. Retrofit Roof Vents & Fans
- 7. PVC Vent Caps
- 8. Ducted Roof Vents
- 9. Breather Roof Vents
- 10. Off Ridge Roof Vents
- 11. Soffit Vents
- 12. Curbs for Roof Vents
- 13. AC Motors

Active Ventilation Products, Inc

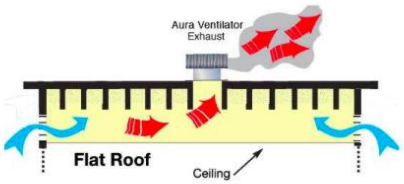
311 First Street
Newburgh, NY 12550

Attic Ventilation – Flat Roof

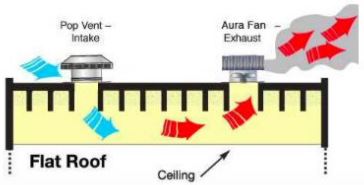
Air intake with Aura Fan exhaust



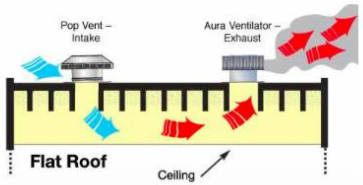
Air Intake with Aura Vent Exhaust

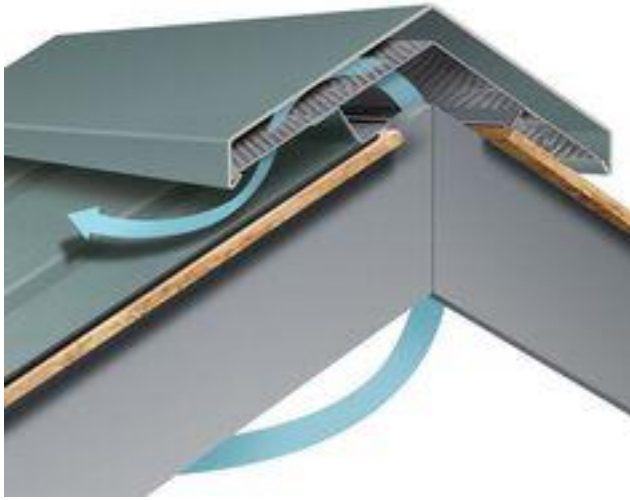


Pop Vent intake with Aura Fan exhaust



Pop Vent air intake with Aura Ventilator air exhaust





What do we need for air flow?

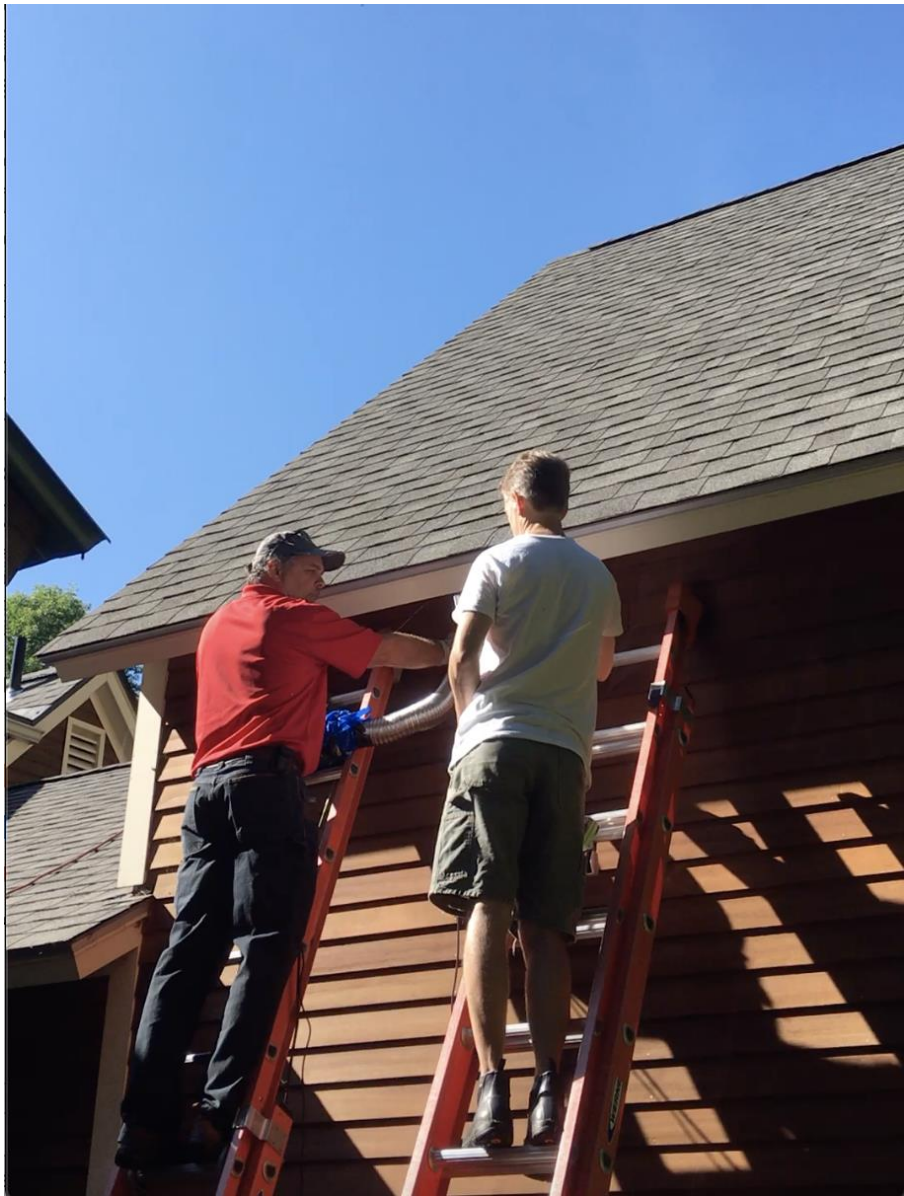
- A hole
- Another hole
- A driving force
  - Stack effect
  - Wind
  - Mechanicals (fans)

What affects cathedral roof ventilation?

- Pitch?
- Cardinal direction?
- Depth of vent space?
- Length of roof run?


RIGHT WING


retrotec
CHARIOT 12
HURRICANE



Interim Conclusions?

- Pitch matters
- Temperature matters
- Wind is complicated…
- Hard to say how much vent depth matters
- Connecting truncated vents to neighbors works

What else to test?

- New venting manufactured products?

What else to test?

- New venting manufactured products?

ValleyVent BY DCI

- Achieve the proper air flow around obstacles
- Prevents mold and moisture build up
- Easy hip, valley and skylight installation
- Compatible with most exhaust vents
- Provides 9 NFA of airflow

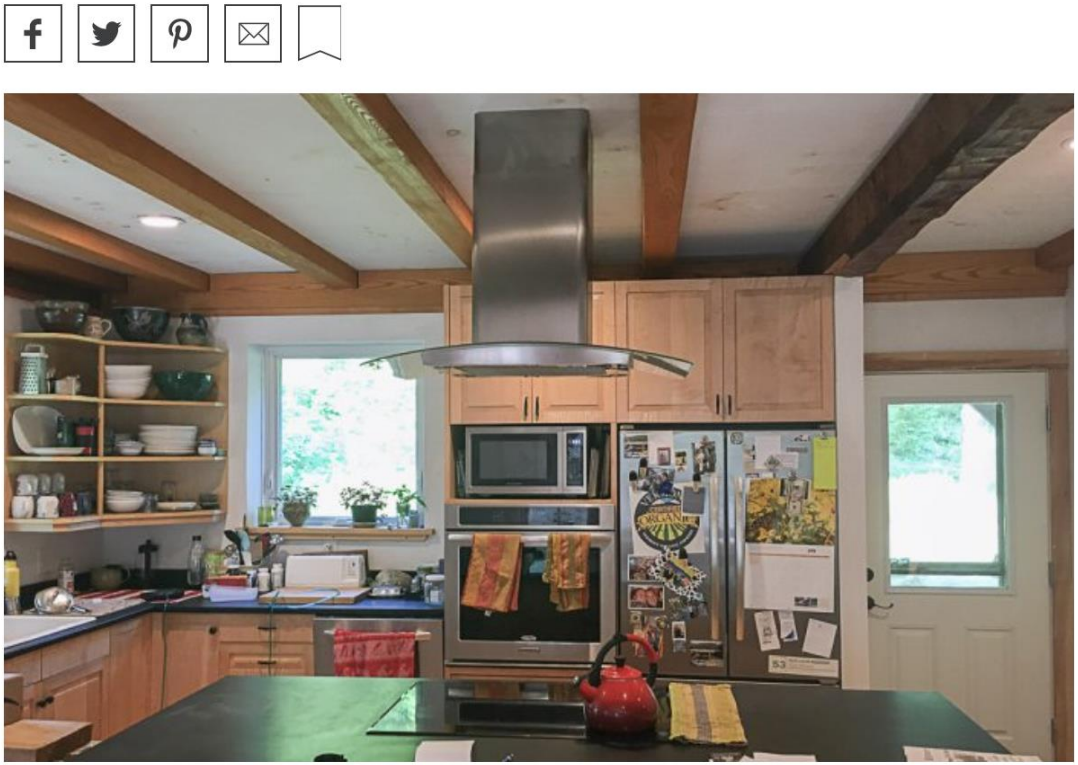
What else to test?

- Staggered valley and hip furring?

Does My Vent Hood Need Makeup Air?

With plans for building a tight house, a homeowner wonders whether makeup air should be provided for the kitchen hood

By Scott Gibson | August 5, 2019



How well do kitchen range hoods really work? GBA's Peter Yost tested this one to find out.

Range Hood Exhaust

Range Hood Exhaust

WTF Conclusions…

- We need standardized testing but as necessary but not sufficient
- We need benchtop and real-world testing
- Do “goofy” stuff and share
- Levenson: you must learn from the mistakes of others; you can’t possibly live long enough to make them all yourself

Thanks…

PETER YOST

BUILDING - WRIGHT