Using Mineral Fibre Insulation as a Vented Airspace in Historic Masonry Walls

A Special Presentation for Joe's Summer Camp!

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Westford, MA

UNIVERSITY of TORONTO

Canadian Centre for Building Excellence || Engineering Health and Efficiency

Research Driving Forces?

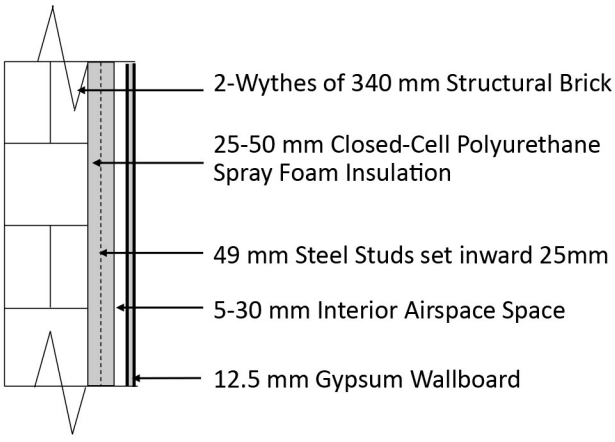
Energy-Efficiency, Durability, IEQ and Comfort!

Challenges with Historic Buildings

- **Low envelope thermal resistance**
  - ~0.5 – 0.7 m^2K/W – Walls
  - ~0.2 m^2K/W – Windows
- **Uncontrolled air leakage**
  - >16 ACH_{50} … Ventilation difficult to control
- **Varying masonry properties**

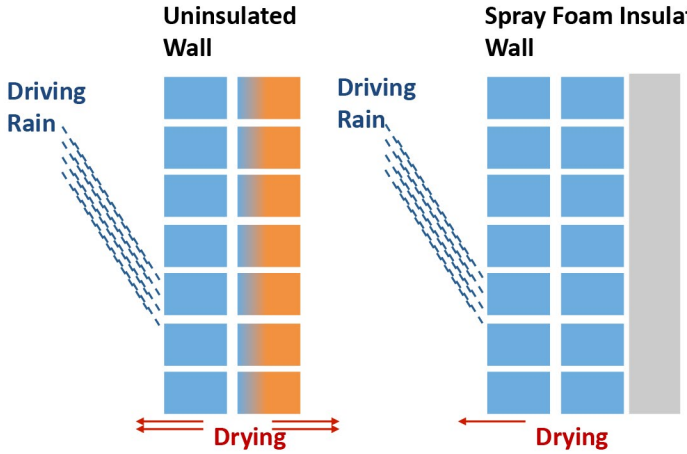
Durability issues during retrofits

Standard Retrofit Approach



4

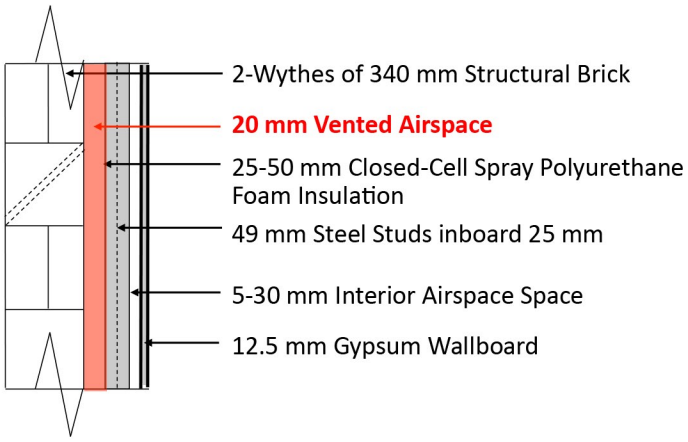
Insulating Solid Masonry Walls



What happens to the thermal environment when we internally insulate a solid masonry wall?

5

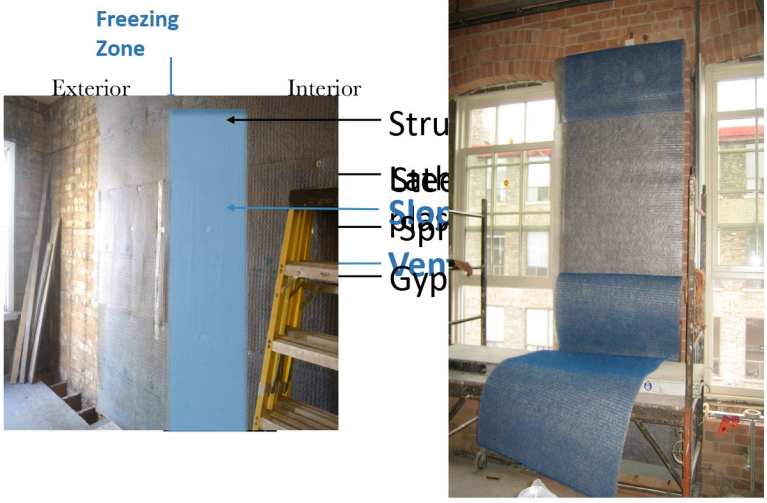
Vented Masonry Retrofit



6

Standard Thermal EIFS Retrofit

Vertical Masonry Veneer



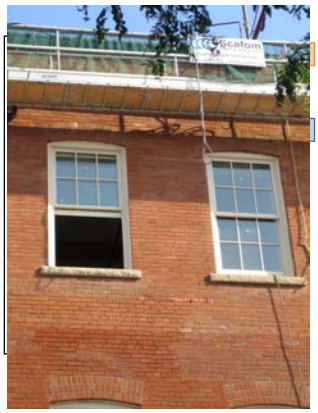
7

Field Trials

Barrymore Building	Gemini House
Two years (2011-2013)	One year (2014)
20-25 mm vented cavity thickness	10-15 mm vented cavity thickness
South & East facade	South & North facade
Temp., RH monitoring, Pressure	Temp., RH, Pressure, Embedded moisture, Surface water activity monitoring
1.5-2.5 RSI Walls	4.9-10.3 RSI Walls

8

The Barrymore Building



VMR Wall

Standard Wall

South Elevation
Simulates drying effects

East Elevation
Simulates wetting effects

9

Brick/Vented Cavity Interface

10

Mortairvent

11

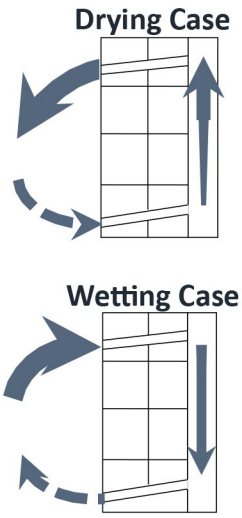
Gypsum/Cavity Interface

12

Drying and Wetting Periods

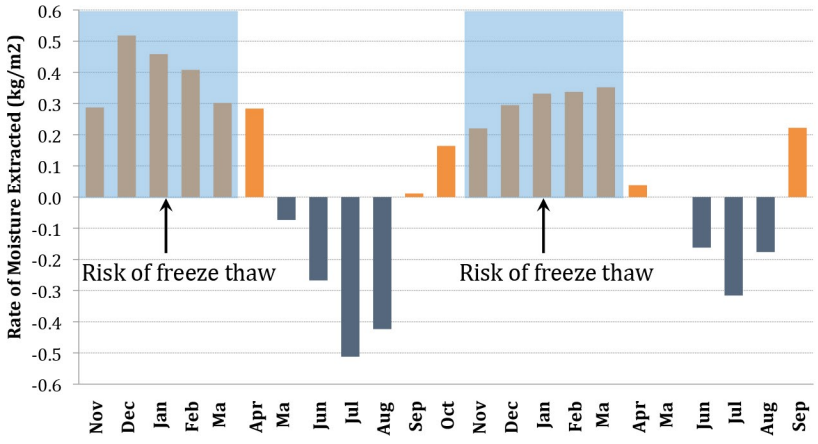
Assumptions

- Equally distributed leakage openings
- Neutral pressure plane mid-height
- Only air moving through ventilation holes is considered
- All moisture deposited in the masonry (wetting case)



13

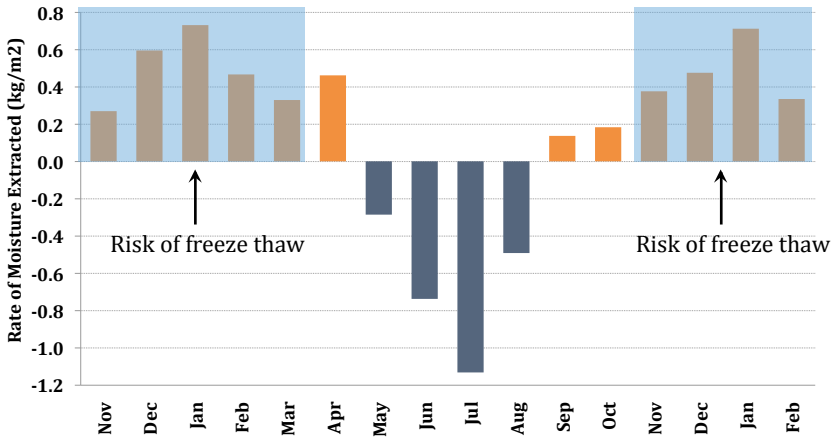
Moisture Movement- South Wall



Net Drying: 1.03kg/m² per Year

14

Moisture Movement– East Wall



Net Drying: 1.09kg/m^2 per Year

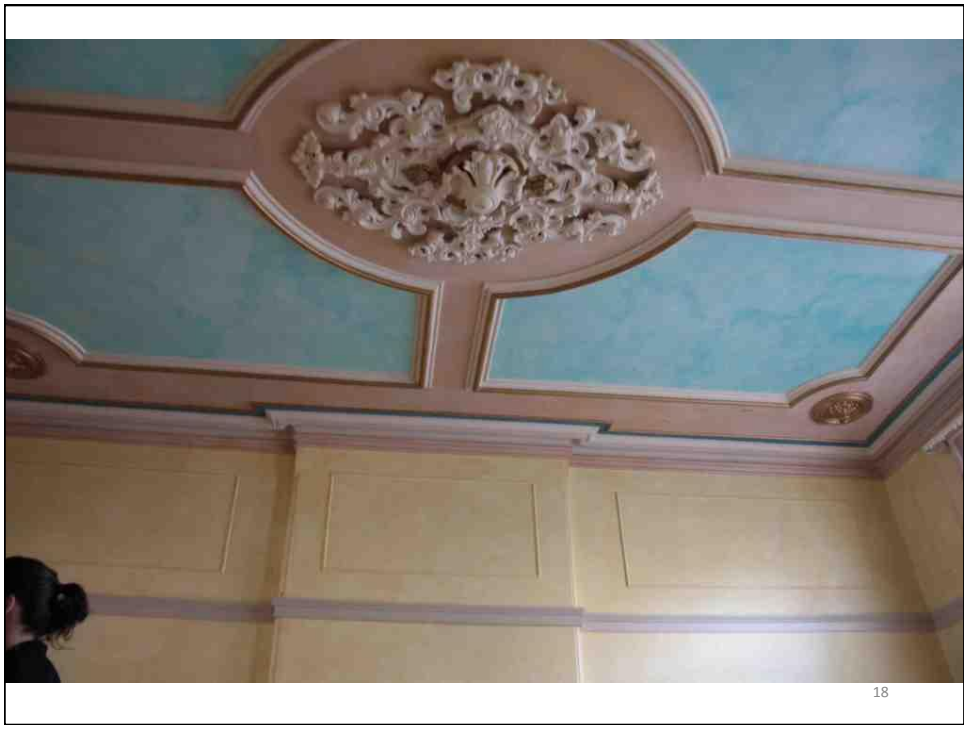
15

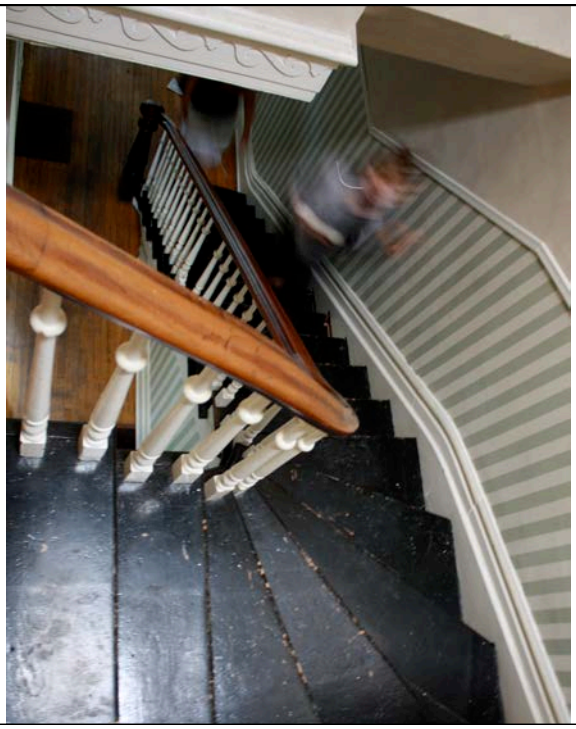
The Gemini House

- Owner: U. of Toronto
- Built in 1879
- 2 Storey detached
- Solid Masonry
- > 16ACH @ 50Pa
- 1220 ft^2 (Standard)
- 740 ft^2 (Core)
- 480 ft^2 Perimeter

16


17


18



19

20


21

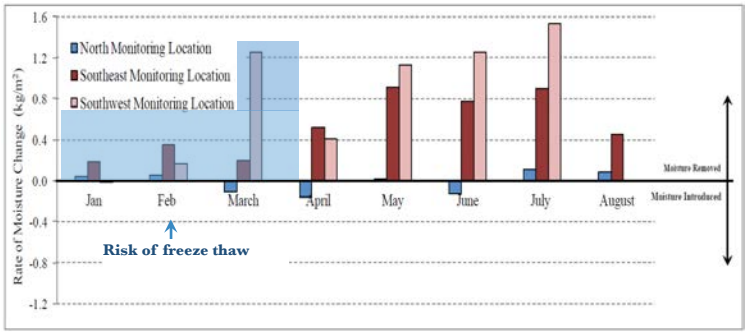
Monitoring Locations

North Elevation

South Elevation

23

Moisture Movement– Gemini

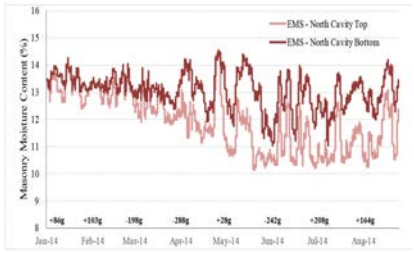


South1: 4.3 kg/m^2 removed per yr.
South2: 5.7 kg/m^2 removed per yr.

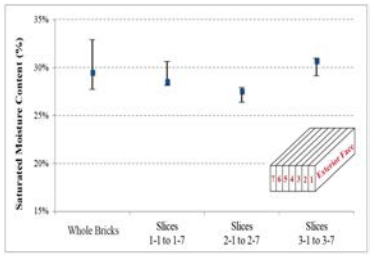
North: 0.08 kg/m^2 introduced per yr.

24

Masonry Moisture Content



← Field Measurements
North: 13% - 15%



← Laboratory Measurements
26% - 30%

25

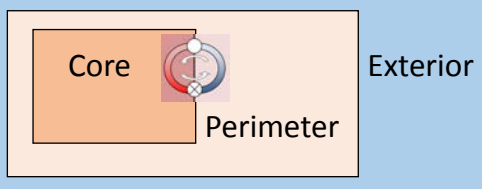
Gemini is a low-energy home…

- Greatly reduced drying potential
- Increased potential for concealed (interstitial) condensation

A Unique Retrofit?

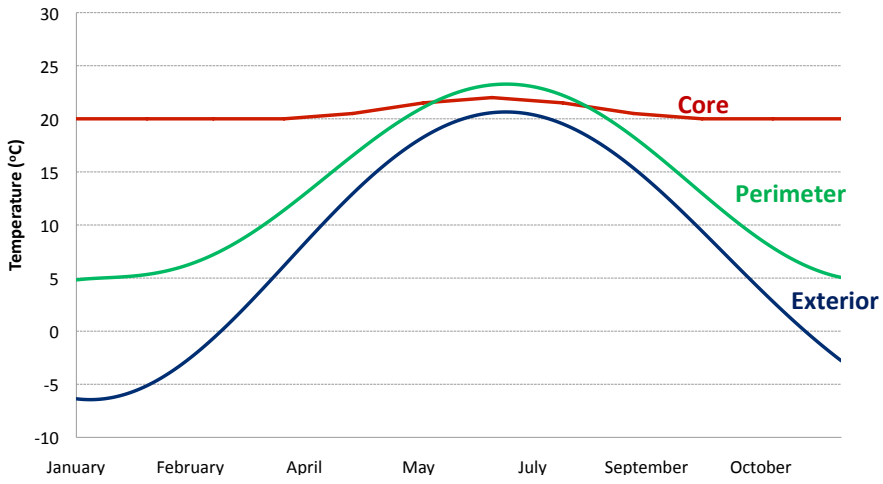
- Two thermal envelopes: “core” and “perimeter” spaces that control heat, moisture, and air movement
- Perimeter used as efficient heat recovery zone during winter months

Nested
Thermal
Envelope
Design



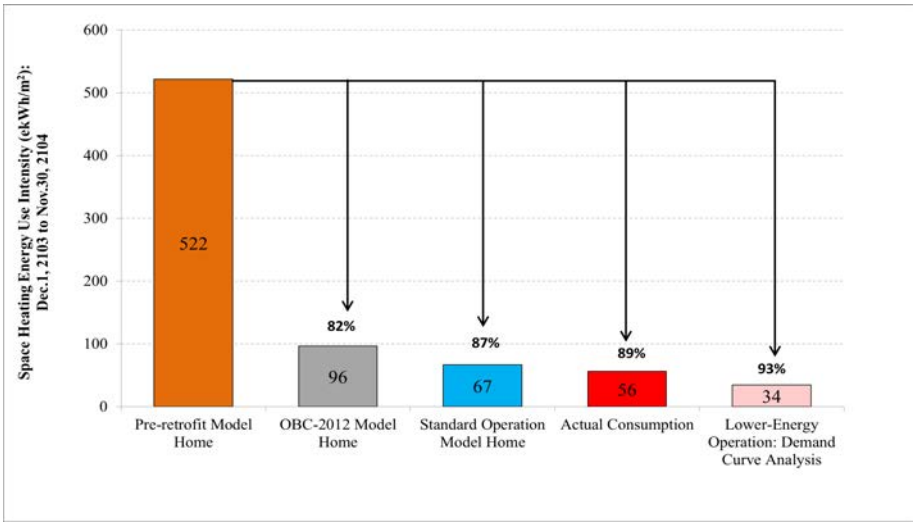
27

Average Core, Perimeter, and Outdoor Air Temperatures in Toronto



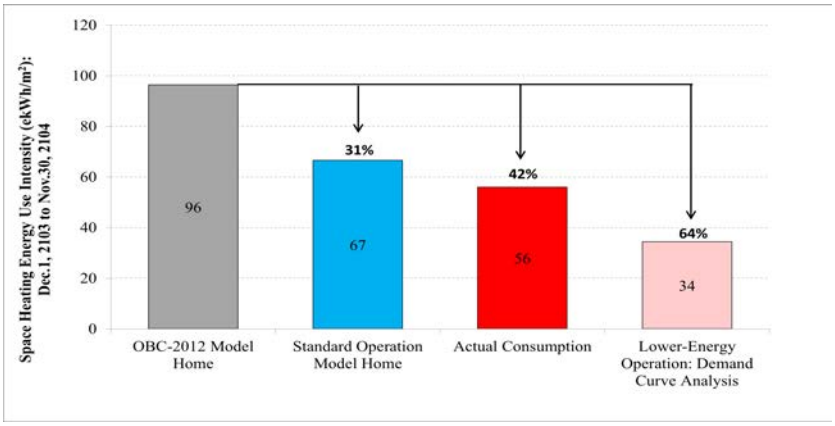
28

Heating Energy Use Compared to Original Building



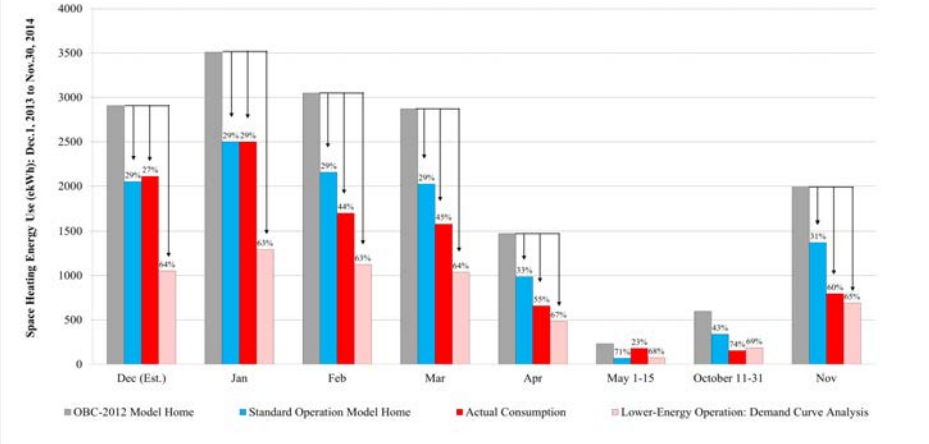
29

Heating Energy Use Compared to a Modern Home



30

Heating Energy Use Comparison by Month



31

Supporting Laboratory Work

Purpose:

- Investigate performance of alternative vented airspace using air-permeable, rock wool insulation

Controlled Variables:

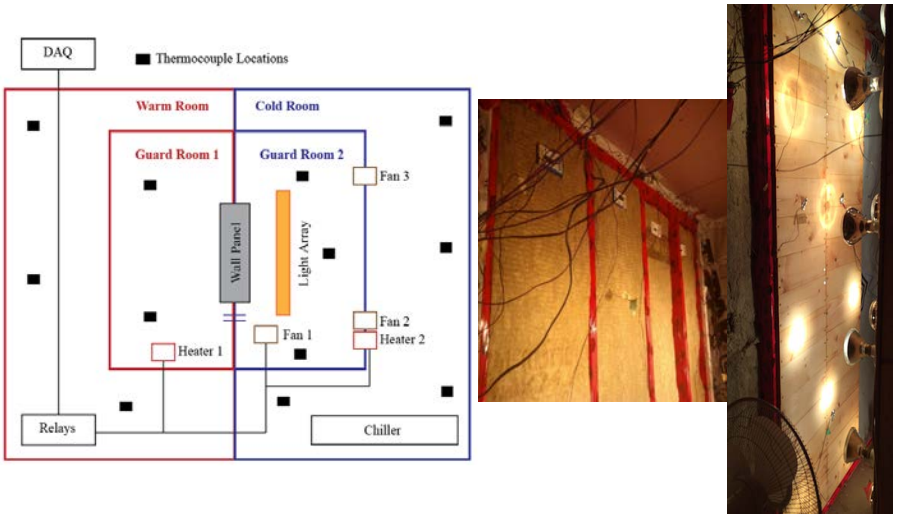
- Vent area ratio, clear airspace, insulation density

Variables of Interest:

- Moisture gain in test walls, estimated moisture removed via ventilation

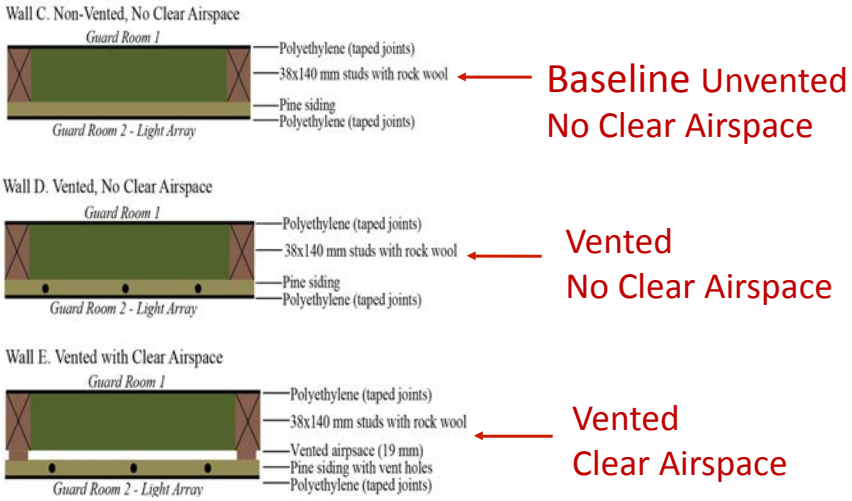
32

Laboratory Testing – Apparatus



33

Lab Testing 3 Wall Types



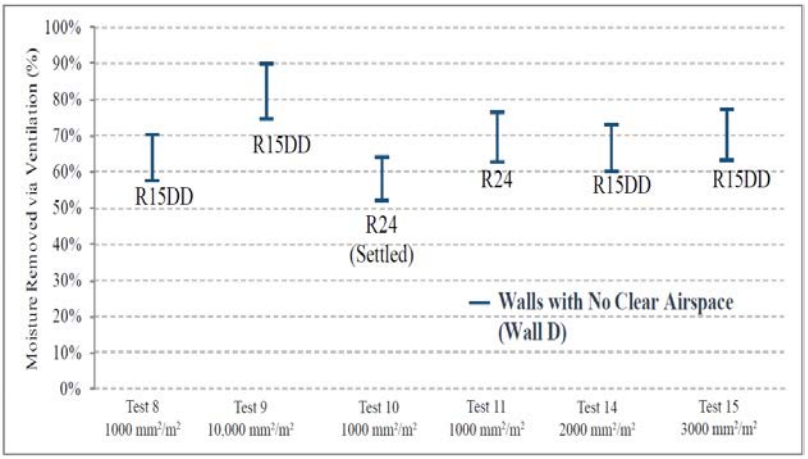
34

Testing Summary

Test	Wall Type	Insulation Type	Clear Airspace	Vent Area Ratio (mm^2 / m^2)
6	Wall C	CAVITYROCK DD	No	No
7	Wall E	CAVITYROCK DD	19 mm	1000
8	Wall D	CAVITYROCK DD	No	1000
9	Wall D	CAVITYROCK DD	No	10,000
10	Wall D	ComfortBatt	No	1000
11	Wall D	ComfortBatt	No	1000
12	Wall E	ComfortBatt	19 mm	1000
13	Wall E	CAVITYROCK DD	19 mm	2000
14	Wall D	CAVITYROCK DD	No	2000
15	Wall D	CAVITYROCK DD	No	3000

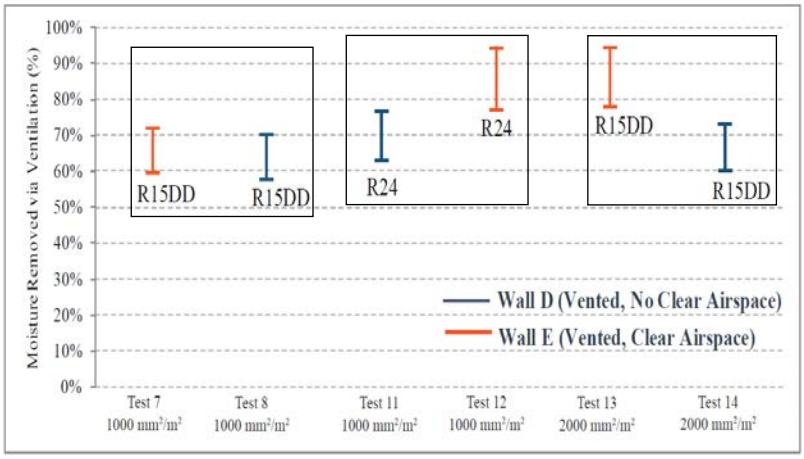
35

Moisture Removal: No Clear Airspace



36

Moisture Removal
Airspace v. No airspace



37

Finding Summary

- Moisture can be removed from the walls without a clear airspace with vapour permeable insulation
  - 59% - 95% with clear airspace and vent holes
  - 52% - 90% with vent holes only
- Enough air was able to move through the air-permeable insulation to dry the wall assembly.
- Drying occurs by air movement –solar heating and wind
- Vent area and insulation density can affect the amount of moisture removed

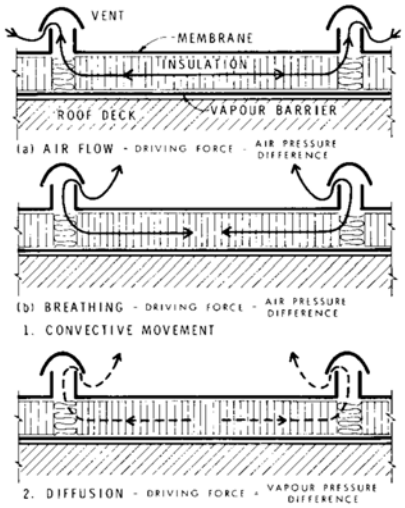
38

Ventilation Drying

- Is far more effective than diffusion drying
- Is dependent upon the climatic zone
- Has been used in Ontario for 100's of years to dry sawn lumber and even firewood!

Using Fibre Insulation in Place of a Vented Airspace?

- The Canadian Building Digests: venting a flat roof through fibre insulation!
- … and that was back in the 1960's!



40

Applications of this work in suitable climates?

- Venting solid masonry as well as masonry veneer
- Venting cathedral ceilings
- Venting flat roofs

41

Acknowledgements

Paul Pasqualini,
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ROXUL Inc.
The Ontario Power Authority
Natural Sciences and Engineering Research Council

Obama's Inaugural Address!

January 20, 2009

And to those nations like ours that enjoy relative plenty, we say we can no longer... consume the world's resources without regard to effect.

…each day brings further evidence that the ways we use energy strengthen our adversaries and threaten our planet.

What is required of us now is a new "Era of Responsibility".

David Orr

This planet needs…

..people of moral courage willing to join the fight to make the world habitable and humane.


Onward and as always…
Upward!
All the best!
K.D.Pressnail
AUGUST 3, 2015
45