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Assessment of Moisture Performance of National Building Code Canada Compliant Wall Assemblies under Climate Change

Max Junginger[1], Maurice Defo[2], Travis Moore[3], Michael A. Lacasse[4] and Vanderley M. John[5]

[1] Polytechnic School, University of São Paulo, São Paulo, SP, Brazil. Maxjgg@gmail.com

[2] Construction Research Centre, NRCC, Ottawa, ON, Canada, Maurice.Defo@nrc-cnrc.gc.ca

[3] Construction Research Centre, NRCC, Ottawa, ON, Canada, Travis.Moore@nrc-cnrc.gc.ca

[4] Construction Research Centre, NRCC, Ottawa, ON, Canada, Michael.Lacasse@nrc-cnrc.gc.ca

[5] Polytechnic School, University of São Paulo, São Paulo, SP, Brazil, Vanderley.John@lme.pcc.usp.br

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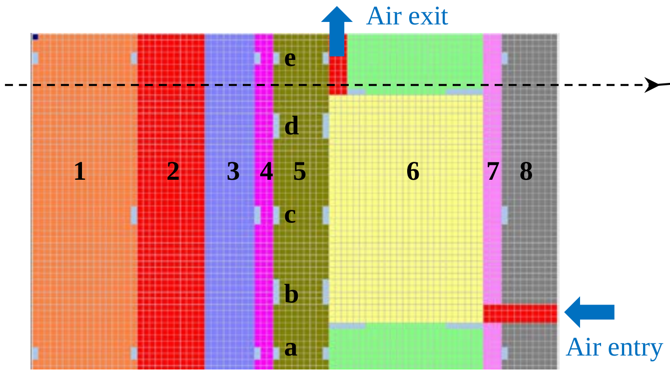
1 Introduction

Climate change has received increasing attention globally due to many possible consequences, including building long-term performance issues arising from temperature increases and more severe and frequent rainfall events. It is also expected that weather extremes will intensify in the future and, even though rainfall events might decrease in some areas, these are likely to increase for over most of Canada (Bush and Lemmen, 2019). In some regions, increases in precipitation as high as 40% are expected and this will have significant effects on buildings: water infiltration, related mostly to wind-driven rain, will increase accordingly and might pose a higher risk to the premature degradation of moisture-sensitive materials (Lacasse *et al.*, 2018).

To address these issues of moisture accumulation in wall assemblies due to condensation or water ingress, the National Building Code (NBC) sets prescriptive requirements for all the walls separating conditioned from unconditioned spaces. These include: i) minimum thermal insulation according to the climate zone; ii) an air barrier system with an air leakage rate not greater than 0.1 L/s.m^2 at 75 Pa; iii) a vapor barrier with permeance not greater than 60 ng/(Pa.s.m^2); and iv) position of low permeance material in the wall. As well, in case of where an exterior insulation is added, NBC requires a minimum ratio between outboard and inboard thermal resistance (NRC, 2015, p. B-9.159). All these technical requirements are intended to minimize the chance of moisture accumulation in wall assemblies, which can lead to wood deterioration. As such, the primary objective of this study is to assess the moisture performance of code-compliant walls under both historical and future climate loads.

A state-of-the-art hygrothermal modelling software, Delphin 5.9, was used to undertake the hygrothermal simulations for three cities across Canada: Calgary (AB), Ottawa (ON) and Vancouver (BC), with low, medium and high moisture indices respectively. For each city, two cladding types were simulated, brick and stucco. Two sets of climate data were used: historical and future, when a global warming of 3.5ºC is expected to be reached. The walls were also subjected to wind-driven rain (WDR) calculated according to ASHRAE 160 and an air leakage (Leak) rate of 0.1 L/(s.m^2) at 75 Pa. Figure 1 shows the layers for the brick wall; external insulation might not exist if the minimum RSI is achieved using only the interior insulation. The performance assessment focused on the mould index that was calculated according to the VTT model. Table 1 shows the maximum mould indices, with and without air leakage.



1. Brick
2. Air layer
3. External insulation
4. Sheathing membrane: 30' paper
5. OSB (11.1 mm)
6. Stud with low density glass fiber insulation (140 mm)
7. Polyethylene (6 mil = 0.15 mm)
8. Gypsum board (12.7 mm)

Figure 1. Layers of the brick wall.

Table 1. Maximum mould index in the worst position of OSB for each case.

City	Brick						Stucco					
	NoLe		Leak		Leak - NoLe		NoLe		Leak		Leak - NoLe	
	H	F	H	F	H	F	H	F	H	F	H	F
Ottawa	0	0	0	0	0	0	2.25	4.13	2.57	4.13	0.32	0
Vancouver	3.49	3.49	3.56	3.52	0.07	0.03	4.28	4.48	4.40	4.59	0.12	0.11
Calgary	0	0	0	0	0	0	2.36	1.68	2.55	1.86	0.19	0.18

H - Historical F - Future Leak - air leakage NoLe - no air leakage

Future climate is more humid in Ottawa than in Calgary and Vancouver, which means higher moisture level in the assembly and higher risk of mould development for both claddings. Brick cladding is safer than stucco in any case in future climate. The higher moisture capacity of the brick, the wider air cavity and the higher air temperature all together increase the drying capacity of the wall and keep the relative humidity below the threshold for mold growth most of the time. Lower values of “Leak - NoLe” in the future suggest that there might be a decrease in the risk of mould growth due to air leakage in the future.

ORCID

Max Junginger: 0000-0002-7112-8584
Maurice Defo: 0000-0001-9212-6599
Travis Moore: 0000-0002-4920-9193
Michael Lacasse: 0000-0001-7640-3701
Vanderley John: 0000-0002-0588-8382

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