Hygrothermal Performance of Super-Insulated Double-Stud Wall Assemblies under Simulated Rainwater Penetration

BCIT School of Construction and the Environment

Nima Khalkhali- MASc Candidate
Dr. Fitsum Tariku-Supervisor

Acknowledgements

Natural Sciences and Engineering Research Council of Canada (NSERC) and the School of Construction and the Environment at the British Columbia Institute of Technology (BCIT)

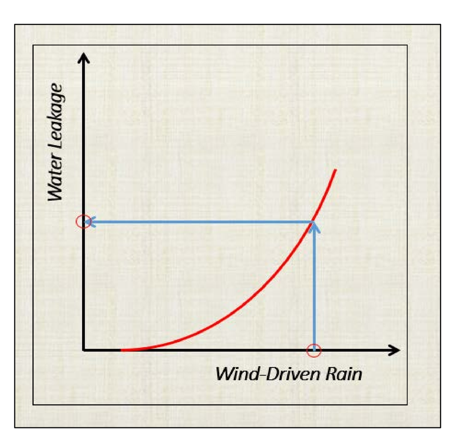
MOTIVATION

- Climate Change, Aggressive targets to lower CO_2 emission
- Net-Zero Emission, Passive Design, …
- More stringent Energy Standards & Codes
- Durability of super-insulated wall system initiative is unknown
- Hygrothermal design of walls with better drying capability

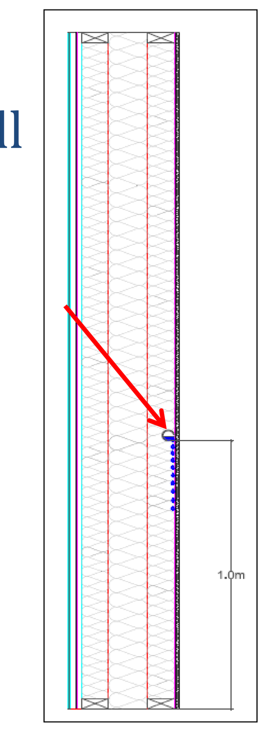
OBJECTIVE

- To compare Drying Capability of the various walls under water ingress from a typical interface defect
- Will lead to choosing the best alternative, and/or improving each or the best option among the rest
- …by enhancing the “Drying Capability” of the walls
- Results could also be used to validate or enhance the existing computer hygrothermal models (HAMFit)

METHODOLOGY



- Research based on Long-term field Experimental study (at least one-year)
- Wall Assemblies will be built, instrumented and installed on the South-East side of BCIT Building Envelope Test Facility (BETF),
- Located in Burnaby, British Columbia, to be exposed to actual exterior weather conditions (similar to Marine Climate Conditions)



- Simulated Wind Driven Rain (WDR) will be introduced to walls’ sheathing at window’s sill height (Region of interest)
- Incorporating a fabric with uniform water distribution and redistribution
- Introduction of rain penetration amounts based on prior research work that correlates WDR to Water Ingress into Walls from a typical interface defect

EXPERIMENTAL SETUP

Wall Panels (General)

- Six 4’x8’ Wall Panel Specimens
- All R-40 (effective)
- Advanced Framing System

Experimental Variables

- Various VB/VR strategies
- Insulation Types
- Wall Assemblies Configuration
- Water Penetration Scenarios

Boundary Conditions

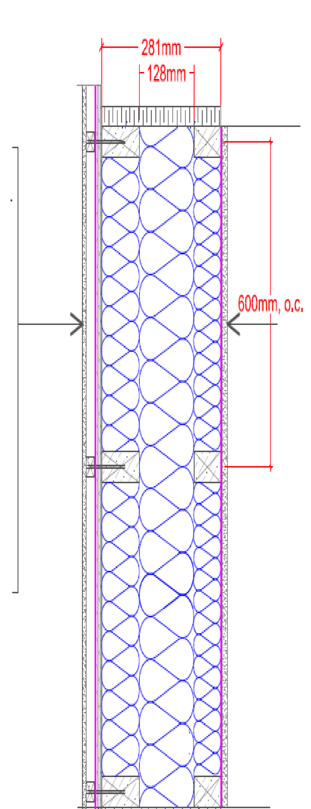
- Interior boundary conditions: BETF air conditions (45-55% RH, 21°C)
- Outdoor Boundary Conditions: Real climate exposure (Burnaby, BC)

Wall Assemblies (Types)

Type A- Double Stud with Dense Fill Cellulose Insulation

EXTERIOR
- 8mm Fiber Cement Cladding
- 19mm Ventilated Air Cavity
- Tyvek Housewrap
- 13mm Plywood Sheathing Board
- 89mm Dense Fill Cellulose Insulation bet. 2X4 Studs
- 128mm Gap filled with Dense Fill Cellulose Insulation
- 64mm Dense Fill Cellulose Insulation bet. 2X3 Studs
- 6 mil Polyethylene
- 13mm Gypsum Board Interior Sheathing

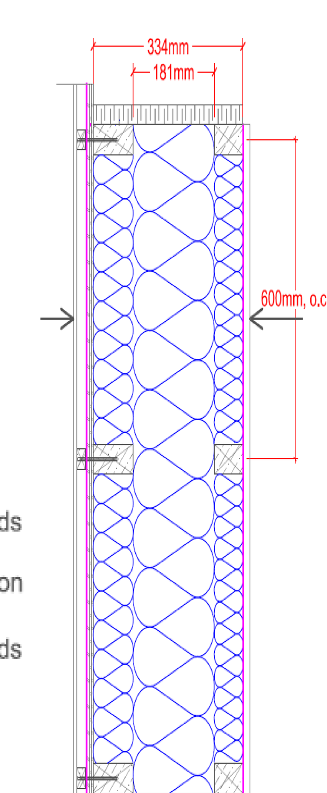
INTERIOR



Type B- Double Stud with GF Batt Insulation

EXTERIOR
- 8mm Fiber Cement Cladding
- 19mm Ventilated Air Cavity
- Tyvek Housewrap
- 13mm Plywood Sheathing Board
- 89mm Glass Fiber Batt Insulation bet. 2X4 Studs
- 181mm Gap filed with Glass Fiber Batt Insulation
- 64mm Glass Fiber Batt Insulation bet. 2X3 Studs
- 6 mil Polyethylene
- 13mm Gypsum Board Interior Sheathing

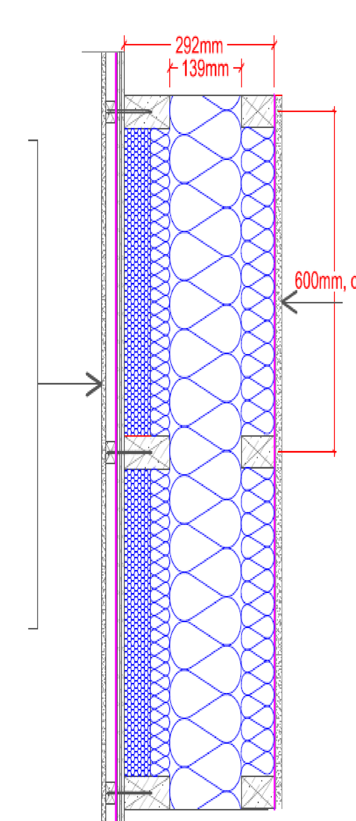
INTERIOR



Type C- Double Stud Wall with Low Density Sprayfoam and Glassfiber Batt Insulation

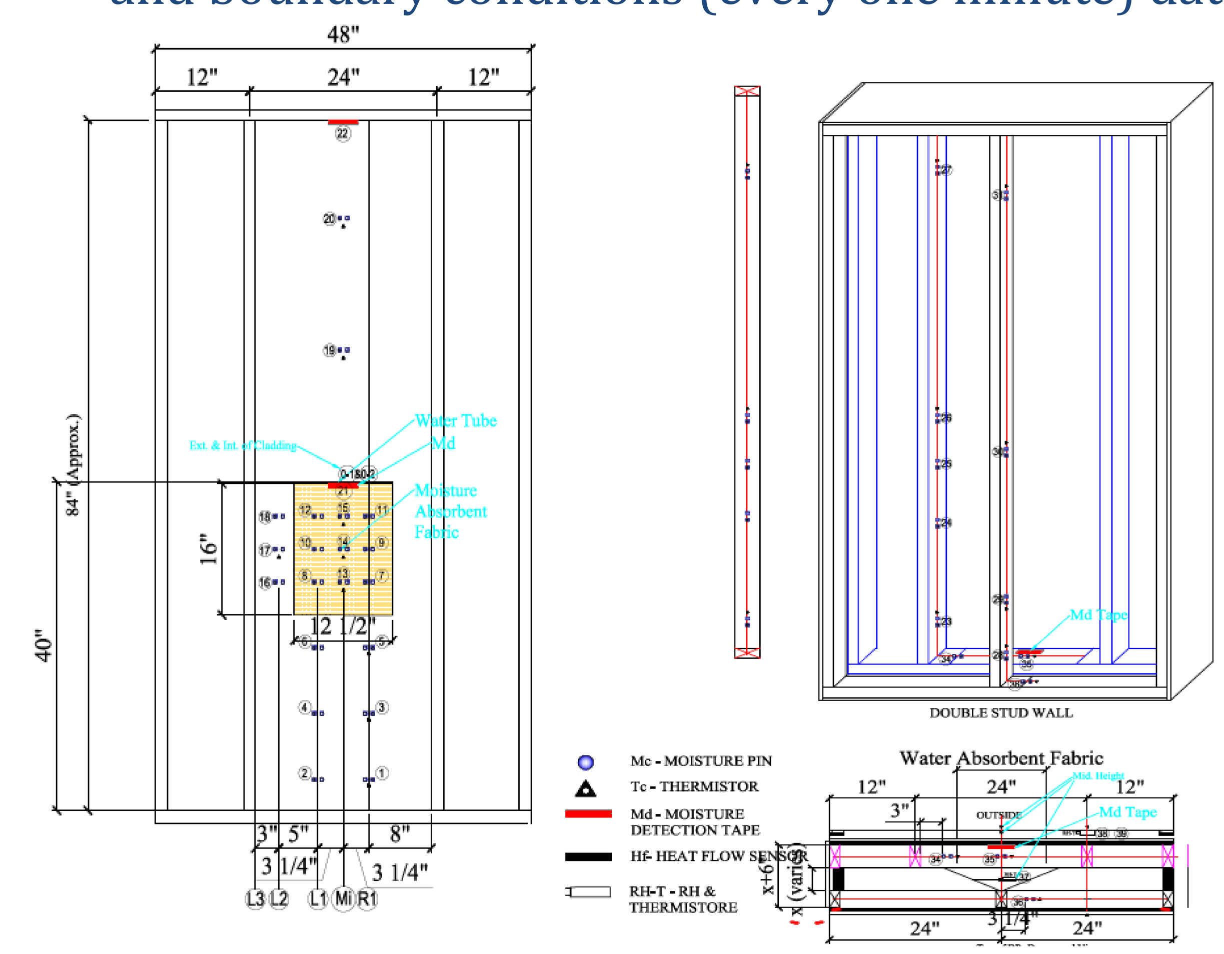
EXTERIOR
- 8mm Fiber Cement Cladding
- 19mm Ventilated Air Cavity
- Tyvek Housewrap
- 13mm Plywood Sheathing Board
- 51mm Low-Density Sprayfoam
- 38mm Glass Fiber Batt bet.. 2X4 Wood Studs
- 139mm Gap Filled with Glass Fiber Batt Insul.
- 89mm GF Batt Insul. Bet. 2X3 Wood Studs
- 6mil Polyethelene
- 13mm Gypsum Board Sheathing

INTERIOR



Instrumentation

- Test panels: moisture pins, thermistors, relative Humidity, and moisture detection tape sensors
- Boundary conditions: Outdoor temperature, relative humidity, wind speed and direction, wind-driven rain, solar radiation and indoor temperature and relative humidity conditions
- Record the hygrothermal performance (every five minutes) and boundary conditions (every one minute) data



Data Analysis

- Wetting & Drying trends of critical regions extracted from recorded data through DAQ
- Comparative analysis between walls
  - Mould, RHT, ICEM, … Moisture Indicators
  - Or will be initiated (if needed)
- Conclusion over better choice of variables (Vapor Control, Insulation Type, and configuration of each) will be drawn
- Variables fed to hygrothermal models to validate the data as well as the models