BUILDING AIRTIGHTNESS: ARE RESULTS REPEATABLE?

University of Victoria | Civil Engineering

Benjamin Croyle, Supervised by Dr. Phalguni Mukhopadhyaya

Department of Civil Engineering

WHY BUILD AIRTIGHT BUILDINGS?

Provincial and Federal governments want to reduce building energy usage. The British Columbia Government has the following goal [1]:

- All new buildings in B.C. will be net-zero carbon
- All new space heaters will be at least 100% efficient

Operationally energy efficient buildings:

- Insulation: well-insulated walls, roofs and foundations lose less heat
- Airtight: minimize air leakage through wall & roof assemblies

What happens if you don't build an airtight building? [2]

- Condensation & frost
- Mold & decay
- Pollution
- Energy leakage leads to more $$
- Acoustics

Many building codes are begging to implement airtightness requirements

BUILDING AIRTIGHTNESS TESTING

How to quantify a buildings airtightness?

- Whole building blower door testing

Building blower door testing includes:

- Using fan, (de)pressurize the building, measure air leakage at different pressures [2]

How is the airtightness of buildings quantified?

- Measurement of airtightness is cfm/ft^2 @ 75 Pa, cubic feet per minute per square foot at 75 Pa
- cfm/ft^2 @ 75 Pa is airflow rate per square foot of assembly at a 75 Pascal pressure difference between inside and outside of building

What is a good airtightness value?

Most jurisdictions have a threshold of 0.4 cfm/ft^2 @ 75 Pa. Any airtightness less than this value passes the airtightness test, anything more fails

Steps of an airtightness test:

1. Prepare the building: seal openings (HVAC ducts, range hood,
2. Place fan in door
3. Measure indoor & outdoor pressure, temperature
4. Zero pressures to calibrate test
5. Turn on fan, induces pressure difference between the inside and outside as air gets pushed in or out of the building.
6. Record data: use indoor/outdoor pressure values, fan speed and house enclosure area to get airtightness value
7. Increase pressure differential between inside and outside to 75 Pa.
8. Visual inspection of building. Use smoke machine to see where air is leaking through the building [3]
9. Repair leaks. Where possible, repair or patch holes where the building is leaking
10. Wrap-up test. Remove all equipment, restore site to conditions it was in

HOW TO BUILD AN AIRTIGHT BUILDING

Buildings need an air barrier system: a system that keeps warm air in the building, dirty air out of the building.

How to build an airtight enclosure [2]:

1. Continuous: gaps in the air barrier are where air will leak through
2. Air impermeability: use materials that don't allow airflow
3. Durable: can last many years, withstand weather damage
4. Strong: air barrier should not break/damage under loads
5. Stiffness: air barrier won't deform under air pressure

In homes, the air barrier is normally housewrap or building paper [2]

METHODOLOGY AND TESTING

Airtightness testing is a new procedure for modern buildings. As it is only 10-15 years old, many places in the world are not using the testing. In jurisdictions where airtightness testing is required, only needed to be tested once.

Minimal research has been done on the repeatability of airtightness testing results. Do the results change throughout the day./year as the climate changes? Research question for this project.

Does the airtightness of buildings change with seasonal and daily changes in climate and weather?

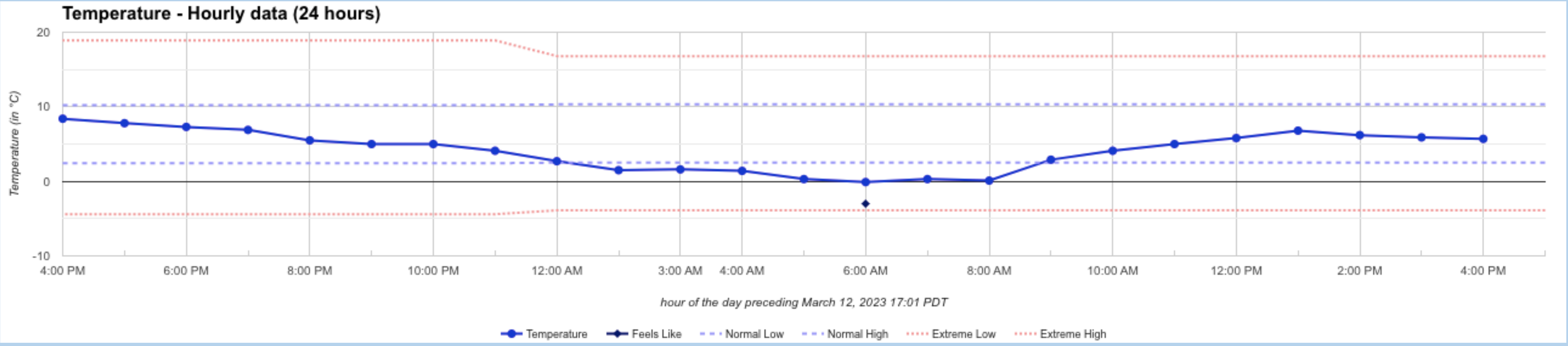
In this experiment, multiple blower door tests will be conducted on a house to test if the airtight values of the building change.

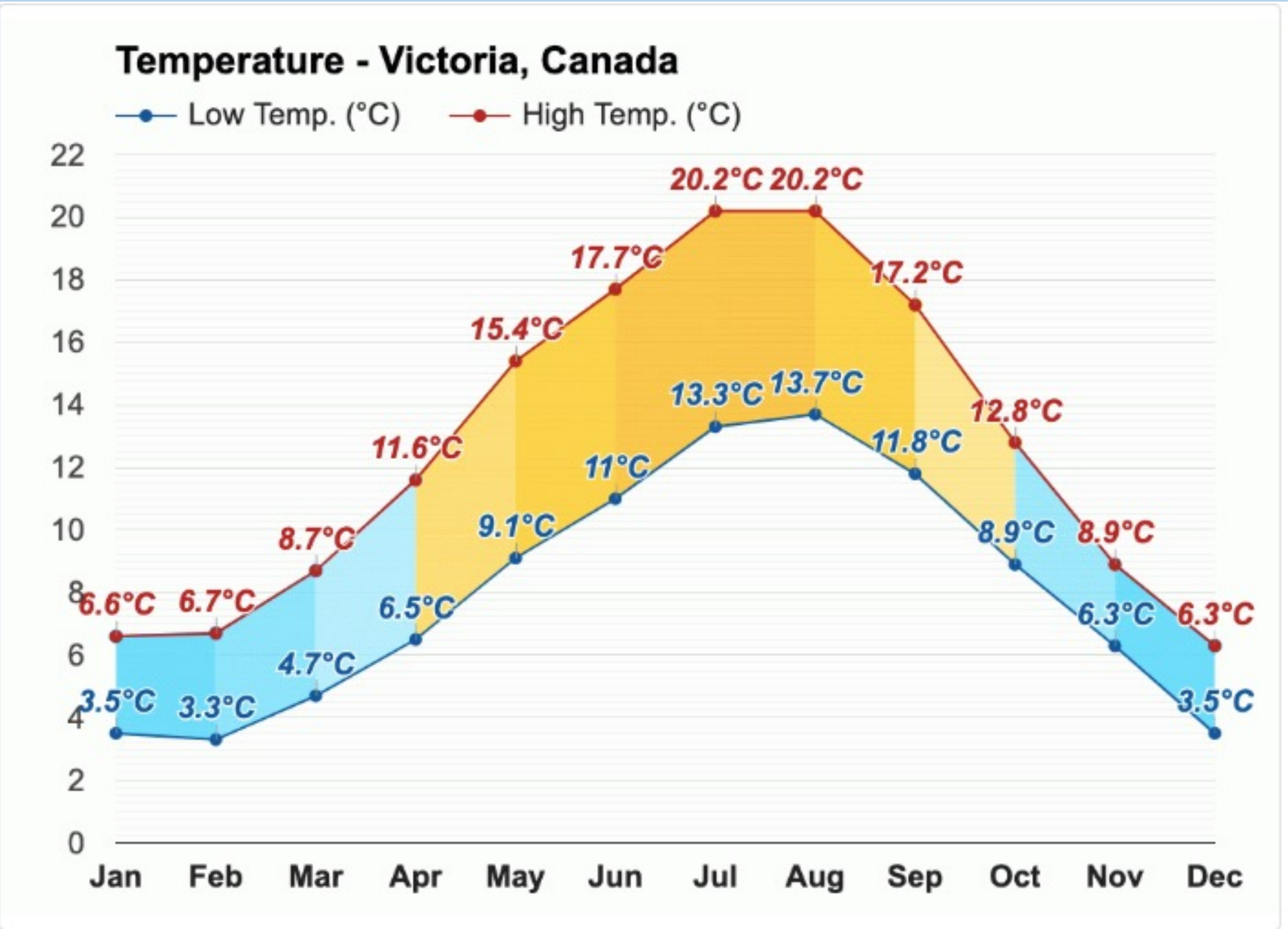
For each day of testing, three tests will be done: [4]

- **6 am:** before sunrise, assembly is at its coldest
- **2 pm:** hottest part of the day, after multiple hours of sun exposure
- **10 pm:** evening, just after the daily cycle of heating, cooling beginning

Seasonally, testing will be conducted in the following months: [5]

- **March:** cold and wet conditions
- **April/May:** cool and damp conditions
- **June:** warm and dry conditions

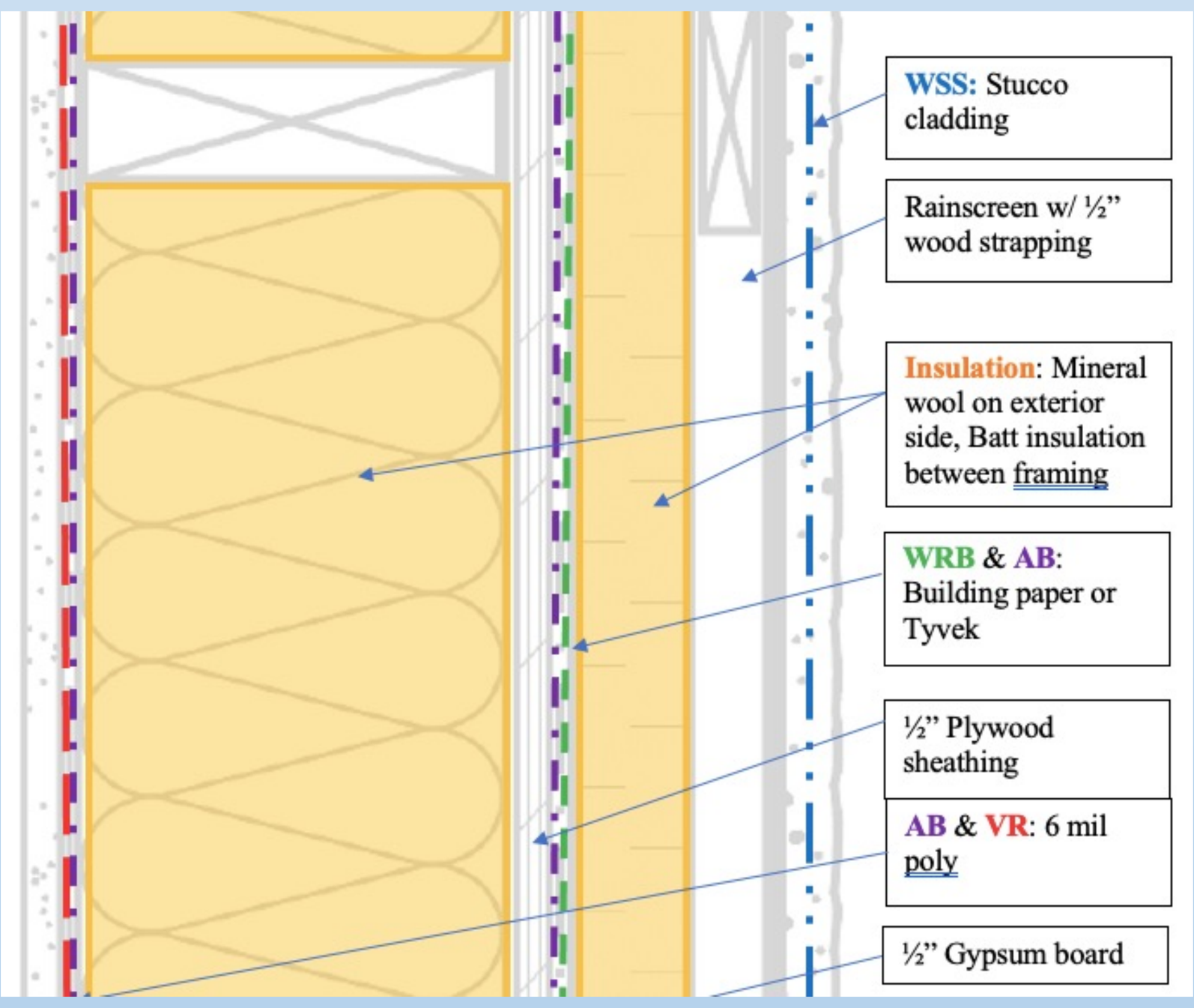




RESULTS

Testing to be conducted throughout the following months. Results from the testing will be the airtightness values of the house throughout the multiple tests.

It is expected that the airtight performance of materials, assemblies and joints will change with changes in outdoor temperature, relative humidity and UV exposure levels.



ACKNOWLEDGEMENTS

This research was supported by the Jamie Cassels Undergraduate Research Awards, University of Victoria

REFERENCES

[1] Ministry of Environment and Climate Change Strategy, "Clean buildings and communities," *Province of British Columbia*, 23-Nov-2022. [Online]. Available: https://www2.gov.bc.ca/gov/content/environment/climate-change/clean-buildings#:~:text=As%20part%20of%20B.C.'s,than%20a%20half%20by%202030. [Accessed: 12-Mar-2023].

[2] G. Finch, "Control of Airflow in Buildings," in *University of Victoria*, 2023.

[3] S. Alfano , "How to smoke out air leaks," *Pro Remodeler*, 01-Jul-2019. [Online]. Available: https://www.proremodeler.com/how-smoke-out-air-leaks. [Accessed: 12-Mar-2023].

[4] "Temperature - hourly data for Victoria," *Amateur Weather Statistics for Victoria, British Columbia*. [Online]. Available: https://victoria.weatherstats.ca/charts/temperature-hourly.html. [Accessed: 12-Mar-2023].

[5] Weather Atlas, "Victoria, Canada - climate & monthly weather forecast," *Weather Atlas*. [Online]. Available: https://www.weather-atlas.com/en/canada/victoria-climate. [Accessed: 12-Mar-2023].