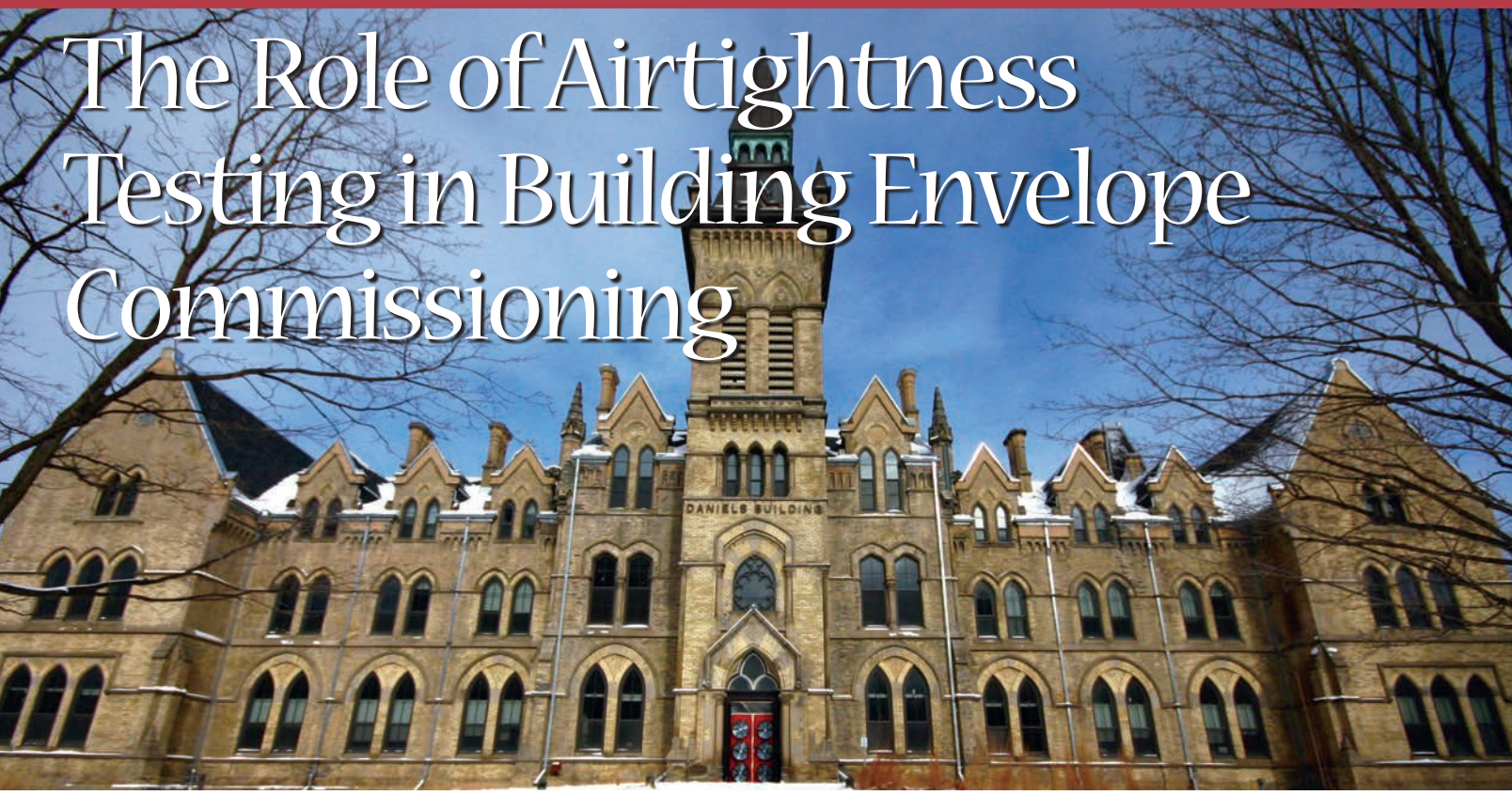
The Role of Airtightness Testing in Building Envelope Commissioning



By Deva Veylan, M.B.Sc., EA, Founding Principal, CoEfficient Building Science & Austin Todd, M.B.Sc., B.Tech., CEA, Vice-President of Business Development, CoEfficient Building Science

Do you know how airtight your recently completed project is? You likely don't, meaning the air infiltration rates used for mechanical system sizing and understanding building performance in energy models is simply guesswork.

Through the emergence of the passive house movement, it has become clear that low air infiltration rates are critically important for low-energy buildings. So, why are we still guessing? How airtight are our current practices, and how do we build for better air tightness?

Performing a whole building airtightness test is a good starting point; however, the best improvements are made when it is accompanied by a building envelope commissioning process. A building envelope commissioning process can include airtightness testing to inform design decisions and verify that the desired levels of performance are being achieved throughout the construction process.

The most commonly used energy codes in Canada for Part 3 buildings are *NECB 2011* and *ASHRAE 90.1*. These employ air infiltration rates that must be used in energy code compliance modeling. An RDH database of 87 surveyed buildings demonstrates that air leakage is 102 per cent higher than what would be modeled using *NECB 2011* and 44 per cent higher than what would be modeled using *ASHRAE 90.1*.

This discrepancy between modeled and actual air infiltration rate can lead to improperly sized HVAC systems, which results in greater energy consumption. With energy codes not allowing credit for reduced air infiltration rates, there is little incentive to verify building envelope performance. Though there has been little support for airtightness testing from building codes, that is beginning to change in municipal codes and voluntary standards. Under British Columbia's *Energy Step Code*, whole-building airtightness testing is mandatory, and the measured air leakage rate is used in the compliance energy model. Under the Toronto Green Standard V3, mandatory testing is also required in Tier 2 and above.

Research by Wiss, Janney, Elstner Associates Inc. illustrates the importance of a performance-based approach to envelopes. Results from 16 modern mid- and high-rise, non-residential buildings found that envelope commissioning efforts reduced the air leakage rate by 67 per cent. Surprisingly, buildings without an environment label were an average of 70 per cent more airtight.

The envelope commissioning process offers the most effective method for ensuring

The University of Toronto's Daniels Building required 12 blower door fans to employ a guarded airtightness testing technique.

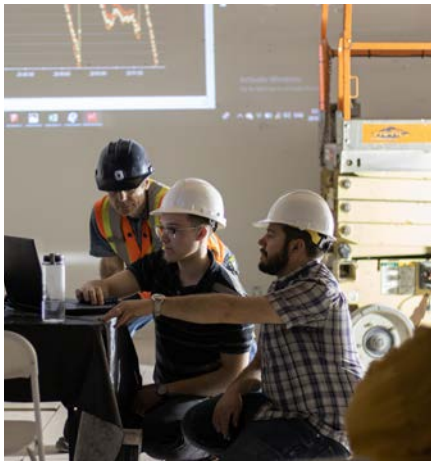
airtight and overall envelope performance. The process ultimately starts by asking a series of the right questions, including:

- Is the ABS continuous in the current design?
- What materials are being used? Are they compatible with each other?
- How long will the materials be exposed to the elements?
- Which trades will be installing the ABS?

Next, comes a design review of critical envelope details for air, water, thermal, and vapour performance, followed by early construction phase testing.

Envelope commissioning shares many similarities with mechanical commissioning. While they both should be considered right from the design stage, the majority of the mechanical commissioning process efforts come to bear later in the project, after all of the equipment is installed. Meanwhile, envelope commissioning efforts are largely taken during the beginning half of the construction process. Therefore, the project team should engage with the envelope commissioning agent early on.

Advanced airtightness testing techniques, like guarded testing, can isolate a section of building envelope, or an entire floor, early in the construction phase. This ensures the assemblies are performing as expected and allows for adjustments to be made if they are not. Guarded testing employs the use of multiple fans to equalize pressure across a boundary, thereby eliminating the pressure difference and resulting airflow across that boundary. This allows for the isolation of any size of test specimen. Employed early-on in construction, guarded testing can act as an excellent learning opportunity for the project team, including trades responsible for installing the air barrier system.



Initial mock-up testing performed early in the design stage ensures adjustments can be made before construction progresses.

The University of Toronto's Daniels Building's 1875 envelope was leaking three times more than the modern addition.

These testing techniques have been used on several projects, including the University of Toronto's Daniels Building, the Ontario Association of Architects (OAA) headquarters, and the ongoing Ken Soble Tower EnerPHit project. Each of these projects offered a unique set of challenges in the envelope commissioning process.

The Daniels Building was tested in collaboration with Russell Richman and Greg Labbe from RRCL, and the project was spearheaded by Professor Bomani Khemet. Though 18 blower door fans were brought to the Daniels Building on test day, only 12 were needed to employ a full-building and guarded airtightness testing technique. This technique allowed the comparison of the air leakage rate for the original 1875 building and the recently completed addition that effectively tripled the building's volume. In the end, the 1875 envelope was leaking three times more than the modern addition.

The ground-breaking Ken Soble Tower EnerPHit Passive House Retrofit Project is chasing stringent passive-level airtightness performance targets. In order to achieve these targets, airtightness testing will be performed throughout the retrofit, including mock-up and guarded tests of multiple units, floors, and the whole building.

To be most effective, the envelope commissioning agency should be brought on board early in the design phase, and initial mock-up testing should be performed as early as possible to ensure adjustments can be made before construction progresses. Let's start asking the right questions, testing our buildings, and adopt a performance-based approach to reduce our building's environmental impacts. ■

Deva Veylan has a Master of Building Science degree from Ryerson University. He is co-founder of CoEfficient Building Science and he has consulted on projects across Canada.

A leading expert in large building airtightness testing, Austin Todd has a Master of Building Science degree from Ryerson University, and is co-founder of CoEfficient Building Science.