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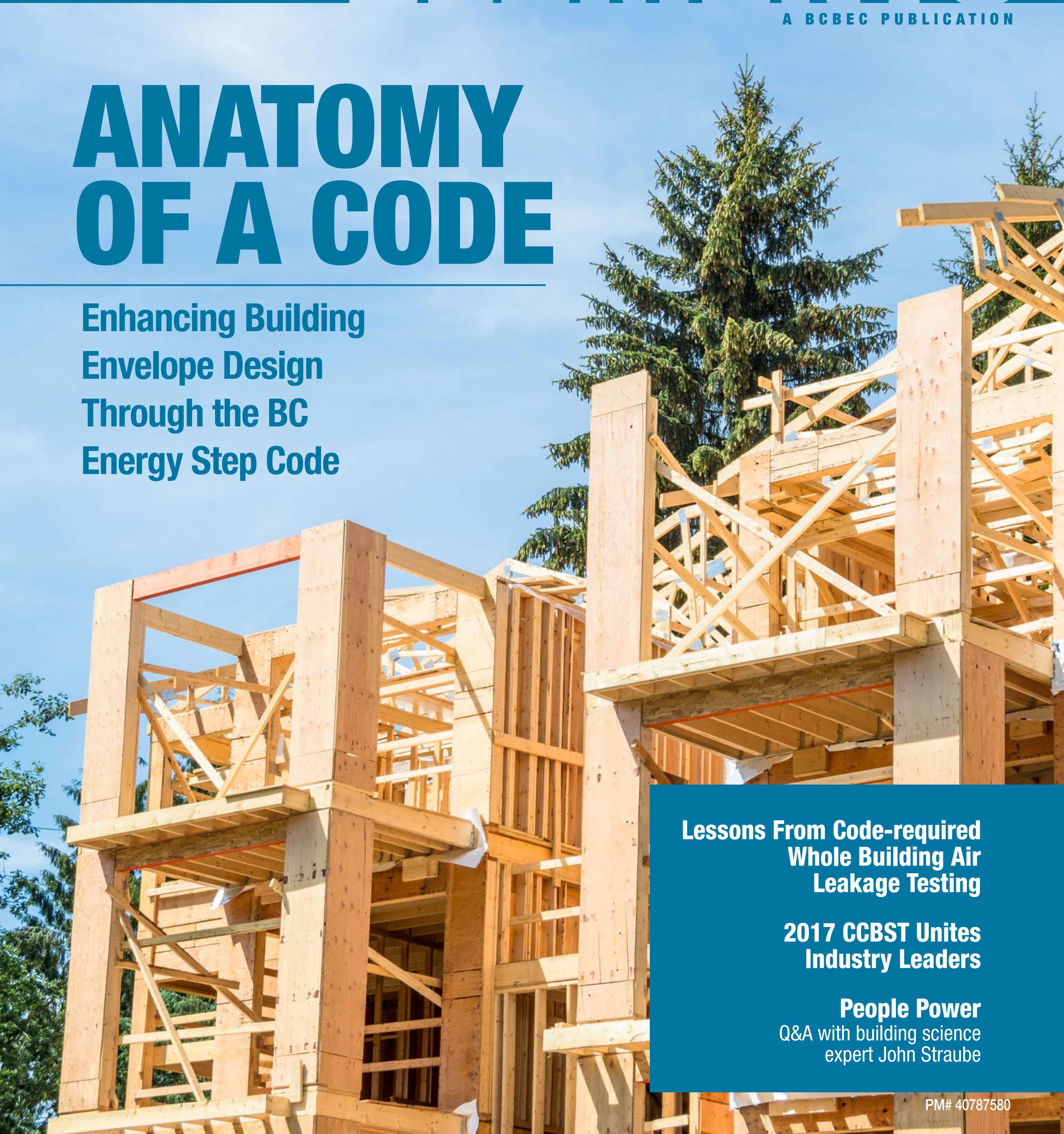

ANATOMY OF A CODE

Enhancing Building Envelope Design Through the BC Energy Step Code

Lessons From Code-required Whole Building Air Leakage Testing

2017 CCBST Unites Industry Leaders

People Power
Q&A with building science expert John Straube

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Shakir Rashid,
President,
BCBEC

An Exciting Year Ahead for BCBEC

Welcome to our spring issue of *BCBEC Elements* magazine. It is an honour for me to serve as the president of the BC Building Envelope Council (BCBEC). We are an organization from different facets of the industry with a goal to provide a platform for building envelope research and ideas to be heard and discussed.

BCBEC Elements is now entering its fourth year and we are very proud of it. In collaboration with MediaEdge, our elements sub-committee, chaired by Kurtis Topping, work very hard to bring to you articles that are educational, current and interesting. We are always looking for article submissions, so please reach out to us if you would like to contribute. You will find our contact information on our website at www.BCBEC.com. In response to advertiser requests, we have also introduced a new section in our magazine for announcements and important press releases, titled Industry News. This is a great section for you to advertise new roles, organization changes and news; promote new products; or anything that you want the industry to take note of.

I would like to acknowledge our advertisers who have kept our magazine going. On behalf of the board, we thank you. Without your support we wouldn't have had the success that we have had. We truly appreciate your support of the magazine and BCBEC.

We are also thrilled to get our website revamped, so please visit our website and let us know how we fare. With a modern appearance, our updated site has simplified navigation to access up-to-date content and resources at any time. Did you know you can also access this magazine electronically? Please visit http://bcbec.com/bcbec-elements-magazine/, where you will find current and past issues of *BCBEC Elements.*

In addition to disseminating information through our magazine, we organize monthly luncheons as well as half-day seminars and an annual full-day Conference and AGM. Vancouver luncheons, organized by Carolina Maloney, and Victoria luncheons, organized by Kevin Pickwick, are very well attended. Our next luncheon is June 21, 2018. Please visit our website for details. I am also pleased to inform you that our annual Conference and AGM this year will occur on October 26, 2018, at JW Marriott Parq in Vancouver.

I hope you enjoy this issue. Please don't hesitate to reach out to me or any of the board members if you have any questions about BCBEC.

Thank you,

Shakir Rashid, P. Eng.
BCBEC President

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Have an article, news or an event for *BCBEC Elements*? Contact our editorial board online at www.bcbec.com

ANATOMY OF A CODE

Enhancing building envelope design through the BC Energy Step Code

By Andrew Pape-Salmon, P.Eng., MRM, FCAE, FCSSE; and Dale Andersson, PhD, B.C. Building and Safety Standards Branch, Ministry of Municipal Affairs and Housing

A. INTRODUCTION

The BC Energy Step Code is an optional compliance path within the BC Building Code (BCBC) and came into force in April 2017. Builders can voluntarily construct to one of the steps, while local governments can choose to require or encourage builders to meet one or more steps as an alternative to the BCBC's prescriptive requirements.

The BC Energy Step Code enables the Province to meet its *Building Act* objective of having more consistent technical building requirements in force across British Columbia, while giving local governments the ability to address climate change through higher energy-efficient building standards.

It also:

- provides the construction and manufacturing industries with a sense of future code requirements, enabling them to cost effectively develop new services and products in advance of market requirements;
- supports innovation by setting performance-based requirements (rather than prescriptive requirements); and
- helps "future proof" buildings to be more affordable over the long term.

The 2016 Pan Canadian Framework on Clean Growth and Climate Change, along with the 2017 Federal/Provincial/Territorial Build Smart Strategy, references a target of "net-zero energy ready" for new construction. B.C. is the first jurisdiction in Canada to provide a technical roadmap to "net-zero energy ready" via the BC Energy Step Code. It achieves this by applying a "building envelope first" philosophy.

B. HOW IT WORKS

The BC Step Code currently has five "steps" of requirements for Part 9 residential buildings in three groupings covering all Climate Zones. Each step requires achieving targets for three distinctive performance metrics:

1. Net energy or peak power losses of the building envelope, normalized for gross floor area, as evidenced through energy modelling;
2. Energy use intensity of the space heating, water heating and ventilation systems, or a percentage better than a reference building, as evidenced through energy modelling using standard operating conditions in reference documents; and,
3. Whole-building airtightness, as evidenced by physical testing prior to occupancy and used as input to final energy model.

Similar metrics are in place for large and complex (Part 3) buildings in Climate Zone 4 only (i.e., southwest

B.C. and southern Vancouver Island) for three occupancy groups:

- C – residential occupancies;
- D – business and personal services occupancies; and
- E – mercantile occupancies.

The three Part 3 performance metrics differ slightly from those of Part 9 buildings:

1. Net energy losses of the building envelope, normalized for gross floor area, as evidenced through energy modelling;
2. Energy use intensity of all energy demand, as evidenced through energy modelling, using standard operating conditions in the National Energy Code for Buildings (NECB) reference; and,
3. Whole-building airtightness with no targets, as evidenced by physical testing prior to occupancy and used as input to final energy model.

Over time, the BC Energy Step Code is expected to expand to apply to most building types, occupancy groups and Climate Zones.

The BC Energy Step Code is the first code in Canada to apply a "building envelope first" philosophy, aligned with the "Passive House" leadership standard and going beyond R-2000 and ENERGY STAR® with maximum air leakage rates of a pressurized/depressurized building at 50Pa. The BC Energy Step Code specifies a maximum thermal energy demand intensity (TEDI) or peak thermal load for all Part 9 housing, and TEDI for Part 3 buildings. This prevents whole-building energy designs that trade-off suboptimal building envelope performance with high-efficiency mechanical and electrical systems. Furthermore, the BC Energy Step Code specifies a maximum air leakage rate for Part 9 buildings (for steps 2-5) to prevent trading air barrier detailing for higher efficiency thermal components. For Part 3 buildings, air barrier trade-offs can be made within the limit dictated by the TEDI, albeit as reflected in the energy model. All of these elements are best implemented at the time of design and construction, not via retrofit.

Why "building envelope first?" The reason is simple: to optimize overall building durability; comfort; indoor environmental quality (IEQ); climate change resilience; and cost efficiency for the longest service life system of a building, often exceeding 100 years. Durability is enabled through minimizing uncontrolled moisture transport and the thermal bridges associated with condensation and mold. Comfort is enhanced by having fewer cold and hot spots and improved acoustics (reduced noise transmission) between units and the exterior. IEQ is enhanced through reduced mould, and by encouraging continuous fresh ventilation air without a space conditioning penalty (due to disallowance of passive ventilation systems and a market trend toward heat recovery ventilators). Resilience is not guaranteed under the BC Energy Step Code, but building performance should be improved with airtight envelopes and high thermal performance components that reduce vulnerability to the extreme heat, wind and rain events anticipated by the mid-21st century in B.C.

C. LOCAL GOVERNMENTS AND THE BC ENERGY STEP CODE

Local governments are showing keen interest in referencing the BC Energy Step Code and are using a variety of tools to do so. Some of this interest comes as a result of replacing local green building requirements prior to December 2017. Some examples include:

- **Construction Regulation Bylaw and Step Code Rezoning Policy for Part 3 Buildings:** City of North Vancouver's approach targets buildings city-wide at lower levels of the BC Energy Step Code. By July 1, 2018, small Part 9 residential buildings (1,200 sq. ft. and under) will have to meet step 1, while larger Part 9 buildings will have to meet step 3. Similarly, Part 3 residential buildings will have to meet step 2, and Part 3 commercial buildings will have to meet step 1. However, under the City's rezoning policy, effective January 1, 2018, at rezoning, Part 3 residential buildings must meet step 3, while Part 3 commercial buildings must meet step 2.
- **Planning and Building Application Fee Rebates Policy:** Comox Valley Regional District adopted a fee-rebate policy as an incentive to build to the BC Energy Step Code. For eligible projects, the two types of rebates increase with higher steps, up to 100 per cent.
- **Incentive:** The District of Saanich and City of Victoria have proposed a rebate for two blower door tests during construction – the first mid-construction when remedial improvements can be made to the air barrier system, and the second post-construction per the BC Energy Step Code requirement, along with the submission of a report to inform development of capacity building measures.

Recognizing that industry needs time to prepare for new requirements, local governments are asked to notify the Energy Step Code Council at two key points in the implementation process: when they start to consult on the BC Energy Step Code (initial notice); and when they have a bylaw, policy or program in place (final notice). To date, 19 local governments have provided their initial notice, and three have submitted their final notice. Collectively, these communities are in Climate Zones 4, 5 and 6.

D. BENEFITS AND COSTS

A significant effort has been made to justify the costs of the BC Energy Step Code on the basis of energy-saving benefits. This is important for energy efficiency regulations across North America, and for the development of energy utilities' "demand-side management" programs such as BC Hydro's Power Smart and FortisBC's Energy Efficiency and Conservation initiatives. To date, one study has been released publicly – BC Housing's *2017 Energy Step Code Metrics Research Report* (Metrics Report) – which reviewed optimized designs, costs and benefits for 10 building archetypes:

1. 10-unit multi-unit residential building (MURB) (Part 9)
2. 6-unit row house
3. Quadplex
4. Large single-family dwelling (511 m²)
5. Medium SFD (237 m²)
6. Small SFD (102 m²)
7. Low-rise (6-storey) MURB – concrete and wood (Part 3)
8. High-rise MURB
9. Office
10. Retail (big box)

Three separate design solutions were optimized to meet three objectives:

- Minimize incremental capital costs (from the developer perspective);
- Maximize the 20-year economic outcome for the owner and occupants (total energy savings over and above capital costs);
- Minimize the carbon abatement costs.

Tables 2 and 3 illustrate the results of the Metrics Report for two of the 10 archetypes, designed to meet the mid-level step 3.

Some general observations:

- Building envelope innovations include:
  - Very airtight buildings ranging from 0.6 ach@50Pa and 0.1 L/(s m²) to 1.5 ach@50Pa and 0.25 L/(s m²);
  - Emphasis on "effective" envelope thermal performance based on the NECB. Note: ASHRAE 90.1 is not used at all for the BC Energy Step Code and thus, nominal insulation R-values are not a valid basis for code compliance.
  - Limited focus on thermal bridging calculations or guidelines. The BC Energy Step Code currently references NECB-2011 procedures, but may

TABLE 2 – BUILDING TYPE #1 – 10-UNIT MURB (PART 9), STEP 3

Measures to achieve Step 3, CZ4		
Item	Least Capital Cost	Highest Net Present Value
Wall Insulation	R-16	R-18
Attic Insulation	R-40	R-40
Slab Insulation	R-20	R-20
Foundation Wall Insulation	R-16.9	R-25
Exposed Floor Insulation	R-27	R-27
Windows/Doors	USI-1.8	USI-1.8
DHW	Electric Storage	Natural gas, combined space and water heating
Heating	Electric Baseboard	
HRV/ERV	60% heat recovery ϵ	60% heat recovery ϵ
Air Tightness	1.5	0.6
Cost/ft² (per unit cost)	$227/ft² ($402,000)	$228/ft² ($404,400)
% premium (per unit premium)	0.3% ($1,100)	0.9% ($3,500)
NPV per unit	$1,800	$11,600
Energy Reduction	24%	28%
GHG Reduction	82%	-57%

in the future reference NECB-2017 that has revised procedures for considering thermal bridging of building envelope assemblies.

- Better than current practice slab and foundation wall insulation.

- In one case, better than current practice windows, albeit windows become the critical design element of higher steps, as illustrated in the Metrics Report.

- For one building type, better attic insulation, albeit improved insulation is also prevalent in higher steps.

- The incremental capital cost above common construction practices is less than one per cent, not including land costs. Also, the differences between "bookends" are very small relative to the overall cost of construction.

- Under one archetype (office), the cost of BC Energy Step Code compliance is lower than common practice, over and above increased costs of energy modelling and airtightness testing. In other words, the flexibility provided by the BC Energy Step Code facilitates innovation in design and reduced costs, as compared to prescriptive standards.

- The "Best Net Present Value" provides the greatest overall benefits to society, considering both incremental capital costs above an NECB/NBC s 9.36 code-minimum design and maximizing energy savings over 20 years.

- The energy savings are substantial, ranging from 24 to 34 per cent with mid-steps.

- The greenhouse gas reductions are even more substantial, ranging from 31 to 82 per cent, with one exception that has a GHG increase of 57 per cent. However, this includes assumptions about the space and water heating fuel of the reference (code minimum) building and some fuel switching that is by no means mandated by the BC Energy Step Code. Other options could be considered to avoid increases in GHGs such as a contract to purchase zero-carbon renewable natural gas derived from landfills and agriculture operations.

BCBEC members will be on the front lines of considering various design solutions, costs and benefits. The science and economics of BC Energy Step Code design will undoubtedly evolve as more building types and constructions are evaluated.

TABLE 3 – BUILDING TYPE #7 – 6-STOREY MURB (WOOD, PART 3), STEP 3

Measures to achieve Step 3, CZ4		
Item	Least Capital Cost	Best Net Present Value
Wall Insulation	R-20	R-20
Roof Insulation	R-20	R-20
Windows/Doors	USI-2.5	USI-2.5
Window-to-Wall Ratio	40%	40%
Air Leakage Rate	0.1 L/(s·m²) at 75 Pa	0.1 L/(s·m²) at 75 Pa
Ventilation Rates	= ASHRAE 62-2001	= ASHRAE 62-2001
DHW	20% savings	40% savings
Heating	Electric Baseboard in-unit, Standard NG for common areas	Electric Baseboard in-unit, Condensing NG for common areas
Heat Recovery	60% heat recovery ϵ	60% heat recovery ϵ
Cost/ft² (total cost)	$226/ft² ($43.9M)	$227/ft² ($43.9M)
% premium (cost premium)	0.6% ($258,000)	0.7% ($324,000)
NPV	$2.9/ft² ($569,000)	$3.1/ft² ($602,000)
Energy Reduction	26%	33%
GHG Reduction	31%	50%

E. THE FUTURE

In alignment with other codes and standards, the BC Energy Step Code is subject to periodic BCBC reviews and amendments. The primary mechanism for proposed amendments is via the Energy Step Code Council and its subcommittees. For example, the Council's Technical Subcommittee is currently considering eight tasks for BC Energy Step Code evolution:

1. Broadening the applicability of the BC Energy Step Code to all Climate Zones in B.C. for Part 9 non-residential occupancies and Part 3 commercial buildings.
2. Broadening the applicability to other building occupancies such as public sector buildings.
3. BC Energy Step Code considerations for small houses and cold climates.
4. Revised energy modelling guidelines.
5. Guidelines for Part 9 HVAC systems.
6. EnerGuide Rating System guidelines and Quality Assurance for Energy Advisors.
7. Part 9 compliance checklists (new pre-construction and as-built forms).
8. Part 3 Building Energy Requirements Tool (compliance checklist).

In the future, the national code development system is expected to "catch up" with the B.C. momentum, and the respective efforts surrounding the BC Energy Step Code and Codes Canada will converge. Canada's Build Smart Strategy commits to providing targets for "net-zero energy ready" construction, starting with publishing the first tier of more stringent model codes for buildings and homes in 2020, followed by publishing additional tiers of increasing stringency, with the aim of establishing net-zero energy ready codes in 2022. The BC Energy Step Code reinforces the national commitment by providing a practical roadmap well into the future. Furthermore, it is the best mechanism for achieving consistency in technical standards for energy efficiency while enabling local governments to provide leadership on reducing consumers' energy bills and reducing greenhouse gas emissions at a pace that reflects their local conditions.

PEOPLE POWER:
Q&A With John Straube

By Matthew Bradford

Dr. John Straube will be the first to downplay his reputation as a renowned building science expert, but his credentials speak for themselves. Over the last 20 years, he has contributed to the design, construction and restoration of buildings across the globe; taught and mentored countless industry professionals; authored numerous papers and books; and provided research into moisture-related building problems that has been applied to projects the world over.

Straube currently serves as Principal at RDH Building Science Inc., an Associate Professor for the University of Waterloo's Department of Civil Engineering and School of Architecture; as well as a consultant and member of several industry groups. Suffice to say, he has many titles; and for this issue of *BCBEC Elements*, he joins us in an equally familiar role as industry interviewee…

BCBEC Elements: You've had the opportunity to watch the industry grow. How do you see it evolving?

John Straube: When you talk about the evolution of our industry, you're really talking about the extension of long-running trends. Right now, those include a trend towards focusing more on increased insulation performance, thermal bridging, and airtightness testing. These aren't new concepts, but they're becoming more prominent.

In terms of materials and systems, we're seeing a continued move to lighter weight assemblies for most buildings. That's because a lighter weight means fewer materials; and that means fewer resources, fewer costs, and the ability to build taller buildings – which is especially important in seismic areas.

Finally, I see a continued trend to lower labour requirements. Usually when I say this, people point out that it takes nearly double the man-hours to build a hospital today than it did 50 years ago. That's true, but our hospitals are five times more complicated and we're only using two times more man-hours.

BE: What are the industry's most persistent challenges?

JS: We're still very reliant on standardized tests to provide reassurance that a certain assembly or building technique will meet the requirements of our building, but the reality is standardized tests are often ill-suited to tell you that. They can provide a comparison of two different assemblies, but that doesn't necessarily mean they can help predict how a specific assembly will work in a specific building application.

I see that issue more in the Pacific Northwest where people do a lot more site and product testing than elsewhere. Believe me, that's not a bad thing because it comes from a place of wanting to better understand building processes and find more effective ways of predicting quality. However, there's a mindset that these tests can actually predict performance in the future, but because they are standardized, they don't take into account factors like workmanship or the way the building will age and move over time.

The other challenge is we still need to make buildings that are much better insulated and airtight without being much more expensive or susceptible to moisture problems. I easily see that being one of the biggest challenges over the next 20 years.

BE: Speaking of the Pacific Northwest, you recently conducted a High-R Walls Study with Walsh Construction. How did that turn out?

JS: That study was done to address the issue of how to insulate wood frame walls to a higher level and not create moisture risks. We compared a range of different wall assemblies that might be used in the Pacific Northwest that had higher R-values and then we assessed the relative risk of different solutions.

The outcomes weren't surprising: if you put a lot of insulation outside of your moisture-sensitive wood framing components, your moisture risk becomes a lot less; whereas if you put a lot of insulation inside of your moisture-sensitive building components – like OSB sheeting or plywood – your risk is higher. That said, we can make either approach work.

Ultimately, we had a pretty good idea of what the answers would be in this study, but we wanted to demonstrate those answers with a tightly controlled test so people would believe us. There were no big surprises, but we developed a useful piece of data to inform and provide comfort to building designers and policy makers.

BE: With a move to higher performance in codes and standards, what should the industry keep in mind in order to avoid issues down the road?

JS: Don't get caught up in the pressure to innovate and evolve at the speed of other industries. The building science industry is routinely criticized for being conservative and slow to change, but I would argue that we're actually wisely conservative and slow to change because we're making buildings that are supposed to last for 50 – or even 100 – years, not shoes or computers that wind up clogging landfills in 10 years. We can't make rapid changes because we don't have tests or methodologies that can reliably predict the future performance of materials and systems with which we have little or no experience working with. Therefore, it would be irresponsible to widely deploy or specify materials that have one or two years of real experience, regardless of how much testing has been done.

"I WOULD HAVE TO SAY THAT GETTING TO KNOW DR. STRAUBE IS A LIFE-CHANGING EXPERIENCE. ASIDE FROM HIS ENCYCLOPEDIC KNOWLEDGE, WEALTH OF PRACTICAL EXPERIENCE AND ENGAGING PERSONALITY, HE IS A GREAT MENTOR AND TEACHER. WHEN YOU THINK YOU'VE FINALLY FIGURED OUT YOUR LATEST BUILDING SCIENCE DILEMMA, ALONG COMES JOHN. IN HIS OWN SPECIAL WAY – A FEW POINTED QUESTIONS, SOME DEBATE AND THEN DIRECTION TO FURTHER STUDY OR ANOTHER RESEARCH REPORT – JOHN ONCE AGAIN BRINGS ENLIGHTENMENT AND A BETTER UNDERSTANDING OF BUILDING PHYSICS. THIS FAMILIAR AND ENDEARING SCENARIO TO MANY IS SLOWLY BUT SURELY CHANGING THE WAY OUR INDUSTRY DESIGNS AND BUILDS MODERN BUILDINGS. JOHN IS A GREAT FRIEND, A DISTINGUISHED EDUCATOR, AND UNDOUBTEDLY ONE OF THE LEADING BUILDING SCIENCE EXPERTS OF OUR DAY."

– MARK GAUVIN, FORMER PRESIDENT, GAUVIN CONSTRUCTION LTD.

BE: What do you think of the new energy step codes?

JS: I think they're great. Historically, the code has defined the worst possible building you can make without going to jail. Over time, though, the industry has grown to expect more from itself. That's led to programs like LEED, which has shown an entire generation of building owners and designers that it's OK and worthwhile to want something that's more than code.

I think the step codes are taking that concept further by giving us another threshold of achievement. They're for owners who want to – and can afford to – rise above and beyond the bare minimum and achieve a more impactful outcome.

BE: Let's turn to you. Out of all the projects you've worked on, what's been the most exciting?

JS: That's a difficult question because usually when people like me get together with colleagues and tell stories, we focus on the famous buildings or the multimillion dollar failures because those are more exciting. So while I can tell you working on the Denver Art Museum was exciting, what's more compelling or interesting to me were the jobs that don't necessarily make for fun stories or media headlines.

For example, some partners and I designed an apartment building in downtown Waterloo that uses half as much energy as an apartment building in southern Ontario and we were recognized by the city as being an exemplary example of fitting into the neighbourhood. Was that written up in an architectural magazine? Do I share that story at conferences? Of course not, that's boring; but it's projects like that which often have the most meaning to me because they make the bigger, lasting impact.

BE: What would you consider your proudest industry accomplishment?

JS: Honestly, knowing there are graduates who started their journey into building science with me as a mentor, lecturer or professor and who are now in the industry doing good work. Personally working on many projects over the years is great, but helping get people to point where they can make a positive difference on 10,000-plus projects is really what makes me proud.

BE: What's your advice to those entering the industry?

JS: For starters, trying to predict where you're going to be in 30 years is a mug's game. I started in this industry to make energy-efficient houses, but then I graduated when oil was $10 a barrel and wound up working on moisture problems caused by the first generation of energy-efficient houses from the 1970s.

What I'm saying is, don't worry about picking a path. Instead, focus on the fundamentals. Seek to genuinely learn your trade and understand, for example, the underlying reasons for heat, air, moisture, fire or noise.

Also pay close attention to the buildings of the world. All of them. The ones built in Mesopotamia thousands of years ago and the sleek new high-rises in New York City. Learn what's worked, what hasn't, or why one failed while another one thrived. That's how you start towards exceptional design.

BE: You've spent a lot of time with BCBEC. What do you consider its most valuable activities?

JS: All of them, really. BCBEC has done a great job at serving as the coordinated nexus of building science and the building industry for people who want to connect with peers, share ideas and spread awareness for the issues of the day. It's through BCBEC's monthly seminars, annual conferences, and industry events where like-minded people in the industry can learn more about their field and spread the word, which is what matters most.

THIS IS A TEST

Lessons from code-required whole building air leakage testing

By Jeff Speert, AIA, LEED®AP, JRS Engineering

As British Columbia embarks on code-required whole building air leakage testing (WBALT), there are lessons to be learned from our neighbours to the south in Washington State – one of the first North American jurisdictions to require such testing. Now in their third code cycle, the Washington State and Seattle energy codes require WBALT on a considerable number of large commercial, institutional and residential buildings. This article gives guidance on WBALT and touches on design and construction issues.

WHAT IS WHOLE BUILDING AIR LEAKAGE TESTING?

WBALT is a procedure that quantifiably demonstrates the performance of a building's air barrier system. This testing commonly uses a fan (or series of special calibrated fans) to induce a pressure difference between the interior and exterior of a completed air barrier. To isolate the air barrier components, intentional openings in the tested area (such as doors, windows and mechanical ventilation openings) need to be temporarily closed or sealed. In addition, all interior doors are typically opened, creating a continuous volume of air so the tested area can be treated as one zone. The air flow required to maintain the specified pressure difference equates to the air leakage rate through unintentional openings or breaches in the air barrier. Care needs to be taken to create an induced pressure within the structure that is relatively consistent – typically no greater than +/- 10 per cent in any one given spot.

These tested leakage rates can be compared to other buildings, to quantify the relative success of an air barrier system's design and implementation. Because there are several test standards, including ASTM E-779 and U.S. Army Corps of Engineers (USACE), requirements for preparing and testing a building tend to vary and as a result, leakage results also vary.

HOW ARE LEAKAGE RATES EXPRESSED AND WHAT IS THE DIFFERENCE?

Two metrics for reporting air leakage results are commonly adopted throughout the industry. The air flow required to induce pressure differences may be described in terms of volume (air changes per hour) or surface area (square foot of enclosure area), and leakage rates are reported at specific pressure differentials – typically 50 or 75 Pascals. Leakage rates for single-family homes and smaller spaces have been historically expressed at air changes per hour at 50 Pascals (ACH50). USACE testing and larger buildings generally tend to use cubic feet per square foot at 75 Pascals (CFM/SF@75). Other units of expressing air leakage exist, such as equivalent leakage area, but are less commonly used.

Because the ratio of volume to surface area changes based on a building's size and configuration, there is no simple conversion between these two metrics. CFM/SF is more easily compared between a range of buildings, because it is framed to

TEMPORARY RANGE HOOD SEALING

the air barrier's location. ACH target values become easier to achieve as buildings get larger and more compact.

WHAT NEEDS TO HAPPEN BEFORE THE TEST?

For successful results, the team must be prepared to handle testing logistics. Assistance from general contractors and subcontractors is also required, for completing all air barrier components and providing temporary sealing at agreed-upon locations.

The testing team needs to calculate or verify the areas and volumes to be tested. Because air flow rates are divided by these quantities, these numbers are very important in determining leakage rates. These numbers are also used to calculate how much fan capacity is needed to achieve the required pressure. Each building needs to be analyzed for efficient placement of fans, and for which doors need to be opened or closed during the test. Also, there may be some spaces that cannot be linked into the building's single testing zone. A strategy for handling this must be determined, and often means using additional fans so these spaces can be tested at the same time as the larger volume.

For the general contractor, it is critical to have all air barrier components or a suitable temporary mock-up in place at the time of testing. Depending on testing protocol, some other elements may need to be temporarily sealed. This could include exhaust fans, range hoods, and fresh air supply.

As mentioned earlier, interior doors need to be held open and all exterior doors and windows closed. Plumbing drains should also be charged with water so air does not make it past P-traps. Depending on the building configuration and height, it is common to need elevator doors open at various floors so the elevator shaft can be used for vertical passage of air. General contractors are well suited to complete these preparatory tasks, but testing agencies can also complete them.

WHAT SHOULD HAPPEN DURING THE TEST?

Before the actual test is attempted, pressure should be induced to make sure the building setup is correct, the target pressure differential can be achieved, and the pressure difference is equivalent throughout the building. The building needs to stay secured, with exterior doors

FOR THE GENERAL CONTRACTOR, IT IS CRITICAL TO HAVE ALL AIR BARRIER COMPONENTS OR A SUITABLE TEMPORARY MOCK-UP IN PLACE AT THE TIME OF TESTING. DEPENDING ON TESTING PROTOCOL, SOME OTHER ELEMENTS MAY NEED TO BE TEMPORARILY SEALED. THIS COULD INCLUDE EXHAUST FANS, RANGE HOODS, AND FRESH AIR SUPPLY.

FANS SET UP WITH OPERATOR OUTSIDE OF THE BUILDING

and windows closed during the test. Although workers and inhabitants can be in the building during testing, problems can be avoided if it is completed during evenings or weekends when there is less activity on site.

For larger buildings, the test should be conducted at a range of pressures and data recorded. Various test protocols have different requirements for the quantity of data points, the range of pressures that should be achieved, and whether the test is conducted by pressurizing, depressurizing, or both. Experienced testers have generally found that leakage rates are marginally lower when a depressurization test is conducted, because depressurized buildings tend to pull gravity dampers shut. This results in a tighter enclosure whereas pressurized buildings tend to push these dampers open, resulting in more leakage through intentional openings.

WHAT THINGS MAKE A TEST MORE CHALLENGING?

Challenges encountered during a test generally fall into two categories. The first relates to testing equipment and building setup. Other issues relate to building configuration and preparation.

Because large building tests require multiple fans working together, setting up equipment in an organized fashion is critical. Software is available to control all equipment simultaneously, but bugs and quirks sometimes need to be negotiated.

Because most fans have a large power draw that will trip ground fault outlets and electrical breakers, it is important to plug fans into outlets that will have uninterrupted power. In residential buildings this can be done at locations for dedicated high-power appliances (clothes dryers, dishwashers, microwaves). In commercial buildings it is typically easier to find power sources, but because each fan should be on a different circuit it is sometimes difficult to find multiple circuits near the intended door. Fan equipment can be placed in a variety of standard-size door openings but if openings are larger or smaller than standard, a custom-built door block-out may be necessary.

In buildings with many smaller internal spaces, such as stratas, it is more difficult to achieve balanced air pressures than for buildings with open interior spaces such as museums, offices and schools. This sometimes requires fan placement strategies, or extra measures for opening elements in the building. As discussed earlier, temporary sealing and closing of operable elements is critical. Sometimes doors or roof hatches that look to be closed are not latched, and are pulled or pushed open by the induced air pressure. Self-adhered plastic sheeting is commonly used to temporarily seal mechanical registers and grilles. This material sometimes gets forced off by the pressure or simply falls off.

WHAT ARE THE RESULTS AND WHY THE VARIATION?

For most newly constructed buildings where a continuous air barrier is designed and installed, JRS Engineering has generally seen projects achieving their leakage rate goals. In Washington State, these have generally been 0.40 CFM/SF@75 and changed to 0.30 CFM/SF@75 in Seattle for the 2015 Code. Many factors influence the tested leakage rate. Small influencers

AUTHOR WITH EQUIPMENT AT LARGE OFFICE BUILDING TEST

EXTERIOR SEALED LOUVERS

generally include small holes in a limited number of locations. Large influencers are listed below. These are generally larger holes or systemic smaller holes.

Large Influencers:

- **Roof assemblies:** Vented roof assemblies are much harder to construct airtight, as opposed to non-vented assemblies.

- **Air barrier components on walls:** Nearly all projects JRS Engineering has tested have used the weather-resistive barrier membrane as the air barrier. Mechanically attached sheets allow for more leakage than fully adhered or liquid products. Sealed sheathing is also a good option for improved airtightness.

- **Quantity of wall penetrations for mechanical exhaust and supply:** The more these penetrations occur, the leakier the test results. This is due in part to small inconsistencies adding up, but is also linked to the next item in this list.

- **Method and approach to temporary sealing:** It seems to make a difference if range exhaust or other appliances are sealed at the range fan or at the exterior louver. When sealed at the interior, the duct and all its joints become part of the tested area. Often, this does not get sealed as tight as the rest of the air barrier.

- **Incomplete air barrier components not temporarily mocked up to finished condition:** This can include missing glass and sealant joints, among others.

- **Elevators within the enclosure on some levels, but open directly to the exterior at one or more levels:** Elevator doors do not seal in an airtight manner, so vestibules are important.

In testing building additions, sealing across the joint between existing structures and additions has been very problematic. Although this joint has little impact on an operating building's energy performance, this issue could be considered during design and construction so that valid leakage results are provided.

WBALT can be complicated and problems that crop up during testing can be challenging, so it is important to have appropriately trained staff, use calibrated equipment, and use an experienced tester that can help coordinate the mechanics of testing and also help contractors and owners through the process so goals are achieved.

CCBST ROUND-UP

15th Canadian Conference on Building Science and Technology unites industry leaders

BCBEC hosted the 15th Canadian Conference on Building Science and Technology, which took place on November 6-8, 2017. The event was well attended and brought together national and international leaders in building science research, design and construction.

2017 CCBST PLANNING COMMITTEE.

CCBST PROVIDED PLENTY OF OPPORTUNITIES TO NETWORK AND LEARN ABOUT BUILDING ENVELOPE PRODUCTS, TECHNOLOGY AND RESEARCH.

SPONSORSHIP BOOTHS WERE SET UP AT CCBST TO PROVIDE AN OPPORTUNITY FOR SPONSORS TO INTERACT WITH ATTENDEES AND DISCUSS THE LATEST IN BUILDING ENVELOPE PRODUCTS AND SERVICES.







MORE THAN 80 PRESENTATIONS WERE DELIVERED OVER THREE DAYS AT CCBST, PROVIDING AN EXCELLENT FORUM TO LEARN ABOUT AND DISCUSS VARIOUS BUILDING ENVELOPE TOPICS.


EVENTS

UPCOMING VANCOUVER LUNCHEONS:

Thursday, June 21, 2018

COMBUSTIBLE WINDOWS AND COMBUSTIBLE FAÇADE COMPONENTS IN NON-COMBUSTIBLE CONSTRUCTION – TESTING, RESEARCH, AND EXPANDING METHODS FOR COMPLIANCE

11 a.m. to 2 p.m., Italian Cultural Centre, 3075 Slocan Street, Vancouver, BC

Presenters: David Steer, M.Eng, P.Eng, CP, Principal, LMDG Building Code Consultants; and Michael Bousfield, Technical Director of Cascadia Windows & Doors

Thursday, September 20, 2018

12 p.m. to 2 p.m., Italian Cultural Centre, 3075 Slocan Street, Vancouver, BC

2018 BCBEC FULL DAY CONFERENCE & AGM:

Friday, October 26, 2018

JW Marriott Parq Hotel
39 Smithe Street
Vancouver, BC

BCBEC FOUNDATION AWARDS PROFILE:

Colin Coulter

By Matthew Bradford

The BCBEC Education Foundation provides financial assistance to high-performing students of the building science industry. In 2016, Colin Coulter received $2,000 from the Foundation in support of his studies at the British Columbia Institute of Technology's (BCIT) Architectural and Building Engineering Technology program. Now, two years later, we've caught up with Coulter to find out where his talent has taken him.

BCBEC Elements: It's been a couple of years since you graduated from BCIT. Where are you now?

Colin Coulter: While I was completing the Architectural and Building Technology program, I was a practicum student with RDH Building Science Inc. in Vancouver. After completing the practicum and graduating from BCIT in 2016, I accepted a full-time position with RDH as a Building Science Technologist, which is what I'm doing today.

BE: What attracted you to the building science industry?

CC: I always had an interest in the aesthetic aspects of buildings and architecture, but combining this with a technical understanding of building performance was what drew me to building science. I believe that the better we are able to comprehend and analyze the ways in which buildings interact with the natural environment, the more equipped we will be to design buildings that are resilient, energy efficient, and comfortable for occupants.

BE: How has BCBEC supported your career?

CC: The support provided by the BCBEC Education Foundation Award definitely eased the financial burden during my time at BCIT. I was able to forego part-time employment, which allowed me to prioritize my education. BCBEC also provided financial support for our building science research projects at BCIT, which was a great incentive.

BE: Have you benefitted from any BCBEC events or activities?

CC: I had the opportunity to attend the BCBEC Annual General Meeting in 2015 as a student. That was a great chance to network with building science professionals and gain a better understanding of current industry trends. I also attended a half-day BCBEC seminar related to air and vapour barriers, which provided some practical context for many of the technical concepts that I had been studying at BCIT. As someone new to the industry, it was encouraging to see that the topics I was studying were directly relatable to actual building science research being conducted in the field.

BE: Similarly, what role do you see yourself playing to support the building science community down the road?

CC: One of the best aspects of working in building science is that there is a definite sense of the common good when it comes to improving building industry practices. Most people I have crossed paths with are very passionate about what they do and are more than happy to share their experiences.

In my current role, I've had the opportunity to provide mentorship to several students studying building science and engineering. In the future, I hope to become a greater advocate for energy efficient building enclosure design, and perhaps to teach future generations of building scientists!

BE: What advice would you offer other students looking to get into the industry?

CC: First, I would say that it's an exciting time to be entering the industry. With the emergence of the BC Energy Step Code, Passive House and new government incentives, there is a growing emphasis on high-performance building enclosure design. There is a multitude of resources available, including through BCBEC, which provide insight into current building best practices and emerging technologies. I would recommend that students practice communication and technical writing skills, which are equally important as understanding building science concepts. I'd also suggest exploring different areas of building science when you are first starting out.

CONVOY SUPPLY NAMES JAMIE MANTLE AS VICE PRESIDENT OF SALES

Surrey, B.C., January 15, 2018 – Convoy Supply, a North American leader in the distribution of construction materials, has announced the addition of Mr. Jamie Mantle to the new position of Vice President of Sales, adding to their team of well-known industry experts.


JAMIE MANTLE

Mr. Mantle will be responsible for the management of all sales and customer-facing activities for both the Canadian and U.S. territories for Convoy Supply.

"This restructuring will allow Convoy to build on the successful collaborative work achieved by our current team of General, Sales, and Operations Managers over the past several years," says Alma Garnett, President of Convoy Supply. "Already a friend and industry partner, I have great confidence that Jamie's leadership will add significant clout to Convoy's sales strategies and market presence as the company continues to expand its reach and its commitment to service excellence."

Mantle joins Convoy from Soprema, where he has spent the last 14 years as Vice President of Sales. He brings a wealth of knowledge and experience to this new role, having worked in both distribution and manufacturing within the building materials industry for the last 36 years.

ABOUT CONVOY SUPPLY

Convoy Supply is the largest wholesale distributor of building envelope materials in Canada, with a growing U.S. presence in Washington, Oregon, Montana and Maryland. Founded in 1972, Convoy Supply now operates in 44 locations. For more information on Convoy's products, services and history, visit www.convoy-supply.com.

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