Only what grows
again can become
something **truly big.**

The Natural Change In Urban Architecture.
INVENTED BY RHOMBERG

2010

IF WE CONTINUE IN THE WAY WE HAVE DONE UP TO NOW, BY THE YEAR...

2030

...WE WILL NEED THE RESOURCES OF TWO PLANETS.

A brief look into the future.

IRREFUTABLE BASIC PRINCIPLES

We have learned to move forward without the use of our muscles and to fly, we have found a wireless way of communicating with each other and are able to send our species to the moon. Even though the progress humankind has achieved has continuously proved a positive surprise, there are, nevertheless, some irrefutable basic principles that cannot be denied. For example, you cannot make two out of one.

Our planet has a lot to offer - but not infinitely so. The global population is growing at a rate of 78 million people a year – about the same number as the inhabitants in Germany. The consequences of the climate crisis that we are experiencing today are quite obvious, we are not using natural sources of energy sufficiently and are causing the irretrievable loss of all resources through our global exploitation. And at the same time we are producing so much waste and CO_2 that you would think we had a second planet at our disposal – one which we would in fact need by 2030 where resources are concerned if we are to maintain the existance of the human race.

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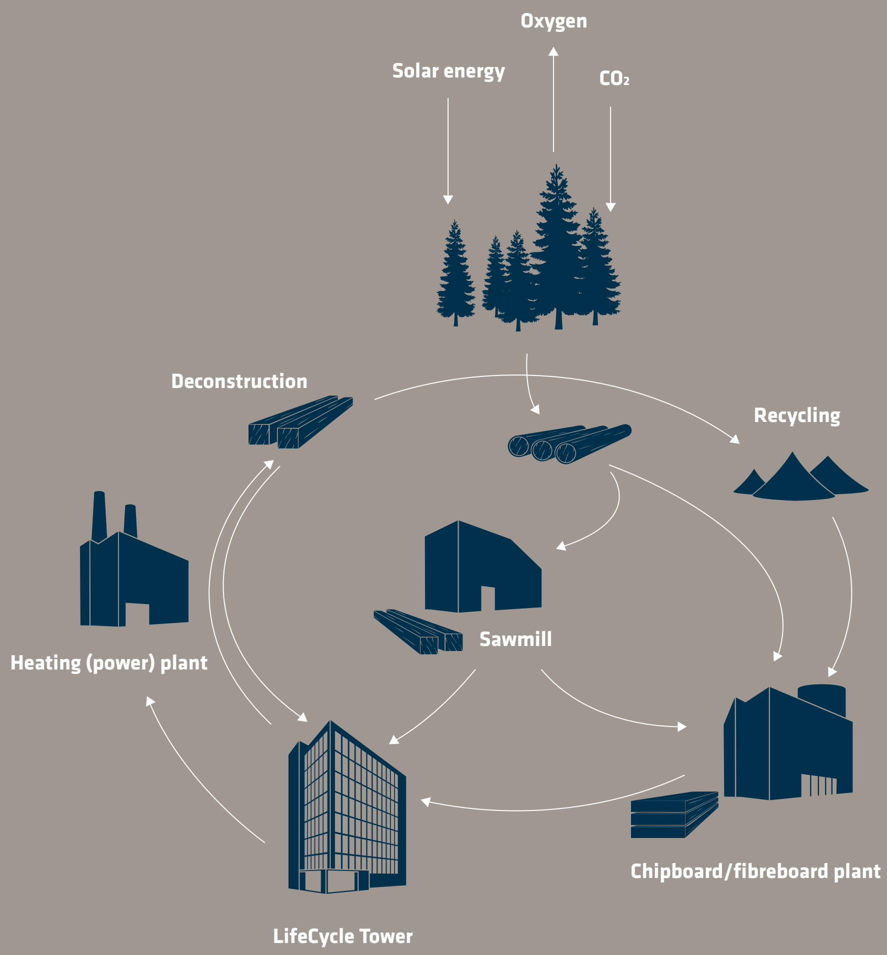
Why less will have to be more in future.

Building better naturally – with renewable raw materials. Every day sees many prestigious and architecturally sophisticated buildings being constructed all around the world. Urban development is based primarily on conventionally produced prototypes. However, the complex construction work this involves goes hand in hand with high building costs, long construction times and high planning risks. And this on top of the fact that the construction industry with its conventional construction methods today consumes **40 % of our energy and resources** as well as generating **40 % of our waste and CO_2 emissions.** The branch is also responsible for **60 % of the world's transport routes.**

Construction waste is valuable.

You do not have to go to great lengths to produce something that already exists: the term »urban mining« is becoming significantly more relevant in the field of sustainable building.

Recovering, recycling and reusing materials from construction waste – **urban mining** contributes significantly to lessening the impact on the environment and reducing dependency on rising raw material prices. You can build so much better with good ideas. For example, by using **natural, renewable raw materials.** Such as **wood.**



Wood is a natural raw material. It can be found in many parts of the world and has a positive impact on the world's carbon footprint. The wood used as building material in the LCT system can regrow in our world's forests. Normally even within a few hours, depending on the size of the project.

Cree. Creative Resource & Energy Efficiency.

If you want to take new paths, you have to rethink. As part of the renowned Rhomberg Group, Cree is the logical outcome of four generations of experience in construction. However, Cree is not simply a construction company but just as much a source of ideas and inspiration for new strategies involving the **sustainable handling of nature and its resources.** We bring wood as a building material into cities – and, with reduced life cycle costs, higher conservation of building value, best possible comfort and state-of-the-art safety requirements, we create a new basis for **modern, urban architecture.** Cree is certified in compliance with ISO 9001 (quality) und ISO 14001 (environment).

We also work a little differently. There are various options as to the extent that we become involved in a **LifeCylce Tower:** just in the planning phase, with consultation alone or for the complete project. A strong team of architects, engineers and planners then work hand in hand until a turnkey building is ready to be handed over – either by us as the general contractor or in cooperation with other project partners.

Like the Rhomberg Group, Cree is also based in Vorarlberg in Austria. Timber technology has a long tradition here – as does a large degree of inventiveness. This is reflected in a high concentration of timber construction. So it is really no surprise that the world's first LifeCycle Tower is being built here: **the LCT ONE**.

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Nature as a role model.

An innovative system can grow better than individual projects. The LCT system is: individual industrialisation.

This is based on a **sustainable wood-hybrid system for multi-storey buildings** that has been thought-out down to the last detail, one that can be designed individually and constructed in the shortest possible time, thus guaranteeing minimised use of resources and energy over the whole life cycle. **The LifeCycle Tower.**

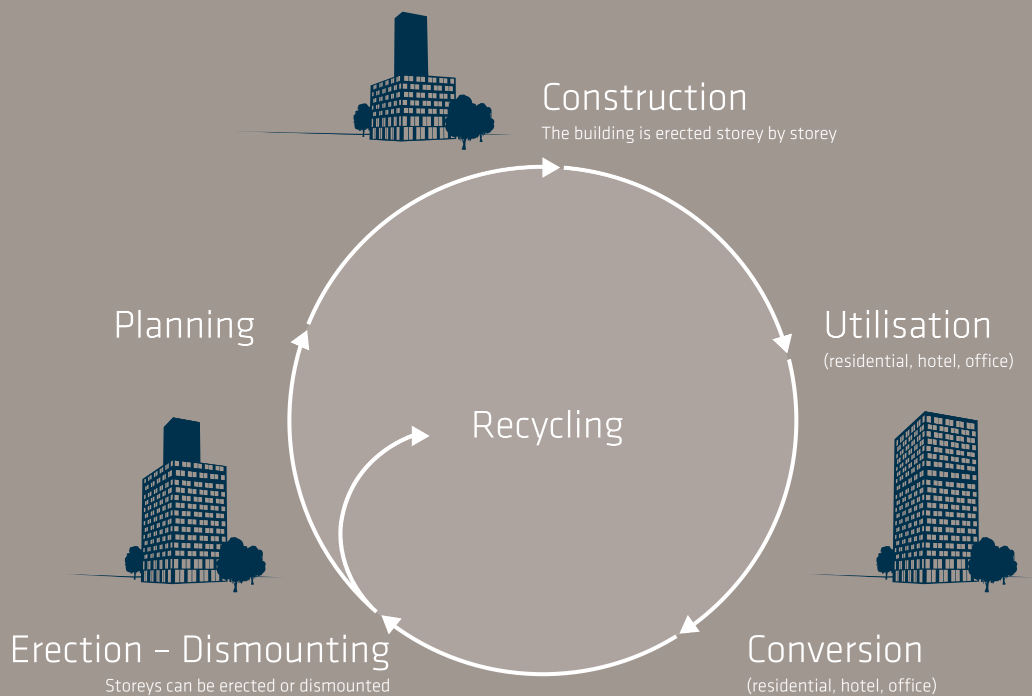
A LifeCycle Tower can be converted at any time in its life cycle, and its modular design makes its renovation a far lot easier.

In this respect we rely on **urban mining** in the LCT system, because we know the materials, know how many different types have been used in the building, and how they can be reused again.

The wood-hybrid high-rise.

The vision: a hybrid timber high-rise building up to 100 m high and with up to 30 storeys. The reality: the LifeCycle Tower from Cree. Up to 90 % improved carbon footprint. Drastically reduced use of resources. And an exceptionally pleasant indoor climate thanks to plenty of visible, exposed wood.

If you want to achieve more, you should do things **systematically.** That is why a LifeCycle Tower is pre-fabricated to plan. This brings a lot of benefits, such as shorter construction times and cost certainty. Lower noise and dust pollution during the construction phase and minimized sources of error in the execution of the construction work. But that does not mean that **building systematically** has to be boring: the facades of every LifeCycle Tower are conceived in such a way that they can be designed individually to suit many different requirements and wishes.



We build our future upon wood.

WITH WOOD, NATURE SUPPLIES US WITH THE BEST BUILDING MATERIAL, ONE THAT INCORPORATES ALL THE NECESSARY PROPERTIES DEMANDED BY INNOVATIVE URBAN ARCHITECTURE. AND THIS IS TRUE DESPITE SOME BIAS AGAINST WOOD AS A BUILDING MATERIAL.

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From bias to benefit.

Wood burns – that is true. But wood also burns »safely«, because unlike a conventional house made of reinforced concrete where the steel collapses in a fire at some point and the concrete crumbles, with wood you can predict exactly how long it will withstand the flames. As you can imagine, fire protection is a major issue for obtaining a building permit for multi-storey buildings. Even more so if the building is built for the most part from wood.

A number of large-scale **fire tests** have therefore been carried out for the floor slab elements of the LCT system. Based on the results of these tests the components have been continuously optimised, which has led not only to a reduction in the amount of concrete used, but finally also to the success of receiving the required REI 120 Certificate.

Another bias: wood is not durable. But wood is indeed extremely durable if used properly, and what is more it needs **no chemical protection when used indoors.** Thanks to its natural resilience, wood lasts for a very long time. And even if a timber house is demolished after several decades, it still produces no unusable waste, but instead reclaimed wood that can be reused into the resource cycle.

Wood is ideal for use in a systematic approach to construction and the pre-fabrication of building components. Its excellent structural properties also make it very interesting for building construction. That is why this stable material can be used for a wide range of building types – **from long-span frameworks to multi-storey buildings.**

Wood.
For a sense of well-being.

THE MORE TIME YOU SPEND IN NATURE, THE LONGER YOU WILL STAY HEALTHY.

But not everyone living in the large cities of this world is lucky enough to have a natural recreational area on his/her doorstep. All the more important it is to at least surround oneself with materials that are not harmful to our health – with wood for example.

Not only does wood provide an incomparable living and working environment, it can actually promote **health.** Studies have shown that solid Swiss stone pine and spruce wood, for example, can reduce the heart beat rate in physical and mental stress situations. The cardiovascular system is less burdened in a room with natural wood and the body's vegetative regeneration process is accelerated. You notice these benefits after a hard day's work and a healthy, refreshing night's sleep.

So wooden rooms promote a general feeling of **well-being** – and even help to lift the mood. Comparative tests have shown that people who spend a longer time in rooms made of wood are more open and communicative than others. Added to this are the pleasant aroma and classic appearance of wood. Could you surround yourself with anything better within your own four walls?

Wood is an excellent building material. Even better if used **systematically.**

Nature
with structure.

THE LIFECYCLE TOWER IN DETAIL.

The LCT system is a standardized system consisting of components that has already integrated the mechanical and electrical systems and can be used globally. The system components (slab, columns, façade) are prefabricated industrially and can be used as components to suit individual requirements. The use of serial »off-site production« enables economies of scale, consistently high building quality and speedy erection on site.

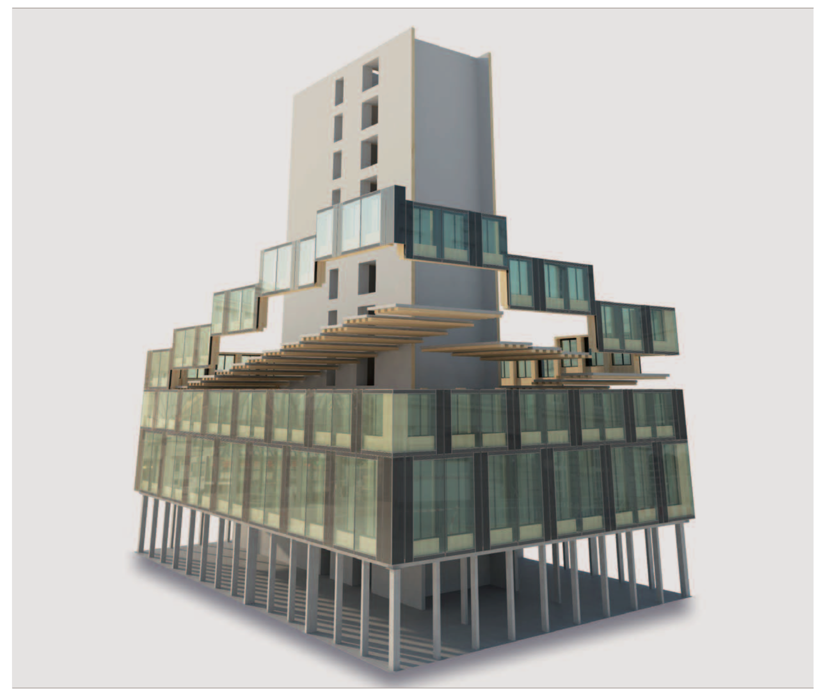
The fact that there are no load-bearing partition walls makes the system extremely flexible, allowing floor plans to be designed individually. It is possible to convert the building at any time throughout its complete life cycle. What is more, the **LCT system components** (slab, columns, façade) can be produced by many different companies, so they offer great opportunities for local craftsmen and the **local timber industry.** In addition, it allows architects to concentrate fully on the design aspect of the building, because **all the technical details have already been taken care of in every LifeCycle Tower.** The LCT system can be implemented for any number of different uses including residential, office, industry, training, science, culture, health, catering, accommodation, etc. The local building requirements of different countries have also been taken into consideration: in contrast to other timber construction projects, Cree takes a **»top-down«** approach, whereby all components are planned in such a way that they can be adapted to the requirements and regulations in the respective country in the case of international projects.

Modular construction.

Building with prefabricated components (modular construction), with meticulously designed standard solutions, also reduces the need for single solutions. All necessary detail solutions are structurally pre-defined, the individual components only have to be fitted together on site. Any subsequent work with no pre-fabricated elements, such as separate fire protection cladding for example, are kept to a minimum. This prevents complex details having to be realised on site, details whose correct execution are very difficult to control during construction on a normal building site.

Access.

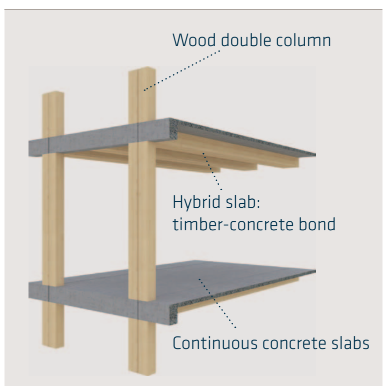
The different storeys and their technical services are accessed via one or several centralised or decentralised access cores. The cores serve as the stiffening elements of the building. Wood is also an option as a material for the access cores. However, the choice of wood or concrete depends on regional building regulations, as does the use of non-combustible building materials for high-rise buildings.



The load bearing system.

The gravity loads are transferred through double columns (hinged columns) directly into the hybrid slabs and out again into the double columns below. The pull out or lateral forces, between the hinged columns and the hybrid slabs, are prevented from separating through the use of simple mortise and tenon joints.

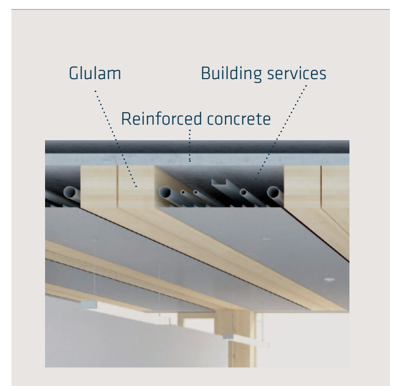
Wood frame walls are attached to the double columns to create one component that can be installed as a facade element. Building progresses much faster than is the case with conventional systems thanks to the **connection of the primary and secondary structures,** because this predominantly dry construction method means that drying out times are irrelevant during the whole construction time. Interior work can be started straight away because the façade is already weatherproof in the shell phase due to the assembly process. **Everything that starts quickly during shell work continues swiftly in the finishing phase.**



The hybrid slab system.

A wood-concrete composite rib construction was developed for the slab. This fulfils several functions:

Firstly it enables the **floor plan to be arranged freely** thanks to its long span (< 9.45 m) and secondly it guarantees the **separation of the storeys** in the building from each other that is required by fire protection regulations. The space between the beams is used for the **technical building services** that are installed flush with the slab. Frame acoustics are improved considerable by this rib structure. Because the **wood is to remain visible** and to be experienced tangibly, as it is in the façade supports, **no suspended ceilings** have been provided for. This reduces the floor-to-floor height to a minimum, which in turn has a positive impact on investment and maintenance costs. In addition, the extremely low dead load has an appreciably beneficial effect on the foundations of the building.



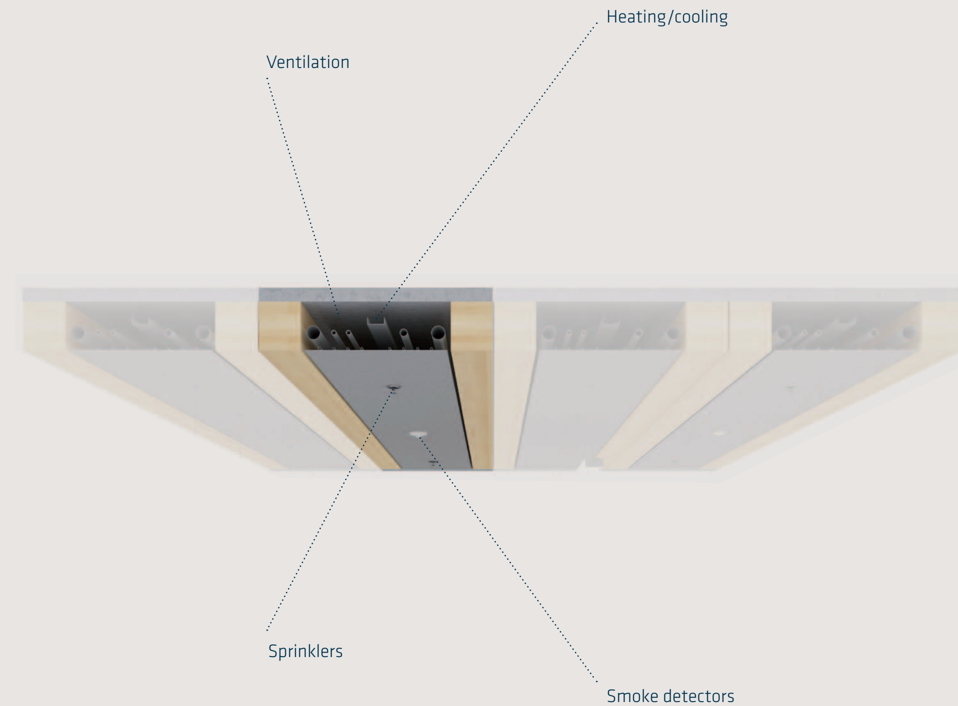
The building services.

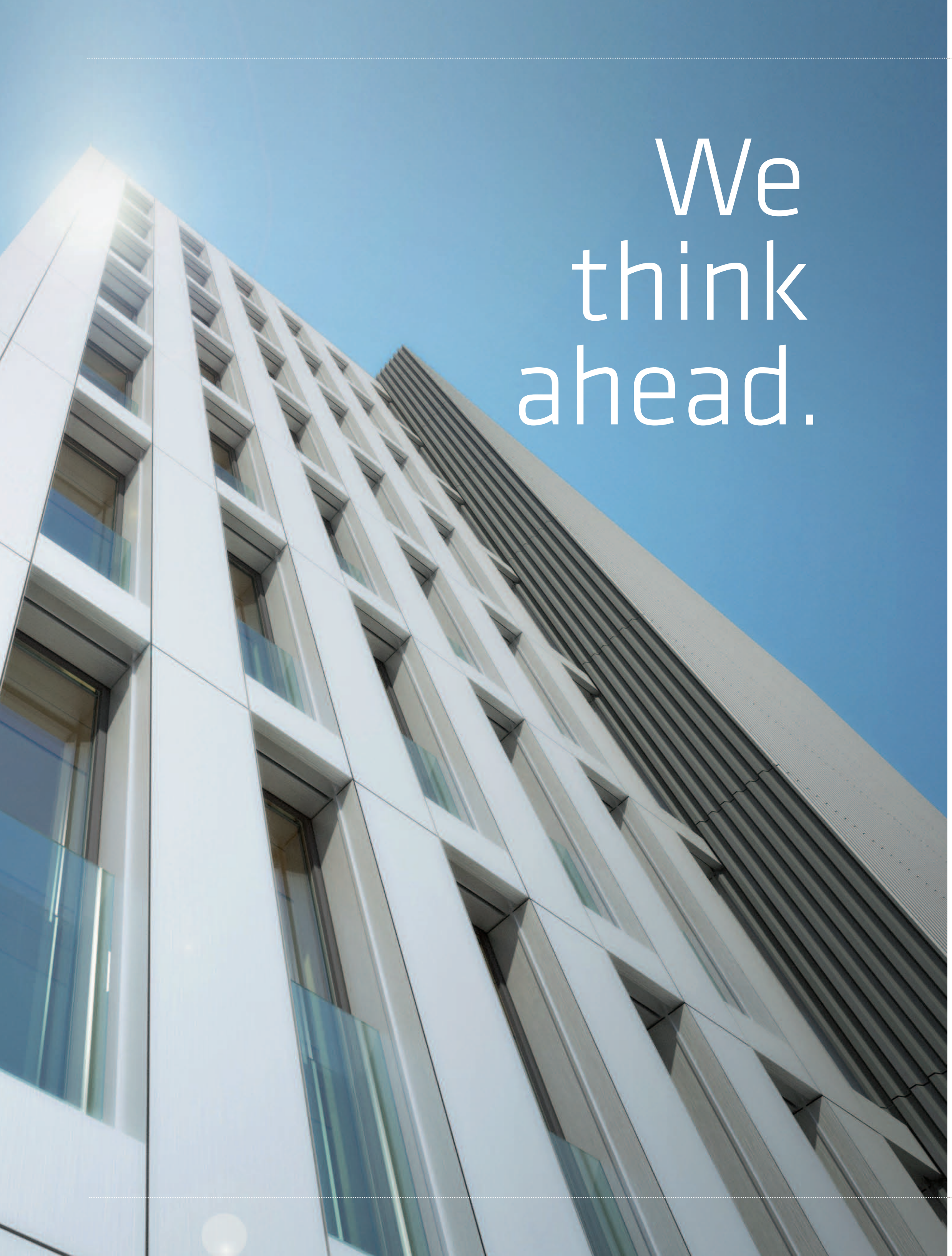
A clever, highly energy-efficient building services concept has been developed for the LifeCycle Tower: the following options are available

low-energy, passive house or plus-energy standard.

The qualities of the respective location are utilised optimally for the building. Priority is given to the use of **renewable energy sources in the energy planning of the building,** sources such as geothermal energy, for example, that can be used for both heating and cooling the building. The distribution and delivery system is adjusted to the respective system temperatures. Combined heating-cooling ceiling elements have been developed for space heating and cooling.

The **lighting, a comfort ventilation system** as well as **smoke detectors and sprinklers** are all integrated between the ceiling elements. Other possible elements focusing on the use of **regenerative energy** include solar thermal systems for hot water, regenerative fuel plants where high water temperatures are required and photovoltaic systems integrated in the facade. Despite sun protection measures, the demands on room temperatures in summer (comfort criteria and workplace guidelines) make the use of passive cooling ceilings to cool the building inevitable. However, the higher energy expense that this involves can be reduced by an **intelligent control concept** (exterior shading controls, automatic night cooling, occupancy sensors) and correct user behaviour.





The façade is configurable. Freely, however you wish.

Seen from the outside the LifeCycle Tower always looks differently – in many aspects its façade can be designed individually.

This is equally true for the interior: the LCT is designed in such a way that there are **no load-bearing walls** inside. Thus, there are no limits to the individual options for design and layout.

All proven materials can be used for the surface of the façade, whereby great importance is placed on the content of **recyclable material** when the selection is made. The possibility of disassembling the components into their individual constituent parts plays a major role in the production of the system façade, in order to ensure an **optimum cycle of materials.**

<<

The construction process.

IT IS NOT ONLY WOOD THAT GROWS QUICKLY

Centuries of experience in design and construction – plus experimenting with different approaches – have shown that building from the bottom upwards is advisable.

The layout of the ground floor and basement will be designed according to the specific properties of the site. In order to exclude any external impacts from humidity or fire on the timber framework of the **LCT system,** the lower stories are built out of conventional reinforced concrete. The **floor slab above the ground floor** is furnished with the **mounting points** of the LCT system for **vertical load-bearing elements** (façade with timber columns). The **access component** that includes the staircase, lift and the utility shaft has the **mounting points** of the LCT system for **horizontal load-bearing elements** (hybrid slabs). Façade and hybrid slab elements are laid in direct sequence and can be delivered and mounted individually or in series. **The percentage of completion can therefore be up to 100 %** - including the integrated sun shading devices.

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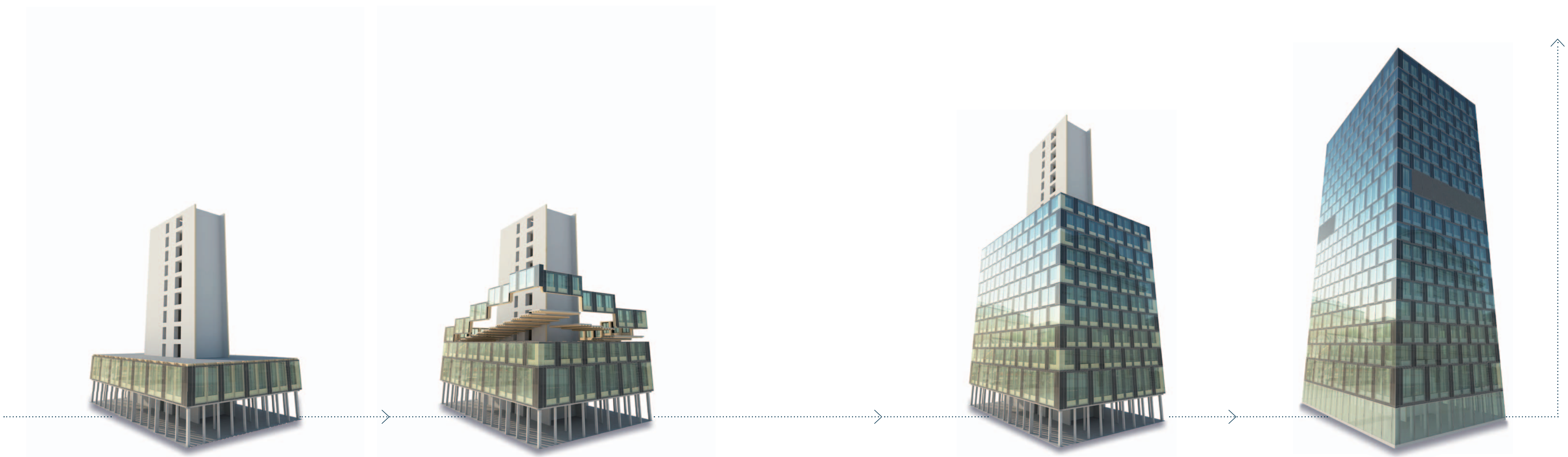

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At the end of each work phase, the facades made out of wood, a moisture-sensitive material, are weatherproof even while in the state of construction thanks to the hybrid slabs. **The building rises at amazing speed.** Due to the **dry construction method,** interior work can begin immediately after parts of the building have been erected. There is no need for drying out time usually required when concrete is poured on site.

This well-thought out building method developed for the structural and facade elements is replicated for the **building services: Ceiling panels are installed accurately onto the underside of the hybrid slabs.** These panels contain the heating, cooling, ventilation systems and improve room acoustics. Other building services such as fire alarms, motion detectors, occupancy sensors, power supply to the façade, fire extinguishing systems and lighting can all be added optionally. In other words, **virtually the complete building services can be integrated on the underside of the floor slabs.**

The modular principle of erection greatly reduces the construction time, **which in turn has a positive impact on emissions, costs and quality.**

Facts and figures of the LCT system.

Dimensions

- Height: up to 100 m (3-30 storeys)
- Grid options: 1.25 m, 1.35 m, 1.5 m
- Floor span: < 9.45 m
- 1 system for multiple uses such as residential, office, industry, training, science, culture, health, catering, accommodation, etc.

Materials

- Basements and ground floor: reinforced concrete
- Slabs from the first floor upwards: wood hybrid, exposed timber
- Façade columns: wood, exposed
- Sense of well-being thanks to natural surface materials

Building service

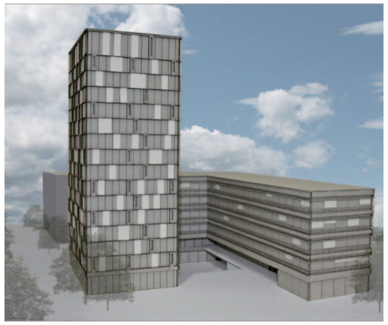
- Individual energy design
  (options: low-energy, passive house or plus-energy standard)
- Power generation via photovoltaic system
- Monitoring of operating costs
- Daylight-dependent artificial lighting control
- Comfort ventilation
- High degree of user comfort thanks to control level of building services

Façade

- Single or double façade
- Integrated shading devices
- Optional manual ventilation vents for natural ventilation
- Individually configurable façade architecture

Inherently adaptable.

The LCT system has its roots in nature – that is probably why a LifeCycle Tower blends organically and harmoniously into its environment in virtually any location. This has been put to the test impressively by the future potential of urban, sustainable architecture that has been designed on the basis of the LCT system by both well-known design studios and several universities.



The city has been waiting for it: **the LCT ONE.**

A vision became reality: The LCT ONE in Dornbirn/Vorarlberg. With eight stories, this flagship project has mainly been fitted out as an office building. But the LCT ONE is also an inspiration to see the bigger picture: as a **»LifeCycle Hub«** which is open for visitors as a showroom and/or museum for sustainable solutions. The LCT ONE is also being sponsored by The **Austrian Research Promotion Agency (FFG)** and the **Ministry for Transport, Innovation and Technology (bmvit)** within the scope of the **Building of Tomorrow+ program.** It is not without reason that the first LifeCycle Tower is called the number one. Because never before has a building of this type been erected. The LCT ONE in Dornbirn will be an international sensation. And will set new standards: in every respect.

<<

The LCT ONE

Project:	LCT ONE
Location:	Dornbirn/Austria
Client:	Cree GmbH
Start of construction:	September 2011
Completion date:	September 2012
Dimensions:	
Length:	approx. 24 m
Width:	approx. 13 m
Height:	approx. 27 m
No. of storeys:	8
Floor area:	approx. 2,500 m² (gross)
Cubic content:	approx. 7,500 m³ (gross)

LCT ONE **Facts**.

- **Dimensions:** 8 storeys, height 27 m, width 13 m, length 24 m
- **Floor space:** individually rentable areas 100 m² - 1,600 m²
- **Architecture:** designed by Hermann Kaufmann, facades constructed from recycled metal, visible wooden supporting structure, reception area
- **Energy standard:** passive house technology
- **Windows:** triple glazing
- **Operating costs:** optimised by automatic energy consumption monitoring
- **Room temperature:** heating/cooling panels integrated in the ceiling, window contacts to prevent loss of energy
- **Air quality:** comfort ventilation system with highly efficient heat recovery, automatic control via CO_2 measurement
- **Intelligent building service control:** shutters with automatically controlled motor drive, occupancy sensors and daylight-dependent lighting control
- **Equipment:** electronic access system, passenger lift, Cat.7 cabling, visualisation of individual energy consumption
- **Lighting:** basic lighting of common areas, individual office lighting
- **Floor construction:** noise-optimised access floor system
- **Floor plan:** individually configurable in dry construction or with system partition walls
- **High safety standards:** automatic fire extinguishing system and fire alarm system
- **Storage areas:** on every floor

above: façade element construction
below: timber module construction progress

The new bandwidth of nature. **The IZM.**

Greatness need not be expressed in height. Cree is erecting a 120-meter long LifeCycle tower with almost 10,000 m² of floor space for Illwerke AG, in Montafon/Austria: the IZM (Illwerke Center Montafon).

A close development partner of Cree won the architectural competition for the new Illwerke center at the end of the year 2010: the architectural firm Hermann Kaufmann ZT GmbH.

The first client order received by Cree is also a showpiece – a hydropower competence center with a staff restaurant and visitors' center is being erected in Vandans, Montafon for Illwerke. The IZM will not only be the **first green building of its size in Vorarlberg,** it will in fact also be **one of the biggest office buildings made of wood in the whole of Europe.**

And thus a **milestone for resource-efficient and sustainable construction.** The features that convinced the client were primarily the **technological, ecological and economical advantages of the LCT system** – as well as its proven high fire safety standard. So good ideas are obviously growing.

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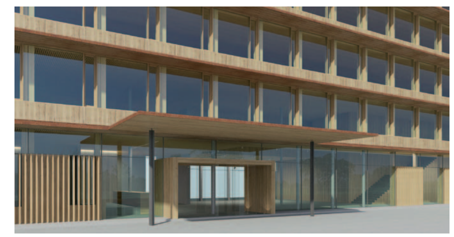
The IZM

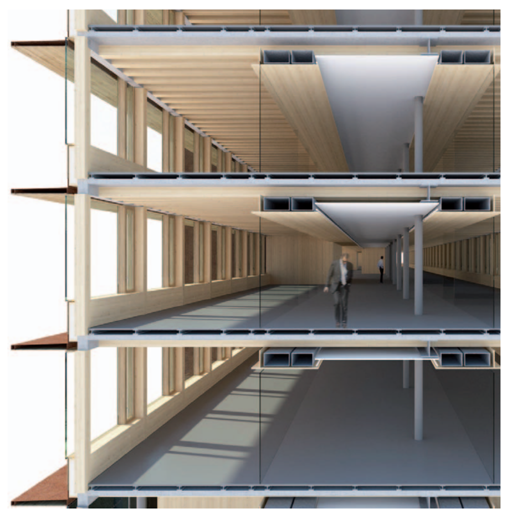
Project:	Illwerke Center Montafon
Location:	Montafon/Austria
Clent:	Illwerke AG in Vorarlberg
Start of construction:	March 2012
Completion date:	August 2013
Dimensions:	
Length:	approx. 120 m
Width:	approx. 16 m
Height:	approx. 21 m
No. of storeys:	basement, ground floor, upper floors 1- 4
Floor area:	approx. 11,500 m² (gross)
Cubic content:	approx. 45,000 m³ (gross)

IZM **Facts**.

- › **Dimensions:** basement, ground floor, 4 upper floors, height 21 m, width 16 m, length 120 m
- › **Location:** 1/3 in the pump reservoir Rodund
- › **Architecture:** designed by Hermann Kaufmann, façades constructed mainly from wood, visible wooden supporting structure, reception area
- › **Energy standard:** passive house technology
- › **Windows:** triple glazing
- › **Operating costs:** optimised by automatic energy consumption monitoring
- › **Room temperature:** heating/cooling panels integrated in the ceiling, window contacts to prevent loss of energy
- › **Air quality:** comfort ventilation system with highly efficient heat recovery, automatic control via CO_2 measurement
- › **Intelligent building service control:** shutters with automatically controlled motor drive, occupancy sensors and daylight-dependent lighting control
- › **Equipment:** electronic access system, passenger lift, fibre optic cabling, visualisation of individual energy consumption
- › **Lighting:** basic lighting of common areas, individual office lighting in LED technology
- › **Floor construction:** noise-optimised access floor system
- › **Floor plan:** individually configurable in dry construction or with system partition walls
- › **High safety standards:** sprinkler and fire alarm system

1 view of north side · 2 view of the east side · 3 view of south side





above: entrance of the IZM · below: foyer in the IZM
left: sectional view of the IZM

www.creebyrhomberg.com

HAUS der Zukunft bmvit FFG

WOOD WORKS!
Project of the Canadian Wood Council

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T5J 3N3

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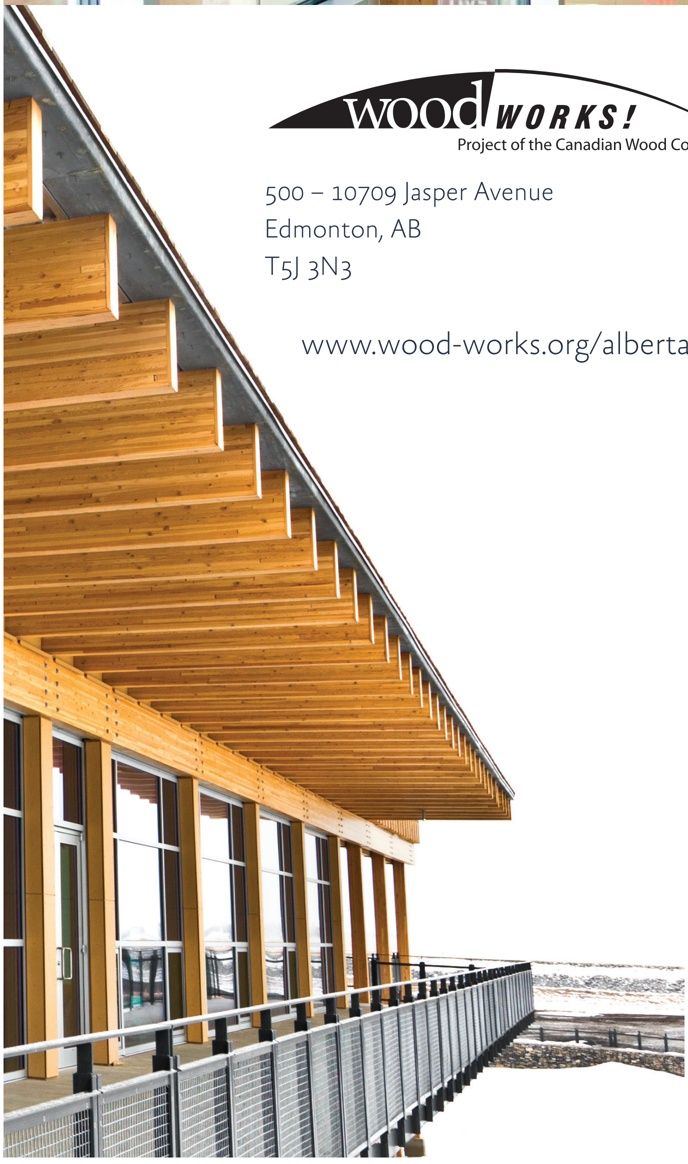

Timber Connection Design Workshop

Register online today at www.shop.cwc.ca

Spaces are limited — don't miss your opportunity to attend!

Registration deadline is Monday, January 30th, 2012

Workshop (including continental breakfast, lunch and coffee breaks) $340 + GST
Wood Design Manual (to be shipped at a later date) $110 + GST

Cancellations after Monday January 30th will not receive a refund.
Registration is limited to 40 participants.

Every pre-registered participant will receive a confirmation by email. If you have any questions contact Rory or Jerry at 780.392.1952

Photo Credit (all): Ralph Klein Park Environmental Education & Ethics Centre, courtesy of Steve Nagy Photography

Join us! February 6th and 7th, 2012 at the
Ralph Klein Park Environmental Education & Ethics Centre
(Dragonfly Room, 12350 84 St. S.E, Calgary, AB)

Timber Connection

DESIGN WORKSHOP

Who should attend?

This two day workshop is intended for the experienced structural engineer looking for an opportunity to do hands-on designs of wood connection systems. The workshop will start with connections found in the CSA 086 Wood Design Standard and move on to connections found in timber frame and log structures.

How will I gain confidence with wood connection design?

The course will take the participants into the workings of traditional timber frame connections, timber bents and trusses, and both moment connections and moment frames. With educators, engineering practitioners and industry representatives, this interactive workshop will place the participant in front of such connections as tight fit pins, bertsche and other European style connections not yet included in CSA 086 but appearing in the market more and more.

What is the program format?

As well as lecture presentations, the program format will include; team problem solving in breakout sessions, case study review and presentations/demonstrations given by representatives of the exhibiting connections suppliers.

SPEAKERS

Ghasan Doudak, Ph.D., P.Eng.
Professor of Structural Engineering in the Civil Engineering Department, University of Ottawa

Ghasan's expertise includes multi-scale understanding of how complete structural systems function, encompassing issues like how complete buildings respond to effects of wind storms and ground shaking blasts. Prior to joining the Engineering Faculty, Dr. Ghasan Doudak held the position of Manager, Wood and Structural Standards at the Canadian Wood Council. Dr. Doudak received his Master of Science degree from the Technical University of Denmark (DTU).

Jasmine B. Wang, Ph.D., E.I.T
Canadian Wood Council, Ottawa, Ontario

Jasmine Bing Wang completed her Bachelor of Science in Civil Engineering and her Master of Applied Science in Civil Engineering (Structures) in China. On completing her Masters', Jasmine worked for consulting firms in Shanghai as a structural engineer. In 2010 Jasmine completed her Ph.D. in Timber Engineering at the University of British Columbia. She currently works at the Canadian Wood Council.

Robin Zirnhelt, P. Eng.
Cascade Engineering Group, Canmore, Alberta

Robin is a partner at Cascade Engineering Group. A graduate of the University of British Columbia, Robin's primary interest is in timber frame structures. Robin's experience ranges from hands on sawmilling and timber joinery to three-dimensional modeling and connection detailing for both traditional and highly-engineered wooden structures.

PROGRAM SCHEDULE

Monday, February 6th
- Registration 8.00 am
- Sessions 8.30 am – 5.00 pm
- Tools for Timber Connection Design
  - > Mechanics of Wood
  - > The King Post Truss – *so you think you know wood*
  - > The King Post Truss – *from a timber framer's perspective*
  - > Traditional Timber Frame – *shape and form*

Tuesday, February 7th
- Sessions 8.00 am – 12.00 pm
  - > Timber Connections Under Seismic Action
  - > Wood Connections – *Past, Present & Future*

UPCOMING Wood *WORKS!* EVENTS — check our website or join our mailing list for more information

- March 26th — Design Seminar, Edmonton
- March 27th — Design Seminar, Calgary
- April 1st — Nominations open for Prairie Wood Design Awards
- April 18th — Massive Wood Solutions Symposium, Edmonton
- April 20th — Massive Wood Solutions Symposium, Calgary

www.wood-works.org/alberta

woodWORKS!
Project of the Canadian Wood Council

You are invited to a FREE information session approved for Core Credit with the AAA!

Topics Include: Building with Fire Retardant Treated Wood, Hybrid Bridges: A Sustainable and Cost-Effective Building Solution & Toward a Culture of Wood

Wood Design Seminar

Monday March 26th at Petroleum Club, 11110 108 St., NW Edmonton
7:30 - 8am breakfast & registration (8am-12pm seminar)

Tuesday March 27th at the Coast Plaza Hotel, 1316 33 St. NE, Calgary
12:30pm lunch & registration (1-5pm seminar)

Register now for this FREE event!!

visit wood-works.org/alberta/seminars

Photo courtesy of Macdonald & Lawrence Timber Framing, Atlas Coal Mine, 2011 Prairie Wood Design Award Engineer Advocate Winner

Alberta Wood *Works!*
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WOOD WORKS!
Project of the Canadian Wood Council

Wood Design Seminar Topics Include:

Building with Fire Retardant Treated Wood
Featuring **Gary Broughton**
Participants will learn the history of Fire Retardant Treated Wood (FRTW), the process used to manufacture it, definitions of FRTW and Flame Spread, and construction applications.

Hybrid Bridges: A Sustainable and Cost-Effective Building Solution
Featuring **Crawford Dewar**
Participants will be introduced to the process of designing with engineered wood products alongside concrete and metal, to create green and economical infrastructure.

Toward a Culture of Wood
Featuring **Jim Taggart**, FRAIC
Participants will examine the future potential of wood as a building material in Canada. By looking at historical examples, we will identify aspects of our wood culture that have been forgotten which may illuminate the way forward.

Questions? Contact Alberta Wood *WORKS!* at 780. 392. 1952
Technical Advisors, Rory Koska and Jerry Calara
Communications Coordinator, Barbara Murray

Register now for this FREE event!

wood-works.org/alberta/seminars

Registration deadline is March 20th, 2012
Other upcoming Wood *Works!* events:
Prairie Wood Design Awards — Nominations open April 1st!
Massive Wood Solutions Symposium — April 18th & April 20th

wood WORKS!

900-10707 100 Ave
Edmonton, AB
T5J 3M1

Timber Connection Design Workshop

Register online today at www.wood-works.org/alberta

Registration

Workshop cost: $340 + GST
(includes a continental breakfast, lunch & coffee breaks)
Wood Design Manual: $110 + GST
(Must be pre-ordered online)

Deadline for registration is Friday, October 12th, 2012.
Cancellations after Friday October 19th will not receive a refund.

Every registered participant will receive a confirmation by email. If you have any questions about this event please contact Barbara at 780. 392. 0761

Join us! October 24th and 25th, 2012 at the

Yellowhead Brewery, 10229 105 Street NW, Edmonton

Timber Connection

DESIGN WORKSHOP

Register today at wood-works.org/alberta

Seating is limited!

Discover the possibilities of Timber Connections through team problem solving, breakout sessions, case study review, demonstrations and presentations. See actual design examples used in theory; tested to breaking point on our connection breaking apparatus!

This is a hands-on workshop for the experienced structural engineer interested in testing the success and failure of Timber Connections. Led by experienced timber connections professionals Professor Ghasan Doudak, Robin Zirnhelt and Jasmine Wang participants will gain confidence in their abilities to design wood connections through interactive connections testing. Over 2 days participants will explore CSA 086 Wood Design Standard connections, tight fit pins, bertsche and other European style connections not yet included in CSA 086 but appearing in the market as well as touch on the following topics:

- Mechanics of Wood
- The King Post Truss — So you think you know wood?
- The King Post Truss — From a timber framer's perspective
- Traditional Timber Frame — Shape & Form
- Timber Connections Under Seismic Action
- Wood Connections — Past, Present and Future

Meet the Speakers

Ghasan Doudak, Ph.D., P.Eng.
Professor of Structural Engineering in the Civil Engineering Department, University of Ottawa

Ghasan's expertise includes multi-scale understanding of how complete structural systems function, encompassing issues like how complete buildings respond to effects of wind storms and ground shaking blasts. Prior to joining the Engineering Faculty, Dr. Ghasan Doudak held the position of Manager, Wood and Structural Standards at the Canadian Wood Council. Dr. Doudak received his Master of Science degree from the Technical University of Denmark (DTU).

Jasmine B. Wang, Ph.D., E.I.T
Technical Services Specialist, Canadian Wood Council, Ottawa, ON

Jasmine Bing Wang completed her Bachelor of Science in Civil Engineering and her Master of Applied Science in Civil Engineering (Structures) in China. On completing her Masters', Jasmine worked for consulting firms in Shanghai as a structural engineer. In 2010 Jasmine completed her Ph.D. in Timber Engineering at the University of British Columbia. She currently works at the Canadian Wood Council.

Robin Zirnhelt, P. Eng
Lead, Heavy Timber Engineering, ISL Engineering and Land Services, Canmore, AB

Robin Zirnhelt is the Lead for Heavy Timber Engineering at ISL Engineering and Land Services. He is a specialist in timber frame engineering and the design of heavy timber structures. His experience ranges from hands-on sawmilling and timber joinery to three-dimensional modelling and connection detailing for both traditional and highly-engineered wooden and composite structures. Before joining ISL in 2012, he was a partner at Cascade Engineering Group for seven years.

Upcoming Wood*Works!* Event

Save the date for our upcoming annual Prairie Wood Solutions Fair on December 13th, 2012
Details will be posted soon at www.wood-works.org/alberta

M.A.D.E. in Edmonton Street Furniture Competition
June 23, 2012

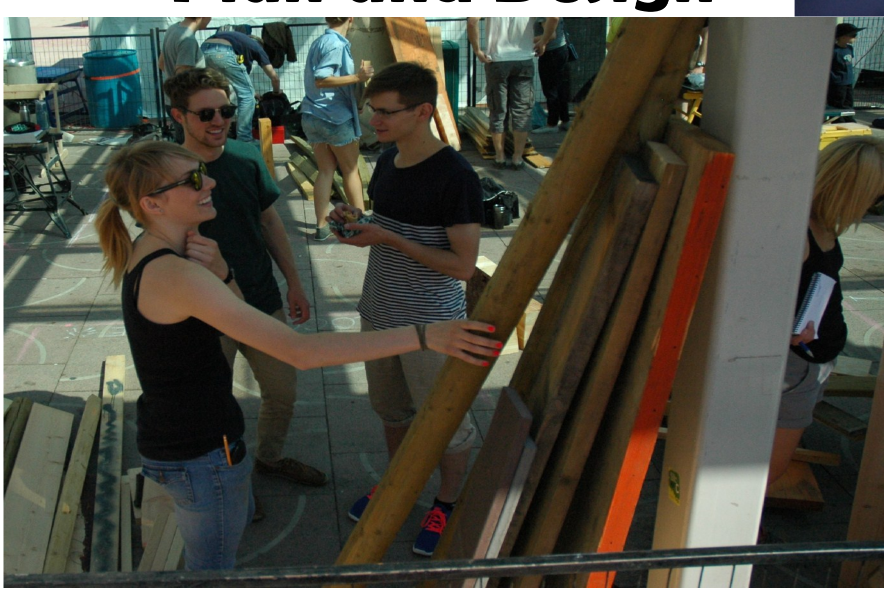
The Sponsors!

Churchill Square was a buzz this weekend with skill saws and creativity as the Street Furniture Competition kicked off the weekend at the Edmonton Works Festival.

Recipe for incredible Street Furniture:
- 1 van of donated wood materials
- 3 sponsors with material for up-cycle
- 11 teams
- 7 hours
- 2 Carpenters
- 3 team members, no blueprints
- dash of ingenuity

Collecting Materials

Plan and Design



BUILD!

The Award Winners!

1st Place

Conversation Piece

3rd Place

Bench with Cooler

2nd Place

Bike Rack

Peoples Choice—Lifeguard Chair

The Competition!

Thank You so much for your contribution!
Your donation of materials made this event a success!

MASSIVE WOOD SYMPOSIUM

REGISTER ONLINE AT WWW.SHOP.CWC.CA

Registration includes continental breakfast, coffee and lunch

Workshop Cost: for CWC member $199 + GST, General $249 + GST

FPInnovations CLT handbooks available for a discounted rate of $150 + GST when bought with workshop registration.

REGISTRATION DEADLINE IS APRIL 11TH, 2012 AT 5PM

Find the detailed Symposium schedule online at www.wood-works.org/alberta

Wednesday, April 18th: Fairmont Hotel Macdonald – Empire Ballroom,10065 – 100 St., Edmonton

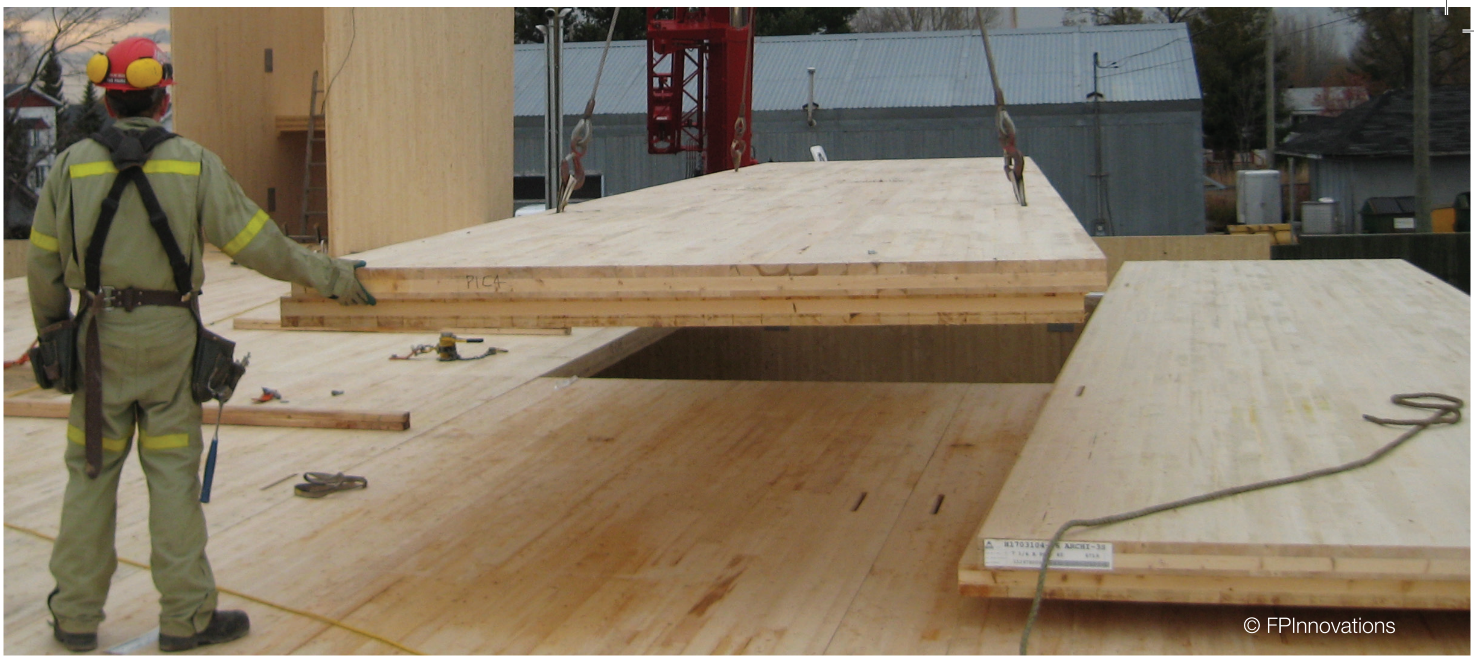
Friday, April 20th: Calgary Telus Convention Centre – Macleod Hall CD, 120 Ninth Ave SE, Calgary

MASSIVE WOOD SYMPOSIUM

REGISTER ONLINE AT WWW.SHOP.CWC.CA

wood WORKS!
Project of the Canadian Wood Council

500 – 10709 JASPER AVENUE
EDMONTON, AB
T5J 3N3



ACHIEVE NEW HEIGHTS WITH WOOD BUILDINGS

Alberta Wood *WORKS!* brings this one time symposium to Edmonton and Calgary and offers design professionals the opportunity to learn about massive structural wood products currently available in Canada.

New building methods will be presented by architects and engineers who have successfully built with products including Cross Laminated Timber (CLT), Glulam Panels, Laminated Veneer Lumber (LVL) and Laminated Strand Lumber (LSL).

MASSIVE WOOD SYMPOSIUM

All major aspects relating to Massive Wood panels and assemblies will be discussed: architectural and structural design, manufacturing, connections, fire safety, acoustics, durability, and environmental performance. During the symposium, we are privileged to host experts from the United Kingdom and Canada including:

- Mr. Christian Dagenais, Eng., M.Sc., FPInnovations, Scientist - Fire Group, Building Systems, Québec, CA
- Mr. Jonathan Fovargue, B.Sc. (Hons), Eurban, Director, London, UK
- Mr. Sylvain Gagnon, Ing., Eng., FPInnovations, Senior Researcher, Building Systems, Québec, CA
- Mr. Andre Lema, Western Archrib, Manager of Business Development, Edmonton, CA
- Mr. Eric Karsh, M.Eng, P.Eng, StructEng, MIStructE, Ing., Equilibrium Consulting, Principal, Vancouver, CA
- Mr. Stefan Mannewitz, Dipl. Ing., Karakusevic Carson Architects, Associate, London, UK
- Mr. Mohammad Mohammad, PhD., P. Eng., FPInnovations, Group Leader, Structure, Building Systems, Ottawa, CA

All presentations are being considered for learning credits with the AAA. This symposium is for:

Architects — Structural Engineers — Builders — Developers — Building Authorities
Wood Product Manufacturers — Fastener Manufacturers — Building Code Consultants
Economic Development Officers — Business & Product Development Managers

THANK YOU TO OUR SPONSORS:

AFPA ALBERTA FOREST PRODUCTS ASSOCIATION

Canadian Wood Council / Conseil canadien du bois

FPInnovations

Cancellation Policy: Cancellations after Wednesday April 11th will not receive a refund.
Questions? contact Barbara Murray, Communications Coordinator at bmurray@wood–works.ca or 780.392.1952


woodWORKS!
Call for Nominations!
The Annual Prairie Wood Design Awards celebrate excellence in wood construction in the Prairie region and the Territories.
Nominations requested from design firms, individuals and communities with recent accomplishments of wood construction.
wood-works.org/alberta
Prairie Wood
DESIGN AWARDS 2012
Photo Credit © Roy Ooms

Alberta Wood *Works!*
900 – 10707 100 Ave.
Edmonton, AB T5J 3M1

Prairie Wood Design Awards 2012

Nominate your exceptional projects and community buildings. All nominations are showcased at the **Prairie Wood Design Awards Gala on November 5th, 2012** in Edmonton. Winning projects will be featured in the North American Wood Design publication for 2012.

It is our pleasure to announce the three-member jury panel for the 2012 Awards:
Duff Balmer, Design Principal of Perkins + Will
Darryl Condon, Managing Principal of Hughes Condon Marler Architects
Christine Macy, Dean of the Faculty of Architecture and Planning, Dalhousie University

The jury will present awards in 7 categories to design firms or individuals with projects in the Prairies and Territories.

Nomination deadline is August 17th, 2012

Applications and guidelines online. Questions? Contact Barbara Murray, Communications Coordinator, at 780. 392. 0761 or at bmurray@wood-works.ca.

wood-works.org/alberta

woodWORKS! ATLANTIC

FOSTERING A WOOD CULTURE IN THE ATLANTIC REGION

WOOD

Cost Efficient
Is Versatile
Meets Code
Is Renewable
Carbon Negative
Minimizes Carbon Footprint
Significant to the Economy

Atlantic WoodWORKS! educates about the economic and environmental benefits of wood construction. We encourage decision makers and design/build professionals to pursue sustainable, life-cycle smart wood construction and to support build with wood policies.

MLB

Canadian Wood Council
Conseil canadien du bois

www.atlanticwoodworks.ca

Municipal WoodFirst Resolution Template

Being a wood champion, **[municipality name]** has the ability to play a central role by demonstrating environmental awareness, stewardship, and leadership. It recognizes the importance of the wood sector, by adopting the WoodFirst Resolution;

THAT Council adopts the following WoodFirst Resolution:

WHEREAS **[municipality name]** recognizes the historic, present and future value of the wood culture in **[Province]**;

AND WHEREAS **[Province]**'s forest industry, as an integral part of the Municipality's economy, is developing new markets and new opportunities for wood products as part of a long-term strategy toward a healthy wood industry;

AND WHEREAS **[municipality name]** recognizes that wood is sustainable, and renewable, and that wood structures minimize or eliminate the carbon footprint of a building;

AND WHEREAS **[municipality name]** recognizes that wood meets building code requirements as permitted in the Canadian Building Code (2010 edition);

Municipal WoodFirst Resolution Template (con't)

THEREFORE BE IT RESOLVED that **[municipality name]** will continue to support the development of its wood culture by:

- when building new structures, renovating or adding on to existing buildings, the government shall employ the material that has the lowest environmental impact, within building code requirement;
- using building materials with the lowest carbon footprint (where technical standards permit), when considering new construction, retrofit and refurbishment projects;
- using building materials and systems with the lowest embodied energy – wood-frame solutions – (where technical standards permit), when considering new construction, retrofit, and refurbishment projects;
- always including a wood structure/material option when considering new structures, or performing renovations or additions to existing buildings;
- ensuring that all municipal infrastructure projects receiving Provincial or wood industry financial support employ the appropriate structural or architectural use of wood;
- ensuring that the performance of wood systems and products are considered whenever appropriate throughout all phases of infrastructure procurement and ownership.

WOOD DESIGN SEMINAR

FREE ADMISSION

and continuing education credits
for qualified industry professionals

The Wood Design Seminars are an Atlantic WoodWORKS! initiative for all industry professionals.

emerging wood technologies

January 25th, 2012 8:00 am
Marriott Harbourfront
Halifax, NS

January 26th, 2012 8:00 am
Crowne Plaza Downtown
Moncton, NB

News Release

FEDERAL AND PROVINCIAL GOVERNMENTS SUPPORT ATLANTIC INITIATIVE TO PROMOTE BENEFITS OF WOOD CONSTRUCTION

AMHERST (NS) – JANUARY 10, 2012 - The Government of Canada and the provinces of Nova Scotia, New Brunswick and Newfoundland and Labrador today announced their support for Atlantic WoodWORKS!, a new regional initiative to promote and advance the economic and environmental benefits of wood construction. The initiative is led by the Maritime Lumber Bureau.

“Creating jobs and growing the economy remain our Government’s top priorities,” said the Honourable Bernard Valcourt, Minister of State for the Atlantic Canada Opportunities Agency (ACOA) and La Francophonie. “We continue to invest in industry and initiatives that will make Canadian forest products even more attractive in the global marketplace. With this investment, we are helping the forestry industry in Atlantic Canada to meet its market challenges and pursue strategic opportunities for growth through training, education and innovation.”

“From the days of tall ships to modern building design and construction, we know the importance of making value-added products from wood,” said Charlie Parker, Nova Scotia's Minister of Natural Resources. “Nova Scotia strongly supports WoodWORKS! as a step toward a more innovative and sustainable forest industry.”

“This joint initiative is a wonderful opportunity to help promote our forest products industry to the rest of the world,” said New Brunswick Economic Development Minister Paul Robichaud. “The Atlantic WoodWORKS initiative will assist our producers and our wood sector.”

“This initiative complements many of the concepts our government is proposing to further the forest industry in Newfoundland and Labrador, including assisting in the development of niche markets and diversifying the solid wood products industry,” said the Honourable Jerome Kennedy, Minister of Natural Resources and Minister Responsible for the Forestry and Agrifoods Agency. “Our $50,000 commitment in this initiative enables us to work with municipalities and other stakeholders to further increase the understanding of the benefits of building with wood.”

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Canada NOVA SCOTIA NOUVELLE-ÉCOSSE New Nouveau Brunswick Newfoundland Labrador

Atlantic WoodWORKS! is an expansion of the Canadian Wood Council's successful WoodWORKS! program into the Atlantic region. Its overarching objective is to encourage the expanded use and consumption of made-in-Atlantic Canada solid wood products in commercial and municipal construction projects. Various promotional activities will be carried out under the program, including technical support and seminars, the development of a newsletter and website, among other activities. The goal of this activity is to demonstrate to project decision-makers that wood, as a building material, is a renewable and responsible choice that meets their environmental objectives by lowering a project's carbon footprint.

"The expansion of the national WoodWORKS! program to the Atlantic Region will build upon the wood culture that has existed in this area for generations," said Diana Blenkhorn, President and CEO of the Maritime Lumber Bureau. "Our communities already know that building with wood is the right choice to meet their environmental objectives. Approaching our issues on a regional basis is an excellent opportunity to build upon past successes and secure the future of this important sector and economic contributor."

The Maritime Lumber Bureau (MLB) based in Amherst, Nova Scotia is a federally incorporated not-for-profit association. It is an internationally accredited quality control, certification and licensing body. Formed in 1938 the MLB has 73 years of experience in meeting the needs of the Atlantic region's large and small primary and secondary producers of forest-based products. While membership is voluntary, the MLB provides services to over 100 members located in the four Atlantic provinces. Membership is made up of sawmills, secondary producers, wholesalers/brokers, equipment suppliers and others who are committed to the sustainability of one of the region's most important natural and renewable resources, and maintaining the important historic economic contribution to the Atlantic provinces.

In 2010, the forestry sector contributed $1.9 billion to Atlantic Canada's economy, employed close to 21,000 Atlantic Canadians, and exported $2.6 billion worth of products.

The Government of Canada, through ACOA, is contributing $500,000 over a two-year period to the project under the Business Development Program (BDP). The provinces of Nova Scotia, New Brunswick and Newfoundland and Labrador are investing a combined total of $134,096. The Canadian Wood Council is investing $159,317.

FOR BROADCAST USE:

Atlantic WoodWORKS! – a new regional initiative to encourage the use of locally-produced wood in non-residential construction projects throughout Atlantic Canada was launched today by ACOA Minister Bernard Valcourt; Nova Scotia's Minister of Natural Resources, Charlie Parker; Minister of Business New Brunswick, Paul Robichaud; and Newfoundland and Labrador's Minister of Natural Resources, Jerome Kennedy.

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Atlantic WoodWORKS! will help the industry to address its market challenges and pursue opportunities for growth through training, education and innovation. Various promotional activities will be carried out under the program, including technical support and industry seminars to demonstrate that wood, as a building material, is a renewable and responsible choice for commercial and municipal construction.

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(This news release is available on ACOA’s website at www.acoa-apeca.gc.ca under **Media Room.)**

Canadian Design & Construction Report
www.cadcr.com
VOLUME 3, ISSUE 3, SUMMER 2012

Wood *WORKS!* British Columbia Wood Design Awards

Nova Scotia's Construction Industry

The Alberta Painting Contractors Association

Bidding and Tendering Practice Changes Create Pressures and Challenges for Industry

Should the building code be changed to make it easier to build six-storey wooden buildings?

This article submitted by the Ontario Wood Truss Fabricators Association (OWTFA) is an abridged version of Wood WORKS! material originally published in Sustainable Builder Magazine. Wood WORKS! is an industry led initiative of the Canadian Wood Council that promotes the use of wood and wood products in construction - providing free technical assistance. Contact Wood WORKS! for more information, toll free at 1-866-886-3574 or www.wood-works.org.

For more than a decade, Ontario Wood *WORKS!* has been working diligently behind the scenes to advance the use of wood and wood products in commercial, institutional, and industrial construction projects by providing free technical guidance to design-build professionals. How? By connecting practitioners with wood industry suppliers and information, and by delivering presentations and educational opportunities to municipal and building officials, architects, engineers, builders, developers, and students.

Ultimately, through educational outreach and technical support, Wood *WORKS!* seeks to establish a wood "culture," where wood is recognized as a sustainable and economical building material used for all types of construction.

Team members report that the technical wood information Wood *WORKS!* provides has a direct, positive impact on some projects, leading to wood use in applications where it might not have otherwise been used if the technical question had not been resolved satisfactorily.

By answering technical calls and disseminating the information the group has from sources like the CWC and FPInnovations, Wood *WORKS!* is helping practitioners increase not only their comfort and capacity for wood design, but also their consideration of environmental and socio-economic outcomes. And that translates into great news for the communities and the buildings.

In addition to responding to questions and helping resolve wood-related issues through the technical call service, Wood *WORKS!* also helps Ontario's design professionals keep current with key developments in the wood industry. Wood *WORKS!* strives to provide information proactively through regular workshops, seminars, and other educational events, including the annual Wood Solutions Fair and wood design luncheon conferences.

For example, in advance of proposed changes to the Ontario Building Code, the group conducted a research study and completed a report on wood solutions in mid-rise construction.

Individual projects highlight wood construction's potential. In B.C. plans are underway to construct what is expected to be the tallest wood building in Canada, and possibly the world. The proposed 10-storey Wood Innovation and Design Centre will become an example of wood's potential for higher-rise buildings.

"The valuable thing about this mid-rise information"is that it's useful whether or not there are updates to the next edition of the building code; though, of course, we hope to see the proposed changes implemented," says Steven Street, a technical director with Wood *WORKS!*

Explains Street: "With our current performance-based code, a designer can already go above four storeys in wood. He or she just has to show the design meets the same structural and safety requirements a building made of other materials would have to meet. Given the proven performance characteristics of wood and engineered wood products, this is not especially difficult. But, going through the process of proving equivalency does take more time."

Updating the code to permit wood buildings up to six storeys in height is something Wood *WORKS!* believes is necessary in order to eliminate what it sees as an existing bias against wood products in current edition of the code. A prescriptive limit based on a rigid interpretation of combustible versus non-combustible materials stifles innovation. It unnecessarily limits the use of a sustainable, locally available material that has the potential to reduce construction costs and support the forest products sector – the second largest economic engine in Ontario.

Though there is widespread support in favour of raising the allowable height for wood buildings up to six storeys, as with any potential change, there is also some opposition. There are people who would prefer to see the height limit on wood construction stay capped at four storeys.

Why? According to Street, "Not everyone can be a leader. Some people just naturally resist change and are unable to break outside of the comfort zone of doing 'what has always been done.' In other instances, opposition to the proposed code changes stems from a lack of knowledge, and that's fine as long as a person is able to recognize this is his or her own limitation. What isn't acceptable is continuing to support unnecessary restrictions on the people who have the capacity to innovate and devise new structural solutions that meet or exceed the public health and safety requirements of the code, regardless of the material used."

The OWTFA is a member of Wood WORKS! Ontario. The OWTFA represents the common interests of the truss industry in Ontario, including promoting the use of wood trusses in residential, commercial and agricultural structures. For more information please contact executive director Mike Phillips) at 416-235-0194 or www.owtfa.com.

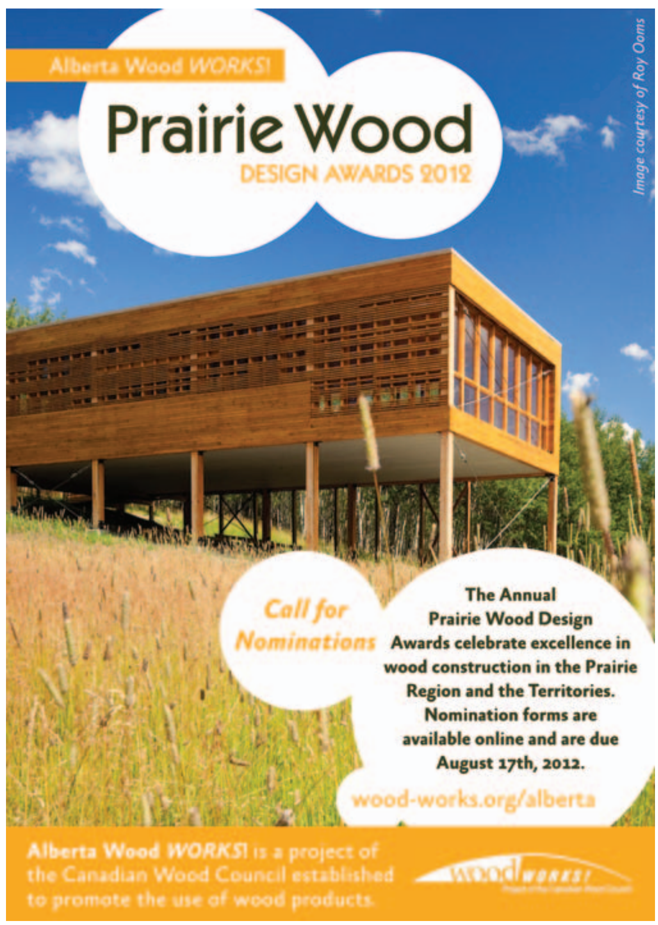


Image courtesy of Roy Ooms

Wood WORKS! Project of the Canadian Wood Council

Wood *WORKS!* British Columbia
Wood Design Awards

Finalists selected from record-breaking entry volume as competition attracts increasing interest and recognition

Staff Writer – Canadian Design and Construction Report

The 8th annual Wood *WORKS!* B.C. Wood Design Awards has achieved record-breaking interest: Judges selected finalists from 106 entries in 12 categories.

Mary Tracey, Wood *WORKS!* B.C. executive director, says every year the bar is raised and she continues to be amazed at the quality of the projects and the creativity put forth. "Submissions are based on a combination of written and pictorial background. Every year we think of the wood innovations category and wonder what we can possibly see that we haven't before and every year we are surprised and impressed."

Though Tracey says the nominations arrived from previous participants as well as from architects who have recently embraced wood in their projects.

"I think the awards attract a lot of attention, especially perhaps the architect and engineer awards, which look at a candidates' work over a period of years instead of just single projects, she said. "We were very pleased this year to see some new names in these categories and hope that continues."

Not surprisingly, she said that "B.C. has always accepted wood as a building material and is a bit ahead of the environmental movement in recognizing wood as the only truly renewable material in Canada and we are more significantly ahead in some ways with changes to building codes allowing for higher wood structures."

Tracey says this year's judges, from a cross section within the industry and community, reported how they have been impressed by the the variety of woods and their diversity of uses. ons.

Judges spend a day examining the "blind" nominations, divided by category, and Tracey says there are often lively discussions on perspectives and ideas. "The judges can get into some pretty emotional debates and discussions but when the vote is called for at the end of the day, we always find consensus; it is never the case of a project winning, but grudgingly."

The awards, hand carved statuettes each from a unique species of wood, are not only pieces of art in themselves but symbolize recognition from both peers and the broader spectrum of builders and government. Tracey says every year she has people telling her at the event to watch out for projects they will be submitting for the following year.

This year's event recognized both national and international projects in categories including the B.C. Premiers' Wood Champion Award, Green Building, Wood Innovation, Interior Beauty and Western Red Cedar.

For more information visit wood-works.org.

All photos courtesy Wood WORKS BC

Residential Wood Design

C.C. Yao, Read Jones Christoffersen

Linear House, Salt Spring Island

This project had broad appeal, and was awarded high marks by the jury.

A 16-acre farm located on Salt Spring Island, the site of this house is bisected from east to west by a long row of mature Douglas fir trees. Given the site's remoteness and the owner and architect's unique design intent for a structure in complete complement with the natural landscape, and transformable into an open-air pavilion, wood was deemed the best choice in material for many reasons, including its versatility in cost-effectively addressing the structural/large span challenges and its local availability.

Green Building

Craig Duffield, McFarland Marceau Architects

École Mer et Montagne, Campbell River

Demonstrating the sustainability of wood to future leaders resonated with the jury. This, and the fact that this project utilized wood in every conceivable manner possible, resulting in a warm and friendly learning environment, quickly put this project at the top of the list.

The concept for this project evolved almost entirely out of the re-use and re-purposing of existing wood joists discovered within the derelict existing school building on the site – partly in support of the LEED Gold target, but mainly as an appropriate response to a remarkable resource.

One of the many similar schools rapidly constructed across BC in the late 1960s and early 1970s, the existing building had long outlived its service life and was slated for demolition. However, the building contained two key resources worth preserving – a treasure-trove of beautiful 3X12 tight-grained Douglas fir joists, and a serviceable gymnasium which was beyond the areas currently prescribed the province for a small new elementary school. The building form is expressed entirely with the salvaged timbers, which undulate up and down as wall, roof, eaves and column. The beautifully-aged patina of the rough sawn structure is unfinished, except for a light sanding below 2.4 m to remove splinters. The salvaged timbers have been re-purposed with reverence: as structure, doorway, cabinetry, seating, shelving, privacy screen and doorway – all in support of a small school which will function as a de-facto community centre and the most visible presence of the francophone community in Campbell River.

Multi-Unit Residential

Paul Hammond, Chow Low Hammond Architects

Camas Gardens Supportive Housing, Victoria

The jury noted the architect's efforts resulted in a strong statement, with a project that fits into the neighbourhood in a very elegant way.

Located in a neighbourhood described as a dichotomy of architectural languages and typologies, the designers of Camas Gardens sought to translate the diversity of architectural languages within the neighbouring context by offering a solution that is contemporary, durable and restores a piece of the city fabric. They set out to challenge a pre-conception about government-funded housing that it visually reflect "low cost", by exceeding the expected quality of space and material, yet meeting the project budget; aiding in the rehabilitation of the inhabitants while contributing to the greater urban context of the built environment.

The designers stated that the use of wood on the façade and soffit in the building structure and surrounding landscaping is an important contribution to the quality of experience and the sustainable goals set for this project. Designed to LEED Gold standards, the building is a mix of three and four storey wood-frame construction with the main entrance punctuated by a one-storey common room that partially encloses a south-facing courtyard. The internal layering of the building weaves around this courtyard, at once embracing the residents within, and gesturing to the neighbourhood a sense of openness. This warming to the community is achieved through the elegant use of Western red cedar, emphasizing the creation of shared courtyard space, while addressing the street and enhancing the neighbourhood. The wood ribbon becomes a beacon on the residential street as well as from within the building and is symbolic of the human primordial affinity to nature.

Commercial Wood Design

David Poiron and Ben Checkwitch, Checkwitch Poiron Architects, Vancouver and Nanaimo

Nanaimo Cruise Ship Terminal Building, Nanaimo

The jury described this project as attractive, airy and honest, and also appreciated the connection between past and present.

The project is located on the Nanaimo Assembly Wharf, a location that once supported three sawmills (one of which is still in operation) and was a major point for the storage and shipping of lumber on Vancouver Island. As the facility is the first point of contact for many cruise ship passengers to Nanaimo, it was important to portray the region's historical and ongoing relationship with the wood industry. As such, wood plays a dominant role in the passenger experience through the building. The wood clad office box, located partially interior and partially exterior to the building, gives an initial wood impression to passengers who must walk underneath the suspended structure while being processed by Canada Customs. Proceeding to the welcome centre space the passengers are surrounded by the main structure, glulam columns and beams which are curved, and wood slat screens, giving a sense of enclosure, warmth and directionality to the space, as well as opening up the space to the view of the harbour beyond. When passengers return to the terminal building, the welcome centre space also serves as the last point of contact and thus gives a reminder of the importance of wood, specifically to this site and to Nanaimo in general.

Interior Beauty Design

Antoni James, Warner James Architects

"Art's Place" – a Food Services Outlet – Fine Arts Building, University of Victoria, Victoria

The jury applauded the architect for using wood to solve design challenges.

Designed as a free-standing sculptural object in the Fine Arts Building lobby, the coffee outlet had to float in the space without touching walls or windows. When secured after hours, the design takes on a glowing lantern effect from within and below; it also had to achieve transparency to allow daylight to continue into the lobby. Wood slats achieved these objectives and wood was specifically used as a contrast in warmth, colour and texture within this elegant two-storey space. Western birch, birch plywood and custom millwork are the predominant wood features.

Institutional Wood Design: Large

Jesse Garlick, McFarland Marceau Architects

École au Coeur de l'ile Comox, Comox

The jury summed up its appreciation for this award-winning project by stating that theappropriate and elegant use of wood in this warm and inviting building makes it a place that will encourage learning.

Wood was used extensively and was important to the design solution. The 2960 m^2 roof structure is constructed entirely of FSC certified wood. Interior spaces (project rooms and reading alcoves) are created using solid timber decking. These solid wood elements create a durable and warm interior finish matching the finish of the wood roof structure.

Reclaimed wood is also a significant feature of the school. 7.5 m. high glazing walls utilize the reclaimed timber joists to support the wind and seismic loads. Left unfinished, these timber "fins" speak to the history of the site, and bring the texture and warmth of 60-year-old fir. This material is also used as benches and display cabinets. The remaining millwork is constructed of veneer core birch plywood with exposed edges, and custom perforated (CNC) plywood panels are used as balustrades, and acoustic wall paneling.

Institutional Wood Design: Small

Darryl Condon, Hughes Condon Marler Architects

Steveston Fire Hall, Richmond

There were a number of strong contenders in this category, and the jury appreciated the project owner's willingness to use wood for a building with this purpose and function.

The new Steveston Fire Hall is located on a site owned by the City of Richmond. It's a two-storey building consisting of three main spaces: fire hall, apparatus bays and hose drying, and training tower. In keeping with the city's commitment to sustainability, the building has been designed targeting LEED Gold certification. The use of pine beetle-killed wood helps to mitigate impacts from the provincial mountain pine beetle infestation and facilitates socio-economic benefits to the region. Situated at the door step of the Steveston community, the fire hall acts as a natural gateway to the community with its hose/training tower announcing its presence as a beacon. To this end, wrapping the building interior with wood consistently throughout imparts a sense of familiarity, friendliness and visual warmth to the community. Transparency of the space layout and the consistent use of wood contribute to the success of the design, creating an iconic and functional facility for the City of Richmond.

Western Red Cedar

City of Courtenay

Courtenay City Hall renovation, Courtenay

The jury described this project as an astounding transformation, highlighting how Western red cedar can transform something so drab into something so beautiful.

Wood played a starring role in the Courtenay City Hall renovation. With a mandate to use local products as much as possible, Western red cedar and Douglas fir were natural choices. Historically these were harvested and milled in the Comox Valley, and they remain a favourite option for local building materials. Wood was also chosen for its beauty and popularity with the public. The use of wood helped add a traditional element to the contemporary look of the building. It visually connects

City Hall to other public buildings downtown, including the Courtenay Library and the Comox Valley Art Gallery which both have wood strongly incorporated into their designs. It was noted that as a local government, remaining fiscally responsible is a necessity. Wood is a cost-effective finish for public buildings, and with proper maintenance, it will remain durable and functional for years to come. The use of wood also helped the project meet environmental considerations, as it is a renewable and sustainable material. The City of Courtenay hopes this project sets an example to the development community on how wood can be incorporated as both a structural and a design element, hopefully guiding and influencing future local development.

Wood Innovation

Gerald Epp, StructureCraft Builders

Commercialization of Mechanically-Fastened CLT (Cross Laminated Timber) at Fire Hall 15, Vancouver

The jury noted that this award winning firm is "innovative, brave and courageous – and knows how to "think outside the box".

StructureCraft's CLT product is an appearance-grade solid wood roof, floor and wall panel created from ordinary dimensional lumber, laid plank-wise in layers at varying angles, mechanically-fastened together and customized to suit occupancy, loading, span and desired finish and acoustic performance. CLT was utilized in Fire Hall 15 due to its intense use of wood with its beneficial properties: renewable, locally-available, strong, lightweight, high thermal mass coefficient, aesthetically pleasing, low embodied energy and sequestering carbon. Innovations included the use of mechanical fasteners rather than glue to connect the layers of lumber. The advantages to StructureCraft's mechanically-fastened CLT include its availability in any transportable size and thickness; shop-applied architectural textures and finishes can be provided on exposed faces; large panels are rapidly erected, thereby reducing site costs; and acoustic treatments can be integrated into the panels if desired.

Wood Innovation

Brian Woudstra, StructureCraft Builders

Commercialization of the WoodWave © Structural Panel at Alberni District Secondary School, Port Alberni

A first step in the commercialization of the WoodWave Structural Panel, StructureCraft supplied and installed the WoodWave to replace standard steel decking on open web steel joists. The idea began in response to the desire for structural efficiency along with acoustical absorption, requiring a panel with some depth, hollow and with perforations. The end result was a structural-architectural-acoustic panel which carried the Port Alberni snow loads, supplied an appearance-grade ceiling and absorbed the gymnasium noise.

The 5,600 sq. ft. WoodWave roof deck was erected in one day, and consisted of 10 panels 11′ wide X up to 54′ long. Wood products used included SPF lumber from pine-beetle-affected forests in B.C. and Douglas fir plywood from B.C. forests. The fabrication involved a completely unique process including a custom computer numerically-controlled (CNC) cutting, splicing and screw-reinforcing of each 2X4 strand. The result is a composite multiple span panel whose structural performance is complex, but in which each component performs at optimal efficiency.

2012 Wood *WORKS!* Architect Award Winner – Sean Barrington Pearson

Gulf Islands residence and boat house, Salt Spring Island

Sean Barrington Pearson, with RUFproject (Rural Urban Fantasy project) was the winner of the 2012 Wood Architect Award for his efforts on the Gulf Islands residence and boathouse on Salt Spring Island and the football training centre in Soweto, South Africa.

Gulf Islands Residence and Boathouse on Salt Spring Island

Tasked with designing a home to satisfy the clients' mixed desire for a traditional log home and a modern glass home on just over three acres of ocean front property, Pearson says much of his inspiration came from the island itself, where he lived in a small cottage while he was creating the design, and from what he feels is the strongest architecture on the west coast; the modernist influence.

"The house has been nestled in the landscape, partly submerged, and partially hovering over the land. With the large expanses of uninterrupted frameless glazing, the landscape around the house effectively becomes the walls. Pushing the post and beam structure to its limits - allowed for strong horizontals, contrasting the strong verticals of the surrounding fir trees, and framing views to the ocean and landscape outside. Having spent 10 years working in Europe, and then coming back to the Canada for this project, it was important for me for the house to be rooted in the spirit of the west coast, and as such we were consciously influenced by the principles of west coast modernism."

Using carefully placed seismic walls Pearson created an open house plan with traditional room enclosures, offering privacy and stunning views from throughout and a structure that seems to float over the landscape.

Pearson says while brick, stone and steel may be considered traditional building materials, for him wood is a natural. "In Europe I saw a lot of really beautiful things made of stone and concrete, but here in Canada, and especially on the west coast, our trades are very skilled in wood; another reason wood makes sense."

The challenge in creating an interior all of wood was eliminating the standard log home feel so Pearson looked to using different woods in different patterns and in different treatments. "The outside is done in Alaskan Cedar which is local to BC, has the structural properties of pine and spruce, is resistant to bugs and mildew and is durable."

The only challenge to this wood, which is also used for the ancient totem poles and ocean posts, according to Pearson is that it wants to age silver so the trick may be in maintaining its golden hue.

Inside Pearson used hemlock, which can't be used outdoors, flooring of oak, and walls of fir and white oak to create varied textures, looks and feels.

Football Training Centre in Soweto, South Africa

Completed in under six months from design to finish, the football training centre in Soweto will serve 1200 teams and about 20,000 players each year and was constructed used local materials in a refined way to create a structure that floats over the football field.

The first of its kind in Africa, the facility includes two full-sized artificial pitches, two junior pitches, a clubhouse and lounge, an education facility, change rooms, administrative offices and other supporting spaces.

"We used a steel frame and large sandstone slabs cut into smaller pieces. The wood wrap and ceilings were rough cut, giving it an endearing but elegant roughness," says Pearson. "One wall is exposed sandstone which will house the names of players who distinguish themselves on and off the pitch."

Made from a unique wood treated for durability the wooden ceiling and skin are designed to protect the structure from the sun and will change the appearance of the building depending on the sunlight. "Depending on the direction of the sun the building goes from red to gold to almost a transparency that is really beautiful."

Pearson is appreciative of the award and what it represents. "I was up against some amazing architects and some stunning projects. It is an honor to be recognized and especially so to have that recognition in Canada."

Pearson says it can be challenging for new firms and young architects to get the recognition they need to be awarded big projects but that one of the great things about these awards, besides confirming the beauty and versatility of wood, is confirming the potential of 'new' people in the field.

Engineer

Fast+Epp Structural Engineers

Samuel Brighouse Elementary School, Richmond

The jury chose this engineering firm, which went the extra mile to prove that it is possible to use wood for public buildings which meet the objectives of being cost effective, architecturally expressive and engaging, while adhering to a strict budget.

Samuel Brighouse Elementary School in Richmond is a 50,000 sq. ft. replacement of an existing elementary school. The southern building, constructed entirely with wood, provides a single storey of classrooms, office and multipurpose spaces wrapped around an existing gym and stage. The northern block consists of a timber-frame second storey above a concrete main floor structure. Heavy timber construction was chosen as it would allow for an expressive structure yet still meet the requirements of the building and fire codes. The use of wood in this school project indicates it is possible to provide public buildings that are cost effective, yet architecturally expressive and engaging, but adhere to a reasonable budget. In particular, creating striking and economical architecture using an abundance of a "grown in BC" staple product (2X4s) is good advertising for the B.C. wood industry and should foster the use of more wood in this province and beyond.

Football Training Centre, Soweto

Situated in the heart of Soweto, the Football Training Centre is the centre of football in South Africa, where 1,200 teams and 20,000 footballers will play each year. In less than six months, the facility was transformed into a state-of-the-art football training centre – the first of its kind in Africa

– the facility encompasses two new full-sized artificial pitches, two junior turf pitches, new lighting, a clubhouse and player lounge, an education facility for the Grass Roots Soccer & Life Skillz program, a training gym, physio and first aid facility, a product trial, catering, administrative offices, viewing deck and new change rooms. The concept was to create a clear but intricately woven relationship of spaces with transparency between functions, such that views between spaces to and from other areas of the building are established. The timber louvre structure was a critical component in the design of the training centre. Its role was multifaceted, acting to create a secure perimeter to the large expanses of glazing facing the field, minimizing passive solar gain to the east, north and west, and helping to achieve a monumentality to the architecture. It was critical that the building have soul and resist the typical concrete block bunker that is often the case with sports facilities, but at the same time, deal with the functional realities of being a training centre.

Elkford Community Conference Centre

Set to become a cultural hub for the 2,500 residents of Elkford, the beautiful new $6.4 million Elkford Community Conference Centre is expected to enhance the community's ability to deliver programs and host functions and events. The 1,800 square metre building features a visitor information centre, playschool, commercial kitchen, banquet hall with a stage for the performing arts, multi-purpose meeting rooms as well as historical displays. Using structural wood construction to conserve energy and reduce the centre's environmental footprint, it is truly a showcase for wood innovation.

> *The wood use in our new centre provides beautiful aesthetics while supporting the wood industry and wood innovation in our province. This building will play a key role in helping our community grow and prosper, benefitting current and future generations.*
>
> Mayor Dean McKerracher

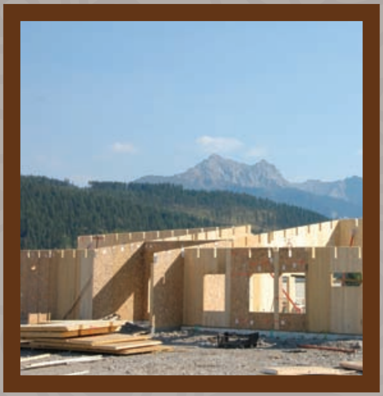
wood WORKS! Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

Elkford Community Conference Centre

Innovating with wood:
Mass Timber – expanding the possibilities of wood



Key wood innovation features:

- *Cross-laminated Timber (CLT) walls and floors*
- *Glulam beams*
- *Structural Insulated Panels (SIPs)*

Mass timber systems are very large, complete wall, floor and roof sections made from engineered wood products, and used in a variety of building types and sizes. These products offer significant benefits in terms of fire, acoustic and structural performance, scale possibilities, rigidity, stability and construction efficiency.

The Elkford Community Conference Centre is constructed with **cross-laminated timber,** which is a large multi-layer wooden panel as large as 10' X 50' made of lumber, and engineered for strength through laminations of different layers placed cross-wise to the adjacent layers.

The use of **cross-laminated timber** (CLT) wall panels in the Elkford Community Conference Centre is the first commercial application in North America. CLT panels are used as the shear walls to resist the high wind load for the building, demonstrating CLTs strength and stiffness, and proving it to be a valid alternative to concrete and steel. It's lighter, more environmentally-friendly and easier to install.

This project has also used **glulam** and **laminated veneer lumber** beams supported on the CLT walls or perimeter columns. Glulam is an engineered wood product comprised of wood laminations that are bonded together with strong, waterproof adhesives, creating an ideal structural component.

SIP panels have been used on the roof and external wall cladding due to their highly efficient insulating property.

This project also demonstrates the effectiveness of off-site prefabrication using state-of-the-art design/ fabrication technologies, such as computer numerically-controlled equipment to ensure absolute precision of structural components.

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Elkford Community Conference Centre

Only wood starts off green, and stays green.






> *Comparative life cycle assessment studies generally show wood in construction performs well relative to non-wood materials in a number of environmental impact measures, including greenhouse gas emissions, other emissions to air and water, embodied energy and carbon storage.*
>
> FPInnovations

With growing pressure to reduce the carbon footprint of the built environment, building designers are increasingly being called upon to balance functionality and cost objectives with reduced environmental impact. Wood can help to achieve that balance. Wood costs less—economically and environmentally—while delivering more in terms of its beauty, versatility and performance. Innovative new technologies and building systems have enabled longer wood spans, taller walls and higher buildings, and continue to expand the possibilities for wood use in construction. Wood is more than a building material; it's a renewable and responsible choice.

reTHINK WOOD


Elkford Community Conference Centre
June 2012
British Columbia
Architect: Douglas Sollows Architect Inc.
Engineer: Associated Engineering Group Ltd.
Volume of wood products used: **658** cubic metres
BC forests grow this much wood in: **11** minutes
Carbon stored in the wood: **512** tonnes of CO_2
Avoided greenhouse gas emissions : **198** tonnes of CO_2
This is equivalent to either
136 cars off the road for one year, or
Energy to operate a home for **60** years
The wood products used in this building help minimize its environmental footprint.

wood WORKS! Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

Elkford Community Conference Centre

Elkford Community Conference Centre is one of several demonstration projects in the province selected in July 2010 to expand the use of wood products by applying traditional products in non-traditional ways, or creating innovative wood solutions. This and two other projects have been supported by the forest products and wood design industries and by the Government of British Columbia (Forestry Innovation Investment) along with Wood *WORKS!* BC and FPInnovations.

> *Elkford Community Conference Centre demonstrates a blend of leading-edge international technologies and BC design concepts. This further accelerates wood design and construction in BC to the forefront of the global experience.*
>
> Mary Tracey
> Executive Director, Wood *WORKS!* BC

> *The District of Elkford wanted a signature building that reflected the optimism of growth in this Resource/Tourism Community in South Eastern BC and incorporating the dynamic forms found in the surrounding mountains.*
> *This project has been designed using pre-manufactured wood elements and systems to create the structure, building envelope and the aesthetic in one complete package.*
>
> Douglas Sollows
> Douglas Sollows Architect Inc.

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Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

Fire Safety and Security

A TECHNICAL NOTE ON FIRE SAFETY AND SECURITY ON CONSTRUCTION SITES IN BRITISH COLUMBIA

wood WORKS!
Project of the Canadian Wood Council

Canadian Wood Council
Conseil canadien du bois

A message from the Canadian Wood Council

The vulnerability of any building in a fire situation is higher during the construction phase when compared to the susceptibility of the building after it has been completed and occupied. This technical note reinforces the importance of compliance with provincial regulations related to fire safety planning during construction and the need for cooperation between all stakeholders in establishing the plan. Builders and developers are encouraged to adopt and implement specific fire safety procedures and approaches to reduce the potential risk and impacts of a fire on any of their construction sites. The Canadian Wood Council, through its network of research and technical expertise, is committed to providing support to those involved in design and construction with respect to safe and effective building practices.

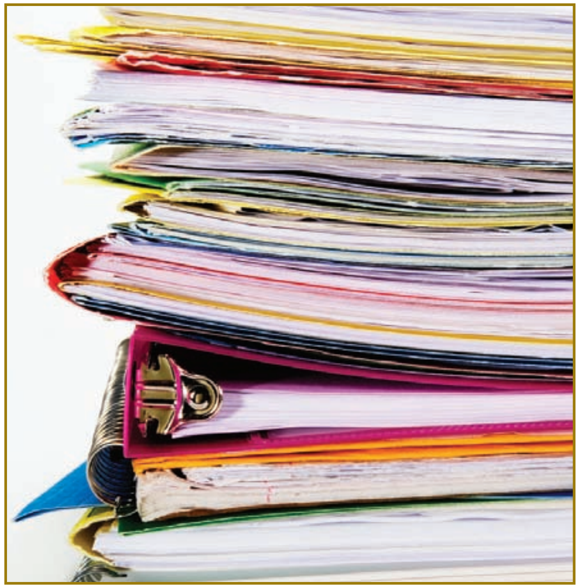
Michael Giroux, President, Canadian Wood Council

1. INTRODUCTION

The construction phase of any building represents a relatively short period of time in the lifespan of the structure during which a unique set of risk scenarios are present. The risks and hazards found on a construction site differ in both nature and potential impact from those in a completed building; and this occurs during a time in which the prevention and protection elements that are designed to be part of the completed building are not yet in place.

For these reasons, construction site safety includes some unique challenges. However, an understanding of the hazards and their potential risks is the first step towards prevention and mitigation.

While there are many types of hazards and risks that require consideration during construction of all buildings, this Technical Note will focus on fire-related aspects.



2. REGULATIONS

Everyone involved in planning and constructing a building needs to understand their roles and responsibilities related to fire safety on the construction site.

The first step is to determine the local regulations applicable to your specific project, and to put in place the necessary measures to ensure compliance to those aspects of the regulations for which you are responsible.[1] In British Columbia, there are several provincial regulations particularly relevant for construction sites and fire safety:

- *2006 British Columbia Building Code (BCBC)*, particularly Division B, Part 8 "Safety Measures at Construction and Demolition Sites" and,
- *2006 British Columbia Fire Code (BCFC)*, particularly Division B, Section 5.6 "Construction and Demolition Sites", under Part 5 "Hazardous Processes and Operations."

The City of Vancouver maintains its own by-laws in these areas:

- *City of Vancouver Building By-law (VBBL) 2007* (By-law No. 9419 and amendments), particularly Division B, Part 8 "Safety Measures at Construction and Demolition Sites" and,
- *City of Vancouver Fire By-law (VFBL) 2000* (By-law No. 8191 and amendments), particularly Sections 2.14 and 5.2.

The requirements of the VBBL and the VFBL are similar to those in the BCBC and the BCFC, respectively; however, the VBBL does have some additional requirements and the VFBL does not contain as many requirements specifically directed at construction sites.

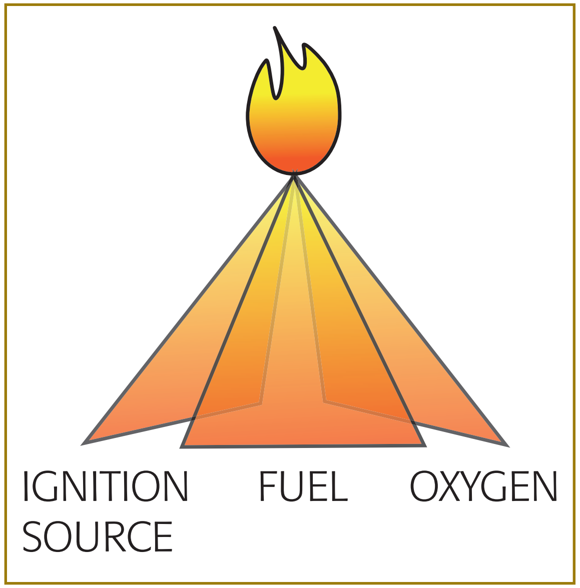
The British Columbia Office of the Fire Commissioner (BCOFC) has produced the OFC Bulletin *Fire Safety Planning for Construction and Demolition Sites*, which provides excellent guidance on the BCBC and BCFC requirements.

Depending on the specific systems and equipment used and the processes and operations taking place on your site, there may be other regulations that are applicable. Some organizations to check with in this regard are the British Columbia Safety Authority and WorkSafeBC. For example, the *Occupational Health and Safety (OHS) Regulation* contains legal requirements that must be met by all workplaces under the inspection jurisdiction of WorkSafeBC, which includes construction sites.

In addition to province-wide regulations, local governments may also have specific laws, regulations or requirements that must be followed. The local fire department often can be a resource in directing you to any additional regulations or requirements that have been implemented in your community.

[1] See the "Sources of Information" section of this Technical Note for additional details regarding documents and organizations mentioned herein.

Of course, the specific applicable regulations provide the base requirements for construction site fire safety. However, consideration should also be given to your project's characteristics, objectives and goals and how fire risks may impact construction at any phase of the work. Safety on a construction site, as in other settings, goes hand-in-hand with quality, productivity and profitability. If this is understood, it can be considered an incentive to meet and exceed the regulated standards. An examination of all possible factors and options can be of benefit. An understanding of some of the basics of fire safety and how to control risk during the construction period can be important to reducing unexpected financial risk and is helpful to the decision-making process.



THE FIRE TRIPOD

3. THE FIRE TRIPOD

For any fire to start, three components are needed: (1) oxygen, (2) a source of ignition – that is, an external source of sufficient energy (e.g. heat), and (3) sufficient fuel that is readily ignitable. These three components make up what is known as the "fire tripod." Take away any one 'leg' of this tripod, and fire cannot start, or similarly, fire can be extinguished if it occurs.

Construction sites tend to have a potential abundance of all three components. However, since it is rather impractical to control the availability of oxygen on a construction site, construction site fire safety usually focuses on the reduction and control of possible sources of fuel and ignition.

4. IGNITION SOURCES

The first line of defense in construction site fire safety is to reduce the potential for ignition to occur. Towards this end, it helps to know some of the causes of fire in these situations.

The three leading causes of fires in buildings under construction are "incendiary or suspicious" (40%); "open flame, embers or torches" (21%); and, "heating equipment" (10%).[1] To a lesser degree, other causes include: smoking materials; natural causes such as lightning; electrical sources such as distribution systems, appliances, or tools; other heat sources, including cooking equipment; and exposure to external fire sources such as forest fires.

Many of the fires in the category of "open flames, embers and torches" are started by "hot work" activities on the site. Section 5.2 of the BCFC and the VFBL includes in the category of "hot work" all activities that involve open flames or produce heat or sparks, including cutting, welding, soldering, brazing, grinding, adhesive bonding and thermal spraying.

In many cases it is possible to "design out" the need for various types of hot work, thereby removing a potential hazard from the site. When hot work is necessary, Sections 5.2 and 5.6 of the BCFC (Section 5.2 of the VFBL) contain specific requirements for particular procedures and protection for such operations, including conformance in many instances to CAN/CSA-W117.2, *Safety in Welding, Cutting and Allied Processes.* As well, the BCOFC Bulletin includes additional guidance on various aspects to be considered when hot work occurs on a site.

Designing and using a heating/drying system that situates the heating equipment outside of the structure under construction can reduce the risk of ignition by one of the major sources of fire on construction sites. When heating/drying equipment is situated inside, care should be taken to maintain appropriate clearance around the equipment and to ensure adequate ventilation and clearances to combustibles if fuel-fired appliances are involved.

In many cases, vigilance and common sense can reduce the hazard posed by potential ignition sources on a site. Maintaining electrical equipment and tools in good condition, limiting or eliminating open burning – particularly of waste materials – and keeping machinery and vehicles with an internal combustion

[1] *Structure Fires in Vacant or Idle Properties, or Properties under Construction, Demolition or Renovation*, NFPA Fire Analysis and Research Division, Quincy, MA, August 2001.

engine a reasonable distance from combustibles are relatively simple ways to reduce the hazard of fire ignition. Cleaning and removal of combustibles from engine compartments can reduce the likelihood of vehicle fires.

Banning smoking on construction sites can be controversial. While smoking materials are a source of ignition, it is recognized that a complete ban may drive smokers 'underground', which may increase the risk of smoking taking place in more vulnerable, less frequented areas of a site. As a result, a designated smoking area either on or just off of the site may be considered an option. In other cases, it has been seen as appropriate to prohibit any smoking materials from being brought onto the site, or ensuring that any smoking materials are kept in a specific, safe location, such as a locker room. If a designated smoking room is used, 'fuel' (see Section 5 below entitled "Fuel Sources") in it should be limited and it should be well-separated from additional fuel sources. It is recommended that a water-filled container or metal container with a self-closing lid be used for disposal of smoking materials. Contents of such containers should be disposed of off-site on a regular basis. In all cases, compliance to local and provincial regulations should be maintained.

5. FUEL SOURCES

The second line of defense in construction site fire safety is to control any readily-ignitable sources of fuel. This reduces the probability of an ignition source starting a fire, and limits the potential for fire spread if ignition does occur.

As with the handling of potential ignition sources, common sense in the management of the quantities of available fuel can significantly reduce the frequency and impact of fire. This can also reduce the fire exposure of structural wood products and wood-based formwork and scaffolding. Such elements do not tend to catch fire easily, but they can become involved if excessive quantities of waste materials, such as paper, wood shavings and flammable materials, are left lying around and become involved in a fire. Consequently, good housekeeping can be one of the most important factors in fire prevention on a construction site – without fuel, the size of a fire is limited and the likelihood of ignition is reduced.

In other words, proper storage of combustible waste on site, and removal of such waste from the site as frequently as possible, reduces the risk of fires. Regular clearance of rubbish can help thwart opportunistic fire setters, as well as reduce the risk of accidental ignitions.

Strict controls on storage of combustible and flammable liquids and gases, as well as any refueling activities, should be observed, and all regulations should be conformed to. For example, Section 5.6 of the BCFC requires fuel supplies for heating equipment and internal combustion engines to conform to either CAN/CSA-B139-M, *Installation Code for Oil Burning Equipment,* or the British Columbia *Safety Standards Act* and its regulations.

Part 4 of the BCFC and the VFBL, *"*Flammable and Combustible Liquids,*"* provides requirements for the storage, handling and use of flammable and combustible liquids, and these requirements are applicable to construction sites.

It can be a good idea to minimize as much as practical the amount of flammable and combustible liquids in or near a building at any given time. Generators and other fuel-fired appliances should be arranged to be sheltered from the rigorous conditions on a construction site. For instance, temporary fuel lines that may be easily damaged, melted or burned, which may result in the leaking of fuel onto a generator, should be avoided and more robust arrangements provided to avoid feeding a fire with an excessive fuel spill.

Lately, there is the desire to continue construction year-round in all weather, and so more temporary enclosures of the site envelope are seen on construction sites. With a variety of such systems in use, it is good to consider the fire performance characteristics of any materials in systems to be used on your site – the fabrics and other materials of some systems are more flammable than others. Contact of such systems with possible ignition sources should also be avoided.

6. ON-SITE FIRE PROCEDURES AND EQUIPMENT

6.1 Fire safety officers

In most of British Columbia, while there is currently no regulatory requirement for a dedicated person to oversee all fire safety aspects on a construction site, it is considered best practice to designate a full-time 'fire safety coordinator' or a 'fire safety officer'. In the past, such a role was sometimes assigned to site managers or site supervisors as an additional function. However, it has been recognized that while the two functions are not mutually exclusive, both have significant levels of responsibility and are time-consuming. As there is typically a requirement for a construction safety officer on site (under health and workplace safety regulations), it is possible that in some cases that person could also assume the role of fire safety officer.

One of the main differences in the VBBL in comparison with the BCBC is that Division B, Part 8 of the VBBL includes the requirement of a full-time Construction Safety Officer whenever a "complex" building (as described in Division C, Subsection 2.2.7. of the VBBL) is being constructed – that is, typically any building that requires a 'registered professional,' as defined by the VBBL. The Construction Safety Officer's responsibilities outlined in the VBBL include aspects of construction site fire safety, but also include oversight of non-fire safety procedures related to such things as traffic control and hoisting equipment.

On larger projects, consideration may need to be given to having an assistant fire safety officer to fulfill the duties of the fire safety officer in their absence.

Such designated persons need to have an understanding of the fire risks on construction sites and of good fire prevention practices. They should also be familiar with applicable regulatory requirements. The responsibilities of such persons can include clear communication of site fire safety requirements and policies to subcontractors and trades, monitoring of the site for fire safety issues, including compliance by everyone working on the site to those fire safety requirements and policies, applying and updating the site's Fire Safety Plan, which sets out those fire safety requirements and procedures (see Section 10 below entitled "Fire Safety Planning"), and liaising with the local emergency services.

6.2 Hot work procedures

There are Code provisions that require 'fire watch' duties to be carried out whenever hot work takes place. Subsection 5.2.3. in Division B of the BCFC requires that "…*a fire watch shall be provided during the hot work and for a period of not less than 60 minutes after its completion…"* and that *"...a final inspection of the hot work area shall be conducted 4 h after completion of work."* However, in practice, since a fire could occur in the three hours between the end of a 60-minute fire watch and a final inspection that takes place four hours after completion of the work, a two-hour watch is sometimes used, with regular checks by designated on-site personnel during the remainder of the four hours. The VFBL requires a fire watch, but has no specific duration or timing requirements.

The BCFC and the VFBL also stipulate that the fire watch is to be performed by "*… personnel equipped with and trained in the use of fire extinguishing equipment."*

A key requirement of the BCFC and the VFBL is the removal of combustibles or covering of combustibles in the area during hot work to prevent ignition. Fire-retardant covering materials are available for this purpose. Since sparks can skip under covers, resulting in ignition, care must be taken in their use.

In the absence of these measures, the BCFC and the VFBL require that the area be thoroughly wetted, since there is the possibility of ignition of fine fuels even when the area is relatively clean. The impact of water on the structure and finishes can be reduced by use of fine water sprays or pressure washers to limit the quantity of water utilized, but wetting should be sufficient to extinguish sparks on contact. It should be noted that in some cases wetting may not be practical, particularly when trying to meet the maximum moisture limits set in order to proceed with the 'closing in' phase of construction.

6.3 Fire extinguishers and standpipe systems

When it comes to fire-related equipment on site, the BCFC requires that portable extinguishers be provided in a variety of locations. As well, it requires that where a standpipe system is to be installed in a building under construction, the system be installed progressively in conformance with the BCBC. The BCOFC Bulletin provides additional guidance on fulfilling the intent of the BCFC.

Plans and specifications should indicate when a standpipe is required during construction. In a cold (i.e. freezing) climate, a 'wet' riser will require insulation and heat-tracing. The advantage of a 'wet' standpipe system is that the water is immediately available and may be used to feed small hoses for firefighting, wetting down of hot work areas and other purposes. For this reason, wet standpipes can have significant advantages over 'dry' standpipes that provide no water until the fire service connects the standpipe to a water source through a pumper truck or other apparatus. As well, with a dry standpipe system, there is the risk that someone will try to use it as a convenient source of water – they may open a valve on the system and then leave it open when there is no water. If a fire subsequently occurs and the dry standpipe is charged, water can be discharged from the valve(s) that have been left open, which may not only result in water damage in a part of the structure not intimate to the fire, but also can mean reduced water pressure available to emergency responders. Therefore, regular checks of the valves to verify that they remain closed may be necessary. However, a manual dry standpipe system does have the virtue of simplicity, particularly in cold climates.

Since the location of and access to a standpipe system may differ somewhat during construction from the final design, it is helpful to communicate this information to the local fire service.

6.4 Fire detection and alarm systems

If a fire occurs during site hours, the primary aim is to make sure everyone on site reaches safety as quickly as possible. This is one reason why the BCFC also requires that a system capable of sounding an alarm that can be heard throughout the building be provided to alert site personnel in the event of a fire. Such equipment and associated response would usually occur in parallel with other emergency procedures to notify the fire service and respond to the fire.

Installation of a fire alarm system that can detect fire as well as notify site personnel can increase the likelihood that personnel will be made aware of a fire before it becomes large enough to compromise escape routes. A significant factor in reducing the potential damage arising from a fire is the speed of detection, together with a reliable means of alerting the fire service. The speed with which the fire service can be made aware of a fire in a building under construction can impact the amount of damage that may occur.

It should be taken into consideration that fire detection devices typically rely on a localized build-up of heat and/or smoke for activation, which may not occur as readily in a building at various stages of the construction process.

Also, some devices may be activated by operations conducted on the site – for example, hot work, which can generate products of combustion. For this reason, some sites de-activate detection systems during work hours, reinstating the protection when the site is relatively unoccupied. Some types of detectors can be easily contaminated by particles/dust created by construction activities, particularly detectors that require products of combustion to enter a detection chamber of some type. Detectors can also suffer physical damage due to material handling and other construction activities, although the addition of guards to detectors can reduce the degree or frequency of damage. Regular cleaning or replacement of detectors may be considered in some cases, such as where smoke detectors of some kind are used. Some detectors, such as conventional heat detectors, are sealed units and as such are not easily contaminated, although they may still require protection against impact.

Consideration can be given to include supervised wiring to alert to a trouble condition and to provide for automatic notification of a central location, such as an on-site ‘command post’ (see Section 6.6 below entitled “On-site ‘command post’”). The sequence of operation of such systems can be programmed to have this function only after normal working hours, to avoid unnecessary false alarms. It should be noted that the advent of wireless detection and alarm products can reduce the impracticalities related to the installation of wired systems in a building under construction. Distance limits on wireless transmission may need to be considered, but is likely not to be a constraint on most sites, and technology is constantly improving.

PROTECTED SPRINKLER
SUSPENDED FROM CEILING

As can be seen, there are reasons why the fire detection and alarm systems that are contemplated for the finished building are often unsuitable for use during construction. There is an increased risk of damage or contamination of valuable system components if installed too early in the construction phase. For this reason, NFPA 72 *National Fire Alarm and Signaling Code* contains specific language to make designers and installers aware of the potential problems associated with early installation of permanent equipment.

6.5 Fire sprinkler systems

Issues similar to those described for detection/alarm systems and standpipes can also apply to the installation of either temporary or permanent automatic sprinklers and their associated systems at any stage of construction, whenever they might be required in a completed building or considered for use.

There are also specific sprinkler-related issues to be considered in contemplating either the early installation of a permanent sprinkler system, if one is to be present in the completed building, or installation of a temporary sprinkler system, which may be separate from or make use of a permanent sprinkler system’s water-supply piping.

For example, the extent of a temporary system installation (e.g. use of temporary sprinkler protection for specific hazards or localized areas, such as material storage spaces), and the complications related to installing sprinklers in a cold environment both may need to be weighed against the level of potential fire risk and the duration of that risk. The size of a project and the length of time that the project will be under construction are also specific factors to consider.

Automatic sprinkler systems that are intended to protect a building, its occupants and its contents once the building is fully constructed and occupied are designed to work with certain construction features already in place, such as finished ceilings. The success of automatic sprinkler systems within completed buildings using the fundamental principles and standards developed over many years is well documented. However, there is little information on what design features would be appropriate for successful performance of a sprinkler system during a fire scenario while a building is still under varying stages of construction. As a result, the prediction of possible outcomes in such scenarios, which is necessary to evaluate the effective risk reduction resulting from implementation of such a strategy, can be difficult.

It is possible that different stages of construction might require different sprinkler system design features, which could require moving or altering parts of a system multiple times during the course of construction. This could cause delays in the construction schedule.

The increased likelihood of a sprinkler system being exposed to adverse climatic conditions when installed in a building still under construction can also greatly increase the potential of system problems arising due to corrosion. Designing a sprinkler system that has greater corrosion resistance than may be required for a system designed for a typical completed building can greatly increase the cost of the system.

Access to a sufficient and reliable water supply is important to the performance of a sprinkler system, and therefore water supply issues should be taken into consideration. It may be determined that a fire pump is needed to supply enough water at the appropriate pressure to a sprinkler system protecting a building during construction; however, installation and commissioning of a fire pump for use only during the construction phase can be complicated and expensive.

Whereas most permanent automatic fire sprinkler system installations are currently sequenced from the top storey down, buildings are constructed from the bottom up. As a result, installation of temporary automatic sprinkler protection for buildings under construction may need to consider a similar bottom-up approach.

In a sprinkler system designed to be used during both the construction phase and post occupancy, temporary sprinklers are often recommended, as sprinklers commonly need to be subsequently replaced and aligned with finishes in accordance with the standard installation requirements. Sprinklers can be protected by guards to enable a temporary level of protection of the devices to be achieved during building construction, but some guards can affect activation and performance of the sprinklers while in place.

While some sprinklers are as robust as conventional heat detectors, many newer types can be subject to damage resulting in a greater potential for accidental discharge of water. As a result, when it is decided to install an automatic sprinkler system as part of the plan to mitigate fire risk during construction, consideration should also be given to interconnecting it with a fire alarm system to provide an alarm in the event of either sprinkler water flow or trouble condition.

Automatic sprinkler systems, as well as fire detection and alarm systems, are like any engineered tool or system – they are most effective when designed with the specific situation in mind and when used within their limits. Advance planning and design, and coordination with the local jurisdiction helps ensure the timely provision of various aspects of such systems, including water supply for any fire suppression systems.

6.6 On-site 'command post'

One additional measure that is discussed in the NFPA 241 Standard, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, that may be useful to consider is the provision of an on-site 'command post'. Such a post would contain a copy of the fire safety plan, building and site drawings, emergency information, one or more means of communication, keys and other equipment for use by both emergency responders and site fire safety officer(s). When the use of a command post is implemented, its location should be chosen in consideration of emergency access and overall safety during a potential fire event.

7. SITE SECURITY

One hazard that, because of its very nature, is not currently addressed directly by the codes covering building design and construction is the potential for arson.

For the protection of the public, the BCBC and the VBBL contain requirements in Part 8, "Safety Measures at Construction and Demolition Sites", for fencing or barricades. Such features can help to prevent unauthorized access, thereby reducing the frequency of entry to the site by potential intentional or accidental fire-starters. Good site perimeter control and other security provisions can assist in reducing other financial losses, including material and equipment theft.

Other useful security measures include good lighting or motion-activated lighting. In addition, there is a wide variety of security equipment available, including electronic monitoring and video surveillance. The latter, for instance, has proved useful in detecting intruders via perimeter cameras.

An organized and well-trained security service can be beneficial in discovering a fire in its early stages, particularly at those times that sites are largely unoccupied and fires are less likely to be manually detected. Often, such services are designed to cover all areas of the site at least every hour. Such a service can also notify the fire department of an emergency, keep track of the presence and operational status of on-site fire protection equipment, may identify specific fire hazards, and can review areas where hot work or other hazardous operations have occurred.

8. PROVISION FOR EGRESS

Adequate means of escape for all employees should be provided – from the building(s) under construction, any temporary building(s) and from the site itself.

The BCFC requires that in areas of a building where construction operations are taking place, "*…at least one exit shall be accessible and usable at all times*." An exit in this case is defined as that part of a continuous path of travel, including doorways, provided for the escape of persons that leads from the floor area on any storey of a building to one of the following:

- a separate building,
- an open public thoroughfare, or
- an exterior open space protected from fire exposure from the building and having access to an open public thoroughfare.

Exit routes should be clearly visible, and all site personnel should be instructed on the procedures to follow in the event of a fire emergency.

Multiple exit points around the site perimeter can also be beneficial, since a single exterior exit route can be more easily obstructed in an emergency.

9. ACCESS FOR FIREFIGHTING

The BCFC contains provisions that require that unobstructed access be maintained to on-site fire equipment such as fire hydrants, portable extinguishers and fire department connections for standpipe and sprinkler systems. It also requires that, when there is fencing, "*…provision shall be made for access by fire department equipment and personnel*." This can be accomplished in a variety of ways, including key boxes installed at known or identifiable accessible locations.

Temporary or permanent roads that are free of obstructions (including parked vehicles), made of all-weather material and of appropriate width are important for efficient access of fire apparatus, and dead-end roads may need turnaround provisions.

The BCFC also includes an Appendix Note (Division B, A-5.6.1.4.(2)) that states "*…provision shall be made for the use of elevators, hoists or lifts to assist* [firefighting] *personnel in reaching the upper storeys of the building*."

The BCOFC Bulletin provides additional guidance on several aspects of access for firefighting operations.

10. FIRE SAFETY PLANNING

All construction sites are required by the BCFC and the VFBL to have a Fire Safety Plan (FSP). The site's FSP is the written plan that should set out everything that will be done on that particular project to minimize the risk of fire and to protect the safety of people working on the site. It should take into consideration all relevant regulations (such as those discussed in this Technical Note), as well as anything else that is considered relevant to reduce the risk and impact of fire on the site. In addition, it should include as much information as possible regarding the expected stages of implementation of the various fire protection systems and procedures that are planned.

It should be noted that often a 'one-size-fits-all' approach is not necessarily appropriate when it comes to FSPs – each project and site is unique and those unique aspects need to be considered and addressed in the site's FSP. This may seem obvious for larger projects; however, even smaller projects can present individual features (hazards) that may need special attention.

The BCOFC Bulletin provides an excellent list of questions to consider in the development of a FSP for your site. It includes the reminder that a FSP should not only reflect the unique characteristics of the building design and construction operations and techniques, but should also consider the available firefighting infrastructure. For this and other reasons, the FSP should be prepared in cooperation with the local fire department and other applicable regulatory authorities.

Planning, creating and maintaining effective lines of communication between the various stakeholders in fire safety on a construction site, throughout the construction process, can have a positive effect not only on the probability of an occurrence of a fire event, but on the outcome of an event if one does occur. For example, emergency responders can face significant challenges during a fire situation in a building under construction because the fire protection features and systems are not fully in place and various aspects of the building and site are constantly changing. The more current the information available to them on the existing stage of construction when an incident occurs, the better their decision making can be. This increases the efficiency and effectiveness of their response and enhances the safety of both site workers and emergency service responders. Building relationships that facilitate ongoing information sharing begins with consulting the local fire services during the development of the FSP.

Once the FSP is created, it must be reviewed, and updated as required – for example, at regular intervals as construction proceeds and whenever significant design changes occur.

As the BCOFC Bulletin mentions, it can be beneficial to obtain the services of a consultant who specializes in fire safety planning. Such a consultant should be capable of carrying out a fire risk assessment of the site at various stages, identifying fire hazards, as well as mitigating factors and probable fire scenarios that can vary during the course of construction operations. Such a person should have the experience and training to oversee the development and implementation of any FSP.

The key steps in the creation of a FSP are:

- *Analysis of the site – its risks and factors arising from the construction operations, implementation schedule and phases of work.*
- *Development of the necessary policies, procedures, and systems to prevent and control risks.*
- *Analysis of available resources, both on and off the site, including allocation of key staff to fire and emergency duties. This includes consultation with the emergency services to obtain their feedback and to address any concerns.*
- *Development of a protocol of emergency procedures for various individuals with roles and responsibilities in a fire emergency. This includes procedures for sounding the alarm, calling the appropriate fire and emergency services, shut down of certain hazardous operations/services, etc.*

As projects become larger, more complex, and are developed in several stages, fire protection design tools that have been used in the past for the design of new buildings or for evaluation of fire protection systems in existing buildings are starting to be used to analyze the potential impact of various fire protection strategies in buildings under construction. One example of such a tool is the Fire Safety Concepts Tree, found in NFPA 550, *Guide to the Fire Safety Concepts Tree*.

Also, the SFPE *Engineering Guide to Fire Risk Assessment* provides guidance for the use of fire risk methodologies that can be used in buildings under construction.

11. EDUCATION AND A 'CULTURE OF SAFETY'

Section 4.16, "Emergency Preparedness and Response – Training," in Part 4, "General Conditions," of the BC OHS Regulation stipulates that all workers must be given adequate instruction in the fire prevention and emergency evacuation procedures applicable to their workplace. And, as mentioned earlier, the OHS Regulation is applicable to construction sites.

Therefore, all parties involved in the activities on the construction site and that have staff on site, including owners, designers, general contractors and subcontractors, should work together to ensure all personnel have received at least the training necessary to conform to this requirement.

It is true, though, that developing a 'culture of fire safety' on any construction site can take a little bit of time, money and effort, particularly at the start. After all, personnel need to be trained, changes may need to be made to some long-standing construction processes and procedures, and maintaining good communication with all the fire safety stakeholders can be time consuming. It isn't always easy; but, the benefits of taking these steps can outweigh the effort.

Fire safety on a construction site is all about teamwork. Explaining why certain policies and procedures are being implemented can go a long way to assuring workers understand their importance, so that everyone involved in a project can understand the benefits to themselves and their co-workers, as well as to the project as a whole.

The work environment that emerges can pay off in many ways, not least of which is increased safety of site personnel. A reduction in fire incidents can also increase productivity, and decreases direct and indirect financial losses related to slowdowns in the construction schedule (or a complete shutdown) that can result from a fire incident. Increased avoidance of slow-downs or shut-downs of a site due to fire incidents also means continued employment for everyone involved. A good fire safety plan that is based on a thorough analysis of fire risks, and that is well implemented and integrated into site practices and scheduling of construction activities, can also demonstrate to an insurance company that the project managers and owners are committed to operating a safe site, which can potentially result in better insurance rates.

12. CONCLUSION

Most construction site fires can be prevented with knowledge, planning and diligence; and, the impact of those fires that do occur can be significantly lessened. Understanding both the general and specific hazards and risks that are potentially limited to a particular construction site and addressing them requires education and training, as well as preparation and perseverance.

Conformance with the local safety regulations is the foundation for the establishment of suitable construction site fire safety. Assessment, selection and successful implementation of various 'best practices', based on the specific needs of your site, builds on that foundation and leads to a culture of fire safety that can be understood and practiced by all.

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    d. Fleming, R. P. "Fire Sprinkler Systems During Construction," and,
    e. Prendergast, E. J. "Supplying Water for High-Rise Construction Projects."

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Photos on pages 7, 8, 9 and 10 of this document were obtained on the construction site of New Gate Apartments, Kelowna, BC, courtesy of Greyback Construction Ltd., Penticton, BC

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Canadian Wood Council | Conseil canadien du bois

Natural Resources Canada | Ressources naturelles Canada

Forestry Innovation Investment

Wood *WORKS!* BC Report Card

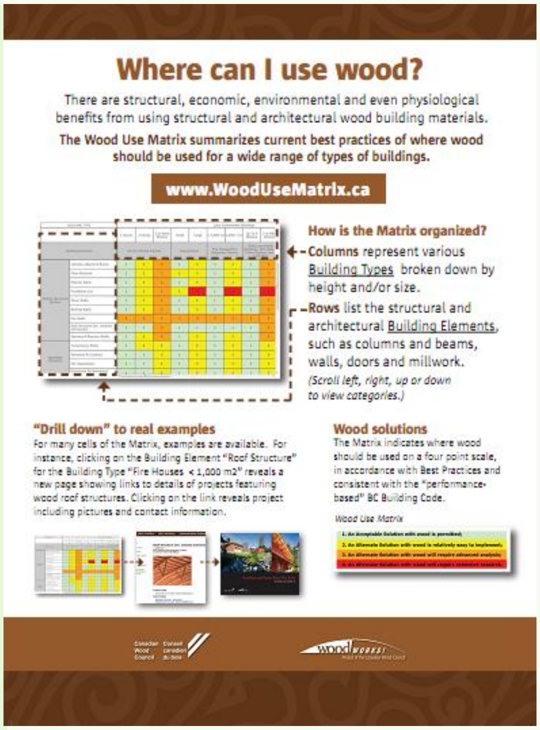
(APRIL—JULY 2012)

Wood *WORKS!* BC continues to develop opportunities for BC wood products in new markets. Our ongoing mission is to increase wood consumption and during this reporting period twelve (12) projects we have been involved with have progressed to the construction phase. The estimated value of these projects is $100,703,000 with an estimated value of wood content of $14,717,000.

The Wood Use Matrix—www.woodusematrix.ca.

Wood *WORKS!* BC was pleased to be an exhibitor at the 2012 Architectural Institute of British Columbia annual conference in Vancouver, May 9–11. More than 500 delegates were in attendance, most of whom were BC-registered architects.

Wood *WORKS!* BC presented the Wood Use Matrix, a computer application which essentially operationalizes the Wood First Act in BC. The Wood Use Matrix is a tool that summarizes the current best practices for the use of wood building materials and systems for various elements of a wide variety of building types. The matrix reflects both the BC Building Code and the current state-of-the-art in wood design and engineering. The matrix enables users to 'drill-down' to examples, case studies and other resources that they may wish to draw upon to realize wood in their projects, making it easier to maximize the use of wood—www.woodusematrix.ca. It is CWC's intention to eventually develop this same Matrix for other Canadian regions.



Wood *WORKS!* BC at BOABC's Annual Conference

Wood *WORKS!* BC was the official host for the Wednesday lunch of the 2012 Building Officials Association of BC (BOABC) annual conference and general meeting. This was a timely opportunity to provide the membership with an update on recent activities of Wood *WORKS!* BC, including achievements such as the Wood First Act; the BC Building Code revision, which now permits six-storey or mid-rise construction; and an overview of the Case for Tall Wood Buildings report.

The main focus for this year's conference was on two White Papers being introduced by The Building and Safety Standards Branch: A Modern Regulatory System and Certification of Building Officials. Both papers were presented to the conference, outlining the government's intent to move forward with these initiatives. A Modern Regulatory System includes the introduction of a uniform building code in BC and also includes the creation of a body of technical experts who would be a decision-making body on alternate solution proposals and new products and assemblies. To view these presentations visit the BOABC website - under the right hand column "What's New?".

Key Deliverables in Interim 1

⇒ Team Planning Session and Provincial Steering Committee meeting

⇒ Attendance at BC Area Association AGM's (AKBLG, NCLGA, LMLGA and VICC); FCM and CHES chapter meetings; and Educational Facilities Planning meeting

⇒ Mailing of magazines featuring the Wood Design Award supplement to our Sponsors and PSC members

⇒ Participated in 10 Tradeshows and Conferences

⇒ Multiple relevant In-House Seminars (Plywood 101 and Mid-Rise Update)

⇒ Canada/US WW Technical Advisors meetings in Quebec

Demo Projects Grand Opening: Three BC Institutional Demonstration Projects Recognized

In June the BC forest products industry recognized wood demonstration project openings and events in British Columbia - North Shore Credit Union Environmental Learning Centre, Elkford Community and Conference Centre and City of North Vancouver Civic Centre Renovation. The showcasing of innovative wood products and building systems has been supported by the Government of BC through the Ministry of Jobs, Tourism and Innovation (Forestry Innovation Investment), Wood *WORKS!* BC, FPInnovations, and BC Wood Specialties Group.

These demonstration projects are intended to help accelerate the adoption of innovative wood design and engineering systems not only in BC, but also nationally and internationally.

These wood demonstration projects were selected in 2010 with advice from Wood *WORKS!* BC to expand the use of wood products by applying traditional products in non-traditional ways, creating innovative wood solutions structurally or architecturally, and creating the greatest potential for commercial viability.

Following completion of the projects, Pat Bell, the Minister of Jobs, Tourism and Innovation with the Government of BC, congratulated project teams, forest product suppliers and manufacturers, and the communities on their new buildings. "As part of *Canada Starts Here - The BC Jobs Plan*, we continue to look for innovative ideas to increase the use of a renewable BC resource, creating new jobs in our province through new demand for BC wood products and expertise."

UPCOMING EVENTS

Summer Wood Seminar Tours:
- Okanagan - August 13-16 (Penticton, Kelowna, Vernon and Kamloops)
- Kootenays - August 27-30 (Revelstoke, Golden, Cranbrook and Nelson)

Attendance at UBCM Convention:
- September 24-28, Victoria

Wood Solutions Fair:
- October 23 , Vancouver Convention Centre (East)

Wood Design Luncheon Conferences:
- Kelowna—November 27
- Victoria—November 29
- Nanaimo—November 30

New Case Study

Funded by NRCan, a new case study outlining 4 demonstration projects was completed in June by the CWC. Highlighted projects include: University of British Columbia's Earth Sciences Building, University of British Columbia's BioEnergy Facility, Port Alberni Secondary School and the Confederation College in Thunder Bay.

CWC would like to thank NRCan, a significant contributor to Canada's Wood *WORKS!* program, for their leadership in helping advance the vision of the Canadian wood products industry and the development of a wood culture in Canada.

To request a copy of the study please contact Natalie Tarini at ntarini@cwc.ca.

In summary, this first trimester Wood *WORKS!* BC has delivered 224 hours of education and training to architects, engineers, design/build professionals and future practitioners.

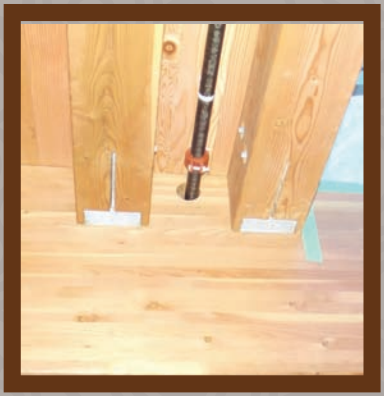
North Shore Credit Union Environmental Learning Centre

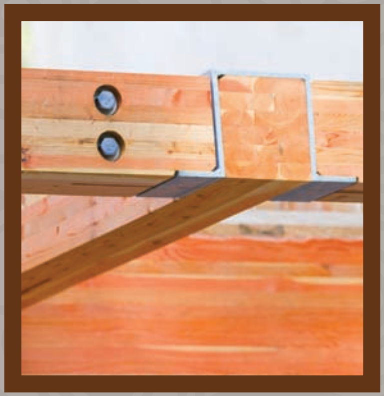
The remarkable new $5.8 million North Shore Credit Union Environmental Learning Centre, an addition to the North Vancouver Outdoor School (NVOS) in Brackendale near Squamish, is an 850-square-metre building which reflects the environmental principles it espouses. The facility, set in a magnificent forest with a treehouse aesthetic, includes a welcoming space, featuring a nature gallery, exhibition space; assembly/dining hall, and classrooms/learning spaces. The building is both energy and water efficient fitting into the area's ecosystem, and befitting of the centre's purpose for environmental leadership and learning. Using structural mass timber construction to conserve energy and reduce the centre's environmental footprint, it is truly a showcase for wood innovation.

> *The aesthetics of the wood inside the building create a seamless connection to the outside world. With a lighter environmental footprint, our building speaks the language of its purpose.*
>
> John Lewis
> Superintendent of Schools & CEO
> North Vancouver School District

North Shore Credit Union Environmental Learning Centre

Innovating with wood: Mass Timber – expanding the possibilities of wood





Key wood innovation features:

- *Cross-laminated timber (CLT) walls and floors*
- *Glulam column and beam super-structure*
- *Reclaimed timber ceiling/roof*

Mass timber systems are very large, complete wall, floor and roof sections made from engineered wood products, and used in a variety of building types and sizes. These products offer significant benefits in terms of fire, acoustic and structural performance; scale possibilities, rigidity, strength, stability and construction efficiency.

The North Shore Credit Union Environmental Learning Centre is constructed with **cross-laminated timber,** which is a large multi-layer wooden panel made of lumber, and engineered for strength through laminations of different layers placed cross-wise to the adjacent layers.

The use of **cross-laminated timber (CLT)** in the North Shore Credit Union Environmental Learning Centre demonstrates its strength and stiffness, proving it to be a valid alternative to concrete and steel. They are lighter, more environmentally-friendly and easier to install.

The centre also features a **glulam column and beam super-structure** made from engineered timbers consisting of wood laminations that are bonded together with strong, waterproof adhesives, creating an ideal structural component.

This project also demonstrates the effectiveness of off-site prefabrication using state-of-the-art design/fabrication technologies, such as computer numerically-controlled equipment to ensure absolute precision of structural components.

wood WORKS! Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

North Shore Credit Union Environmental Learning Centre

Only wood starts off green, and stays green.






> *Comparative life cycle assessment studies generally show wood in construction performs well relative to non-wood materials in a number of environmental impact measures, including greenhouse gas emissions, other emissions to air and water, embodied energy and carbon storage.*
>
> FPInnovations

With growing pressure to reduce the carbon footprint of the built environment, building designers are increasingly being called upon to balance functionality and cost objectives with reduced environmental impact. Wood can help to achieve that balance. Wood costs less—economically and environmentally—while delivering more in terms of its beauty, versatility and performance. Innovative new technologies and building systems have enabled longer wood spans, taller walls and higher buildings, and continue to expand the possibilities for wood use in construction. Wood is more than a building material; it's a renewable and responsible choice.

reTHINK WOOD

wood WORKS! Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

North Shore Credit Union Environmental Learning Centre

The North Shore Credit Union Environmental Learning Centre is one of several demonstration projects in the province selected in July 2010 to expand the use of wood products by applying traditional products in non-traditional ways, or creating innovative wood solutions. This and two other projects have been supported by the forest products and wood design industries and by the Government of British Columbia (Forestry Innovation Investment) along with Wood *WORKS!* BC and FPInnovations.

> *The North Shore Credit Union Environmental Learning Centre demonstrates a blend of leading-edge international technologies and BC design concepts. This further accelerates wood design and construction in BC to the forefront of the global experience.*
>
> Mary Tracey
> Executive Director, Wood *WORKS!* BC

> *We used the natural beauty and warmth of the reclaimed Douglas fir roof structure and exposed glulam beams and columns, to evoke a sense of familiarity and comfort for the students and teachers. We then clad the building in vertical cedar slats that were treated with a natural preservative, to allow the building to slowly weather and take on the qualities of the surrounding trees. And finally, we developed a system of structurally reinforced glulam floor beams that were penetrated allowing the mechanical ducting to be hidden from view, and then used CLT panels as the structural floor system. The result is a building that explicitly shows how 'wood first' initiatives are not only achievable, but rather, intrinsic in our realization of a more satisfying built environment.*
>
> *John Hemsworth*
> *MAIBC | M.ARCH | B.ENG | LEED AP*
> *Project Architect*
> *MCFARLAND MARCEAU ARCHITECTS LTD*

wood *WORKS!* Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

City of North Vancouver Civic Centre Renovation

The City of North Vancouver's stunning new Civic Centre renovation is a 770-square-metre space featuring a one-storey atrium connecting the City Hall to the Library. Visitors are immediately captivated by the modern aesthetic; with large windows and a central skylight flooding the airy space with light; and wood generating warmth, beauty and comfort. The public building is also a showcase for wood innovation, with state-of-the-art design fabrication behind the roof panel system, and an inventive new floor system.

> *The extensive use of wood in the design of the renovated city hall provides a warm welcome to our residents. The use of local, renewable construction materials and connection to the Lonsdale Energy Corporation district energy system demonstrates the City's strong commitment to sustainable practices to reduce our greenhouse gas emissions.*
>
> Mayor Darrell Mussatto
> City of North Vancouver

wood WORKS! Project of the Canadian Wood Council

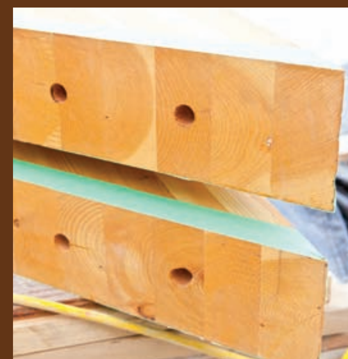
Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

City of North Vancouver Civic Centre Renovation

Innovating with wood: Mass Timber – expanding the possibilities of wood





Key wood innovation features:

- *Laminated Strand Lumber (LSL) structural roof panel system*
- *LSL wall panelling*
- *Composite glulam/concrete floor system with specialized steel shear connectors and integrated radiant heat*

Mass timber systems are very large, complete wall, floor and roof sections made from engineered wood products, and used in a variety of building sizes. These products offer significant benefits in terms of fire, acoustic and structural performance; scale possibilities, rigidity, strength, stability and construction efficiency. They are a valid alternative to steel and concrete as they are lighter, more environmentally-friendly and easier to install.

The City of North Vancouver Civic Centre Renovation is constructed with **Laminated Strand Lumber** (LSL) roof panel systems. LSL is a process which involves cutting wood into thin strands which are then glued together using a steam-injection process. The stranded lumber roof panels provide structural support, architectural beauty, conceal all electrical and mechanical systems and absorb sound.

The composite floor system consists of glulam post and beams supporting the **concrete floor slab**, a first in BC, Canada and the U.S.

This project demonstrates "multiple function components" at a new level, with ceiling/roof panels that integrate services in a single easy-to-install element. It also demonstrates the effectiveness of off-site prefabrication using state-of-the-art design/fabrication technologies, such as computer numerically-controlled equipment to ensure absolute precision of structural components.

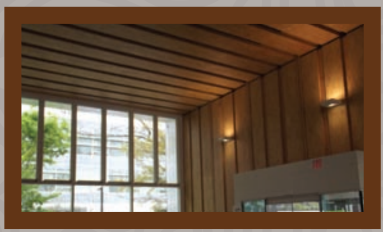
wood WORKS! Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council
Conseil canadien du bois

City of North Vancouver Civic Centre Renovation

Only wood starts off green, and stays green.



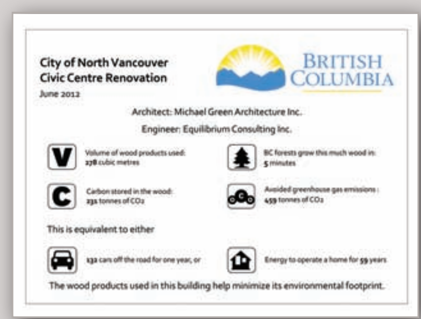




> *Comparative life cycle assessment studies generally show wood in construction performs well relative to non-wood materials in a number of environmental impact measures, including greenhouse gas emissions, other emissions to air and water, embodied energy and carbon storage.*
>
> FPInnovations

With growing pressure to reduce the carbon footprint of the built environment, building designers are increasingly being called upon to balance functionality and cost objectives with reduced environmental impact. Wood can help to achieve that balance. Wood costs less—economically and environmentally—while delivering more in terms of its beauty, versatility and performance. Innovative new technologies and building systems have enabled longer wood spans, taller walls and higher buildings, and continue to expand the possibilities for wood use in construction. Wood is more than a building material; it's a renewable and responsible choice.

reTHINK WOOD


City of North Vancouver
Civic Centre Renovation
June 2012

BRITISH COLUMBIA

Architect: Michael Green Architecture Inc.
Engineer: Equilibrium Consulting Inc.

Volume of wood products used: 278 cubic metres

BC forests grow this much wood in: 5 minutes

Carbon stored in the wood: 231 tonnes of CO_2

Avoided greenhouse gas emissions: 459 tonnes of CO_2

This is equivalent to either

132 cars off the road for one year, or

Energy to operate a home for 59 years

The wood products used in this building help minimize its environmental footprint.

wood WORKS! Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

City of North Vancouver Civic Centre Renovation

The City of North Vancouver Civic Centre Renovation is one of several demonstration projects in the province selected in July 2010 to expand the use of wood products by applying traditional products in non-traditional ways, or creating innovative wood solutions. This and two other projects have been supported by the forest products and wood design industries and the Government of British Columbia (Forestry Innovation Investment) along with Wood *WORKS!* BC and FPInnovations.

> *The City of North Vancouver Civic Centre Renovation demonstrates a blend of leading-edge international technologies and BC design concepts. This further accelerates wood design and construction in BC to the forefront of the global experience."*
>
> Mary Tracey
> Executive Director, Wood *WORKS!* BC

> *Linking two aging concrete buildings with the new innovative wood atrium structure created a new sustainable story for City Hall; a story of a material grown by the sun and connected to the past, present and future of the North Vancouver community and economy.*
>
> Michael Green
> MAIBC FRAIC AAA AIA
> Michael Green Architecture Inc.

wood WORKS! Project of the Canadian Wood Council

Forestry Innovation Investment

Canadian Wood Council / Conseil canadien du bois

Where can I use wood?

There are structural, economic, environmental and even physiological benefits from using structural and architectural wood building materials.

The Wood Use Matrix summarizes current best practices of where wood should be used for a wide range of types of buildings.

www.WoodUseMatrix.ca

BUILDING TYPE		Local Government Buildings								
		1 Storey	2 Storey	3 or More Storeys	Small	Large	< 1,000 m2	1,000+ m2	Up To 4 Storeys	5 or Mor Storeys
Building Elements		Arts & Cultural Centres			Arenas/Pools		Fire Houses/First Response Centres		Office and Admin Buildings, City Halls Police Stations (exc Lock-Ups)	
Primary Structural System	Columns, Beams & Braces	1	2	3	1	2	1	2	1	3
	Floor Structure	1	2	3	2	2	1	2	1	3
	Exterior Walls	1	2	3	1	2	1	2	1	3
	Foundation (iv)	1	2	3	2	4	1	4	1	4
	Shear Walls	1	2	3	1	2	1	2	1	3
	Bearing Walls	1	2	3	1	2	1	2	1	3
	Fire Walls	3	3	3	3	3	3	3	3	3
	Roof Structure (inc. columns and braces)	1	1	3	1	1	1	1	1	3
	Stairway & Elevator Shafts	1	2	3	1	2	1	2	1	3
Secondary Structure	Convenience Stairs	1	2	2	1	2	1	2	1	2
	Entrances & Canopies	1	1	2	1	2	1	2	1	2
	Fire Separations	1	1	2	1	2	1	2	1	2
	Enclosures for Mechanical	1	1	2	1	2	1	2	1	2

How is the Matrix organized?

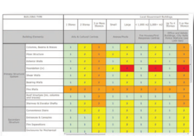
Columns represent various <u>Building Types</u> broken down by height and/or size.

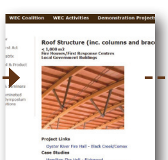
Rows list the structural and architectural <u>Building Elements</u>, such as columns and beams, walls, doors and millwork.

(Scroll left, right, up or down to view categories.)

"Drill down" to real examples

For many cells of the Matrix, examples are available. For instance, clicking on the Building Element "Roof Structure" for the Building Type "Fire Houses < 1,000 m2" reveals a new page showing links to details of projects featuring wood roof structures. Clicking on the link reveals project including pictures and contact information.





Wood solutions

The Matrix indicates where wood should be used on a four point scale, in accordance with Best Practices and consistent with the "performance-based" BC Building Code.

Wood Use Matrix

1. **An Acceptable Solution with wood is permitted;**
2. **An Alternate Solution with wood is relatively easy to implement;**
3. **An Alternate Solution with wood will require advanced analysis;**
4. **An Alternate Solution with wood will require extensive research.**

Canadian Wood Council / Conseil canadien du bois

wood WORKS! Project of the Canadian Wood Council

Using wood wisely

"While the Matrix gives guidance on the use of wood it is not intended to supersede the judgment of the responsible design professionals."

Who created the Matrix?

The Matrix for Building Types typical to local governments was developed by an expert panel including an architect, engineer, fire consultant and code official, as well as the combined staff of Wood *WORKS!* BC and FPInnovations.

For projects developed directly by the provincial government, Wood Use Matrix values were provided by procurement working group representatives from each ministry. They relied on a combination of internal expertise and consulting architectural, engineering and code experts.

The results and links to example projects were coordinated by Wood *WORKS!* BC and are reviewed periodically for accuracy, and to include the impact of the latest designs, wood products and wood building systems.

www.WoodUseMatrix.ca

Testimonials

"The Wood Use Matrix is becoming a valuable new tool for architects. The Wood Use Matrix summarizes the best practices for the use of wood materials and systems for a wide variety of public buildings and provides specific examples and case studies of actual projects."

Richard Bolus - Senior Partner - CEI Architecture Planning Interiors

"As a supplier of value-added structural wood products, the Wood Use Matrix has been extremely helpful by enabling us to show our customers which components of their specific type of projects wood can most easily be used. Being able to drill into each area to show examples of built projects provides them with a lot of comfort."

Andre Lema - Manager – Business Development – Western Archrib

"As a structural engineer specializing in wood, I often see designers avoiding the use of wood because they simply think it is not allowed by the code – or more often are unsure if it is acceptable. This is often the case during the preliminary planning of a project. The Wood Use Matrix demystifies the acceptable use of wood and provides designers with a useful tool to easily determine whether wood is either acceptable by code or may be proven by an "alternative solution".

Grant Newfield – Principal - Read Jones Christoffersen Ltd.

Feedback:

Recommendations for improvements to the Wood Use Matrix should be sent to:
whofstatter@wood-works.ca or call Werner Hofstatter: 1 877 929 9663 ext. 9

The Case for Constructing Tall Wood Buildings - Summary

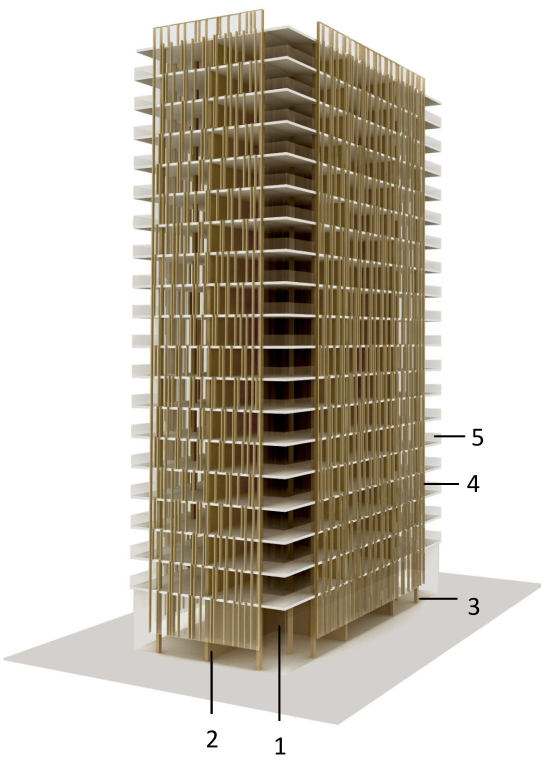
The Case for Tall Wood Buildings **illustrates how Mass Timber structures can meet the relevant structural design, fire and safety criteria within a cost driven market. The feasibility study addresses the difference between small-scale dimensional lumber solutions (light wood-frame) and Mass Timber construction - which uses solid wood panels engineered for strength through laminations of alternating layers that are available in massive dimensions, up to 64 long by 8 feet wide.**

One of the new construction models for tall buildings introduced in the feasibility study is the use of mass timber panels - the concept is referred to as 'Finding the Forest Through the Trees' (FFTT). "We selected the name to acknowledge the scale of the challenge facing the world today," explains Michael Green, Principal at Michael Green Architecture, formerly Principal at mgb ARCHITECTURE + DESIGN and co-author of the report. "To slow and contain greenhouse gas emissions and find truly sustainable solutions to building, we must look at the fundamentals of the way we build - from the bones of large urban building structures to the details of energy performance. We need to search for the big picture solutions to today's vast climate, environmental, economic and world housing needs."

Co-authored by Michael Green, Principal at Michael Green Architecture, former Principal at mgb ARCHITECTURE + DESIGN, and J. Eric Karsh, Principal at Equilibrium Consulting, *The Case for Tall Wood Buildings* uses science, engineering, design, reference and testing information to address some of the preconceptions that exist for consumers, building code authorities, private developers and the construction industry surrounding the use of wood in tall buildings.

The Case for Tall Wood Buildings delves into topics that include wood and climate change, structural and height findings, building code and life safety findings, charring and encapsulation methods, architectural findings, industry and market perception - representing the views of the many interviewed developers/marketing groups/contractors/fire chiefs/ building authorities, and ultimately acting as a precursor for revolutionizing mid-rise and tall buildings around the world.

The study confirms that it is possible to construct 10 to 30 storey buildings using new and existing Mass Timber technologies available from the wood industry. These products used in parallel with the construction system devised by the concept team can offer viable alternatives to existing systems. Massive Timber Building systems offer an exciting and innovative solution with long-term benefits to the construction sector. From an environmental point of view it supports society's fight against climate change. As one of the most sustainable materials available to builders, wood offers an efficient solution for larger scale tall buildings.



Glulam curtain wall and corner balconies

1—Structural core
2—Structural unit partition walls
3—Glulam columns
4—Protective envelope
5—Corner balcony

For over a century, mid-rise and tall buildings around the world have been built primarily with concrete and steel. While these materials will continue to be important, factors such as climate change and housing demands due to urban intensification are realities that need to be addressed with new and innovative design solutions and construction methodologies. *The Case for Tall Wood Buildings* encourages architects, engineers and designers to push the envelope of conventional thinking about wood construction and inspires them to expand this discussion so that wood is positioned as the driving force behind a systemic change for the building industry - one with environmental, economic and common sense benefits.

The feasibility study was commissioned by the Canadian Wood Council on behalf of the Wood Enterprise Coalition (a partnership of Wood WORKS! BC, FPInnovations, and BC Wood Specialties Group), with support from Forestry Innovation Investment, and prepared by mgb ARCHITECTURE + DESIGN, Equilibrium Consulting, LMDG Ltd, and BTY Group.

When wood fibre is harvested sustainably, using wood systems as substitutes for other building materials can reduce greenhouse gas emissions. Wood's ability to store carbon makes it an important alternative structural building material in application where it can replace steel and concrete. *The Case for Tall Wood Buildings* presents buildings from 10 to 30 storeys that can be achieved using new Mass Timber techniques. The report explains why and how these building designs will become increasingly important choices in the future marketplace and ultimately revolutionize construction methodologies for mid-rise and tall buildings.

Tall wood buildings are not a new concept; 1400 years old wood pagodas that are 19 storeys remain intact and standing to this day in Japan, a high seismic and wet climate environment. Recent innovations around the world, such as a 17 storey building in Norway, have triggered a desire to support the construction of taller wood buildings.

About the system

The FFTT solution presented by the conceptual team proposes a unique tilt-up system that effectively balloon-frames Mass Timber panels in a cost-effective and simple manner to build tall wood buildings. The system uses a strong column – weak beam structural approach. Mass Timber panels are assembled together for floors, walls, and the building core. Engineered wood columns (up to 12 storeys) and steel beams and ledger beams (over 12 storeys) are integrated into the Mass Timber panels supporting the floors. The introduction of steel allows for a solution to the weak beam structural approach, as well as adds a great deal of flexibility which allows the system to achieve the necessary heights with a predominantly all-wood solution.

The FFTT system uses the engineered strength of Cross Laminated timber, Laminated Strand Lumber and Laminated Veneer Lumber (panels of up to 8' and 9' wide and 64' long). These products are manufactured in North America and readily available to design and construction teams. The system is adaptable to many building types, scales and locations and allows for the fast erection of very simple, structurally sound buildings. The key principle behind FFTT intends to drive cost of building down to make wood more competitive with steel and concrete. Its success will come from its ultimate simplicity and the environmental benefits it affords. The FFTT solution is driven by the idea of a universal system that requires little or no training . This simple yet effective solution will provide a greater opportunity for wood products to be used locally and world-wide through pre-fabrication.

The system allows for flexibility in tower planning and façade design. There would be some restrictions for structures over 20 storeys in height and the tower would be limited to residential use. A thorough review of acoustic and vibration conditions, systems integration, life safety, fire and finishing has confirmed that there are no obstacles with FFTT to satisfying the typical needs of a tower design, leaving possibilities open to the imagination of all architects. The code consultant has confirmed that a high building of residential occupancy can be designed and constructed to meet the functional statement and fundamental safety objectives of the National Building Code of Canada, on a performance basis, whether it be concrete, steel or Mass Timber construction.

A peer review of the structural, and fire and life safety aspects have reaffirmed the case for wood in Tall Buildings by confirming that the system proposed by the concept team can be safely constructed.

The study concludes that the use of Mass Timber in tall buildings offers a new cost-effective construction option to prospective building owners. In addition the use of wood products reduces the overall impact the building has on the environment.

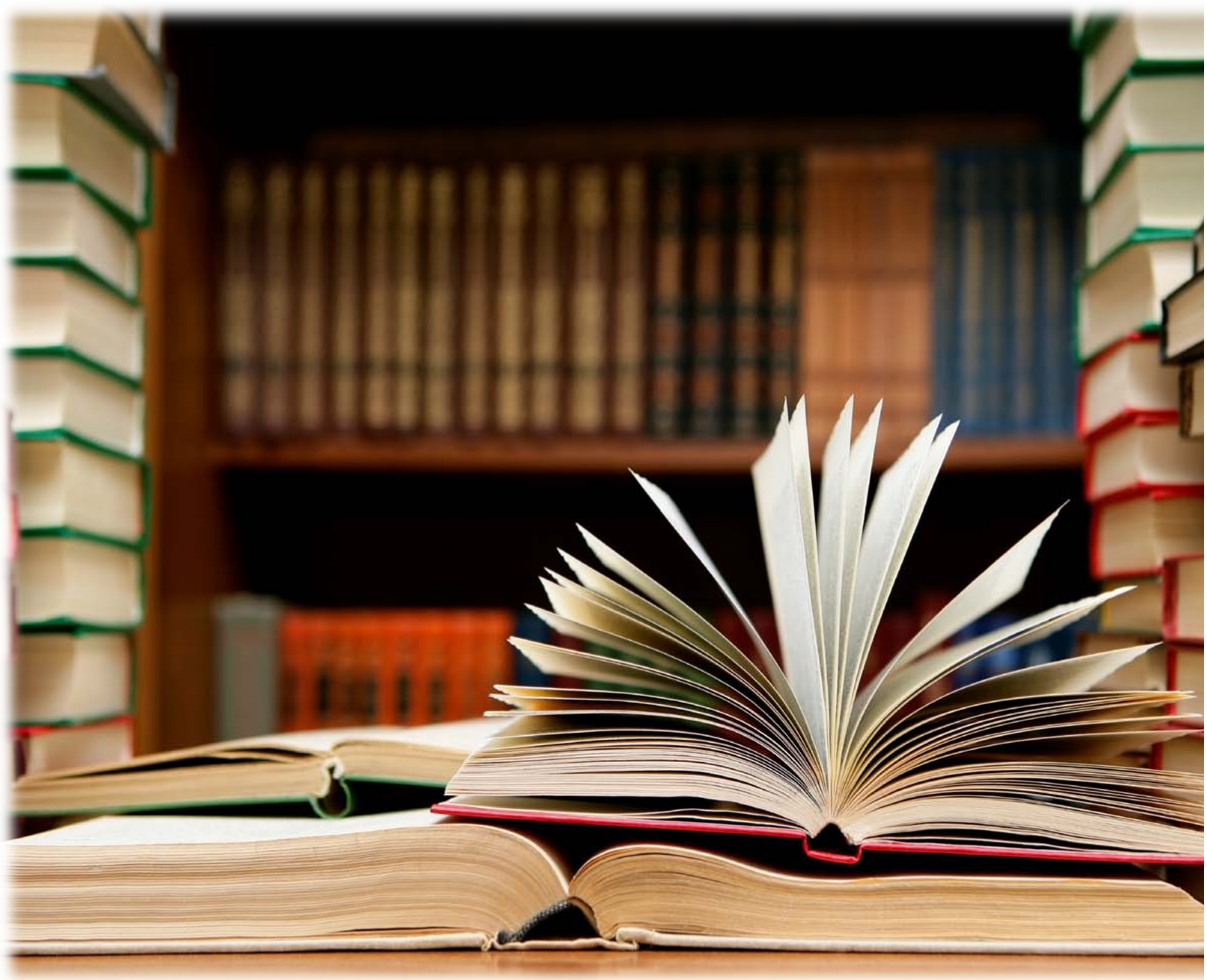
To read a copy of the full report please visit:
http://wecbc.smallboxcms.com/database/rte/files/Tall%20Wood.pdf

While *The Case for Tall Wood Buildings* is positioned as a feasibility study, it's hoped that FFTT represents a new way of thinking that will inspire significant shifts in the way buildings and construction are approached. "In North America and, more specifically, in Canada, we harvest a small portion of our renewable forest potential each year," suggests J. Eric Karsh, Principal at Equilibrium Consulting and co-author of the report. "As architects and engineers, we have the ability to shape the future of our built environment through innovation, and it is now our joint responsibility to ensure that change is directed towards solutions with lighter climate impact. We hope that this report demonstrates that wood is a viable material for tall and large buildings alike - causing us to abandon false misconceptions surrounding its performance and embrace the realities of its many benefits."

Rendering—up to 20 storeys

Evaluating Stakeholder Concerns with Wood Frame Buildings and Fire Risk

A Matter before the Ontario Legislature – Private Member's Bill 52, Ontario Forestry Industry Revitalization Act (Height of Wood Frame Buildings), 2012



Fire Chief Len Garis and Dr. Joseph Clare

August 2012

University of the Fraser Valley
School of Criminology & Criminal Justice

University of the Fraser Valley
Centre for Public Safety & Criminal Justice Research

Executive Summary

1. This report evaluates the key stakeholder concerns with the proposed Ontario (ON) Private Member's Bill 52 – "Ontario's Forestry Industry Revitalization Act (Height of Wood Frame Buildings), 2012" (aka Bill 52): a matter that is currently before the Ontario Legislature.

2. The fundamental change to the provincial building code act that would be possible under Bill 52 would be to increase the maximum building height for wood frame buildings in ON to 6 storeys. The expected impacts, *inter alia*, include creation of jobs, increased availability of affordable housing, increased taxation density, and minimisation of the carbon footprint of building construction in ON.

3. Several key stakeholders within ON have raised a range of concerns towards the changes implicated by Bill 52, which largely focus on concerns with respect to the safety of the wood buildings that would be permitted under these proposed changes. These concerns are summarized within the report, and are responded to with respect to a range of information, including published proposals, research findings, analysis of fire incidents data, and case studies.

4. The proposed amendments implicated by Bill 52 are discussed with respect to similar changes that have already been implemented in 2009 to the British Columbia Building Code (BCBC). This demonstrates that Bill 52 is, in many ways, similar to the due process that has already taken place in BC, which has had immediate positive impacts on the local economy. Importantly, the process by which the BCBC was amended met similar expressions of concern and opposition within BC – a position from which the BC Fire Chiefs' Association has withdrawn.

5. The proposed amendments to the Ontario Building Code (OBC) under Bill 52 are also discussed, and it is explained that the proposed mid-rise wood frame buildings would be utilizing fire safety strategies that have already been demonstrated to be effective, and that implementation of the amendments under Bill 52 would mean that the new buildings would likely perform at least as well as the buildings that are currently permitted under the existing OBC. Furthermore, all proposed amendments to the OBC appear consistent with the intent of the National Building Code with respect to fire safety, and with current best-practice standards with respect to building egress.

6. A range of relevant research findings are discussed that cover fire simulation models, retrospective analysis of fire performance in mid-rise buildings, the significance of the timing of fire safety inspections for fire outcomes, the importance of the area of origin for fires that originate on balconies, the relevance of in-built fire safety systems (particularly sprinkler systems) for volunteer fire departments, examination of the fire services' perceptions of the safety performance of existing mid-rise wood frame buildings that have been in operation for many years, and the seismic response of wood frame buildings in the event of an earthquake. The summary finding across these studies is that they act to ameliorate the concerns raised towards Bill 52 with respect to life safety in the event of fire and seismic activity.

7. Two recent research reports are also discussed which make a case for an ideological shift for the fire service away from current norms and expectations with respect Fire Department costs and constantly building in higher levels of fire protection. Analysis of the overall costs associated with fire in the US reveal minimal reductions in dollar losses in the face of huge increases to the costs associated with fire departments and building construction costs. Furthermore, it is clear from effective fire prevention and operation strategies that the fire service needs to conceive itself as one component in a broader system, that needs to operate effectively and cohesively to reduce the risk of fire. Combined, these two studies call for innovation in order to cease the ever increasing cost of fire protection, with a view to simultaneously driving down costs and increasing the effectiveness of intervention for mitigating loss of property and life.

8. The researchers conclude by acknowledging that they are aware there are objections to the proposed Bill 52 in Ontario, largely stemming from perceptions within the fire service that these buildings will present significantly greater risk to life and property than those currently allowed under the existing building code. The researchers have examined these concerns and are unable to find evidence to substantiate these concerns.

Research Objectives

The purpose of this document is to analyze and address key concerns raised by the Ontario Office of the Fire Marshall, the Firefighters' Association of Ontario, and other key stakeholders who have responded to the Ontario Private Members Bill 52 – "Ontario's Forestry Industry Revitalization Act (Height of Wood Frame Buildings), 2012" (referred to as Bill 52 from this point onwards within this document).

The scope of this research exercise is as follows:

1. Analyzing all public documentation identifying concerns about Bill 52 and responding, wherever possible, to these concerns using evidence produced by:
    a. Published proposals regarding Bill 52,
    b. Relevant published research findings,
    c. Retrospective analysis of relevant fire incidents from BC, and
    d. Analysis of relevant case studies from areas that already have taller midrise combustible residential buildings.
2. Discussing the need for an ideological shift for the fire service towards (a) efforts to simultaneously improve fire safety while also stemming the ever increasing cost of fire protection, and (b) conceptualizing fire risk as existing within a system, comprised of building residents, building owners/responsible persons, and the fire service.

The Details of Bill 52

The exact content of the proposed Bill 52 is as follows [1]:

> **Bill 52 (2012) An Act to amend the Building Code Act, 1992 with respect to the height of wood frame buildings.**
>
> *Note: This Act amends the Building Code Act, 1992. For the legislative history of the Act, see the Table of Consolidated Public Statutes – Detailed Legislative History at www.e-Laws.gov.on.ca.Her Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:*
>
> *1. The Building Code Act, 1992 is amended by adding the following section:*
>
> **Wood Frame Buildings**
>
> ***Building code restriction, wood frame buildings***
>
> *30.1 (1) The building code shall not prohibit a building that is six storeys or less in building height from being of wood frame construction.*
>
> ***Same***
>
> *(2) For greater certainty, subsection (1) does not prevent the building code from,*
>
> *(a) imposing requirements on buildings of wood frame construction; and*
>
> *(b) prohibiting specified classes of buildings from being of wood frame construction.*
>
> ***Commencement***
>
> *2. This Act comes into force four months after the day it receives Royal Assent.*
>
> ***Short title***

3. The short title of this Act is the Ontario Forestry Industry Revitalization Act (Height of Wood Frame Buildings), 2012.

Explanatory Note

The Bill amends the Building Code Act, 1992 to provide that the building code shall not prohibit a building that is six storeys or less in building height from being of wood frame construction. This does not prevent the code from imposing requirements on or prohibiting specified classes of wood frame buildings.

At the time of writing this research note, following consideration by Ontario's Standing Committee on Regulations and Private Bills on June 6th 2012, Bill 52 has been recommended for Third Reading.

The Intent of Bill 52

At the time of producing this report, the Ontario Building Code (OBC) limits structural wood framing to buildings up to four storeys in height. The intention for Bill 52 is to amend the OBC to allow structural wood framing to be used in buildings up to six storeys in height. This is motivated by three broad factors:

1. A wish to increase demand for locally-sourced wood products in order to support the Ontario forestry sector.
   - As Nipissing MPP Vic Fedeli stated, "In the past several years, it is reported some 60 lumber mills have closed across the Northern Ontario, and 45,000 forestry jobs have been lost. Bill 52 is expected to have a reverse effect on this trend, and help re-start a revival in the forestry sector in Northern Ontario" [2].
   - Extending the construction of wood-frame buildings would increase domestic lumber demand, which would have a significant, positive impact on the economy. Fedeli [2] estimated this would result in 200,000 forest industry jobs and would stimulate 103 forest-dependent communities.
2. A desire to increase design/cost options for developers with the hope that this will facilitate increased construction [3].
   - There is a belief that taller wood framed buildings could provide more intensive land use within existing neighbourhoods, converting them into transit-supportive, pedestrian-oriented, affordable areas within cities.
   - Wood-frame buildings would reduce construction costs for mid-rise buildings by 12 to 15 percent, which would allow municipalities to build up instead of out [2].
   - "Market experts estimate that the mid-rise sector could represent 8 to 10 percent of the entire multi-storey market in Ontario in the next 20 years, up from 3 percent today [2012]. This bill will give wood-frame mid-rise buildings an opportunity to help meet that demand" [2].
3. The use of wood framing for a building has the potential to limit the extent to which construction impacts on the carbon footprint, as timber is a relatively low-energy intensive material to manufacture [4].
   - "Wood-frame structures contribute to Ontario's energy efficiency and conservation goals by sequestering more carbon than buildings made from concrete or steel" [2].

In short, the purpose of Bill 52 is to create Jobs, build affordable housing, provide for greater taxation density to communities, and reduce the carbon footprint of construction.

Summary of the Concerns towards Bill 52

Based on documentation provided to the researchers, the sources of concern about the proposed Bill 52 were generated by:

- The Canadian Institute of Steel Construction
- The Cement Association of Canada
- MasonryWorx
- The Fire Fighter's Association of Ontario
- The Ontario Office of the Fire Marshall
- The Ontario Association of Fire Chiefs'
- The Ontario Professional Fire Fighter's Association

The concerns raised were aggregated and can be broadly outlined as follows:

Process Concerns Raised

Science

- There is a concern that there is currently very little research evidence that would support these proposed changes. As a result, caution and time were argued for, to ensure there is a solid research basis for making these changes.

Harmonization

- It is argued that the proposed amendments to the OBC would be inconsistent with building code harmonization initiatives and past practices.
- There is also concern that a reliance on municipal bylaws to restrict construction height and type is inconsistent with the principle for a uniform provincial standard and is subject to Ontario Municipal Board appeals and external factors beyond the control of fire departments.

Consultation

- There is an assumption reflected in a number of consultation concerns that six-story combustible construction poses an increased risk for a number of reasons, including:
    - Capacity to respond to fire incidents at these types of buildings when (a) under construction, and (b) occupied.
    - A potential lack of cohesion and coordination between the Ontario Fire Code, the Ontario Building Code, and possibly occupational health and safety standards.
    - Capacity to undertake appropriate inspections of these new buildings.

Technical Issues Raised

Permitting Other Combustible Materials in Addition to Wood

- This concern focuses on the potential fire risks posed by structural and non-structural combustible materials (other than wood) that would be permitted under the proposed Bill 52 (e.g., combustible plastics). It is argued that these types of materials could significantly increase fuel loading.

Permitting Use of Engineered Wood Systems

- The concerns here can be summarized as:
  - A fear of rapid collapse of this type of light-weight wood framing when exposed to fire.
  - Increased risk over the life of the building due to damage, deterioration, and/or shrinkage of protective membranes.
  - Uncertainty as to the impact of cross laminated timber (CLT) on fire safety.

The Absence of an Overall Height Limit for the Construction

- The concern here is that the specifics of the building height limitations do not exclude combustible peaked roofs that potentially extend up to 2 storeys above the 18 metre sixth floor. The cause for concern here relates to potential equipment and accessibility challenges that this would pose for fire fighters.

The Absence of Sufficient Street Access Points for Fire Fighting

- The concern here is that the proposed Bill 52 only requires fire fighters have single street access to the main entrance of the building, which is considered to be insufficient.

Accessibility Concerns for Building Residents with Special Needs

- Due to building height and the shrinkage typically observed with wood construction, there is a concern that these buildings will pose accessibility challenges for some building residents (e.g., those with special needs and the elderly). This issue likely relates to the ability of all building occupants to successfully evacuate these types of buildings within the required time parameters.

The Absence of a Non-Combustible Exit Stairwell

- This concern relates to the potential for fire spread in exit stairwells. One source of this concern relates to the importance of stairwells as a staging area for firefighting operations.

Issues with Combustible Cladding and Roofing Systems

- The concern here is that the propose Bill 52 would allow for combustible cladding and roofing, which would greatly increase the probability of structural ignition as a result of interface fires, which could climb to the roof space of the building.
- The concerns here also cover the proximity between structures, and the impact that this would have due to radiant heat transfer and fuel load.

Concerns about the Capacity for All Fire Departments to Conduct Effective Operations

- These capacity concerns take a number of forms:

- It is argued that the additional height of these buildings is likely to prevent rural fire services from having sufficient time to conduct search and rescue in the event of a fire.
- Rural fire services may have to travel significant distances to fire incidents, significantly impacting response times.
- Rural fire services may not have appropriate equipment (ladder trucks, water pressure, etc.) and personnel to suppress fires on the upper-levels of these buildings.
- The proposed requirement for 1 hour floor fire separations in these combustible occupancies is a significant reduction in standard from the current requirement for 2 hour floor fire separations for 6-story, sprinklered, non-combustible buildings. This issue is believed to have the greatest significance for municipalities protected by volunteer fire departments, due to the increased time required for volunteers to respond to fire incidents.

Concerns about Training and Education

- The concern here is motivated by a perception that existing training and education standards will likely be inadequate for:
  - Construction processes for these proposed buildings.
  - Fire code changes.
  - Fire safety inspection staff – It was suggested that additional funding would be required to manage the increased inspections workload that would result from these buildings, both during and post-construction.
  - Pre-fire planning, and fire safety during and post-construction.
  - Any necessary amendments to firefighter standard operating procedures.
  - Firefighter education with respect to fire science and building construction.

General Concerns about Quality of Workmanship

- General concerns were raised with respect to building processes such as fire stopping, fire separations, issues of poor workmanship, and the integrity of the membrane protection during the life cycle of the building.

Concerns about the Moisture Content of the Wood

- Concerns here relate to the potential impact of transportation, site storage, and construction conditions on the wood products that will be used, with the potential that they may not always be in a condition as intended by their grading.

Concerns about the Likely Increase to Insurance Costs in these Types of Construction

- This concern relates to building integrity issues that may arise following a major fire incident, including water damage, mould, and mildew. In the event of these types of issues, it is unclear how long buildings would be uninhabitable for, and the extent of work that would be required to repair this damage could result in increases to insurance costs.

Concerns about the Lack of Information into the Impact of Seismic Activity on 6-Storey Combustible Construction

- It was suggested that no research into the impact of seismic activity has been conducted for buildings over 20 metres in height. It was also suggested that no research has been undertaken on seismic activity affecting a single building level.

Section Summary

The concerns raised are in many cases written on the basis of certain assumptions regarding the various fire protection features (or lack thereof) of the buildings that might be designed under the new Bill. Currently, the Bill 52 proposal makes no specific reference to detailed fire protection requirements that might otherwise apply. Thus, it is questionable whether some or even all of these concerns will be applicable in the end, and will depend upon the eventual code wording describing the specific acceptable solutions.

Interestingly and unsurprisingly, these locally-focused concerns largely mirror those summarized in Section 2.1 "Preliminary Survey of Industry Preconceptions" of the February 2012 report prepared by Equilibrium Consulting [4] entitled, "The case for tall wood buildings: how mass timber offers a safe, economical, and environmentally friendly alternative for tall building structures."

From this point onwards, the report will present additional information that relates to the concerns outlined, above. This will include an analysis of the British Columbia Building Code (BCBC) [5] with respect to 6-storey wood frame buildings, analysis of the 2011 proposed changes to the Ontario Building Code (OBC), and an overview of relevant published research findings.

Building Code Amendments in BC and Proposed Amendments in Ontario

From review of the comments and concerns outlined above, there are a broad range of issues around the uncertainly of the technical requirements for the proposed amendments. In order to respond to these, this section outlines the requirements that were implemented when amendments were made to the British Columbia Building Code (BCBC), corresponding specifications as they stand under the British Columbia Fire Code (BCFC), and the 2011 proposed potential changes to the OBC that were published by the Province of Ontario, Ministry of Municipal Affairs and Housing [6].

BCBC – Amendments to Manage Mid-Rise Wood Frame Construction

Provisions were made to the BCBC that were enacted by Ministerial Order in January, 2009, and came into effect in April, 2009. These amendments are summarized online by the Office of Housing and Construction Standards [7]. Essentially, these provisions allowed for mid-rise residential buildings of wood construction up to 6 storeys in height. The amendments to the BCBC involved alterations to *Related Undertakings* involving sprinkler protection, energy efficiency, occupancy, local government, and education/training. In addition to this, there were a range of specific new code provisions concerned with building height, combustibility of cladding, earthquake load and effects, configuration of timber shear wall systems, fire doors in public corridors, and issues focused on shrinkage of wood in structural designs. Some of the specific amendments include:

- Sprinkler protection to NFPA 13, i.e., sprinklers in crawl spaces, concealed spaces such as attics, and all combustible balconies and canopies.
- Standpipes located in exit shafts.
- A one hour fire resistance rating throughout.
- Non-combustible exterior cladding, limited combustible cladding (CAN/ULC-S134), or fire-retardant-treated wood cladding.
- Building height is less than 18 m between grade and upper most floor level of the top storey.

BCFC – Amendments to Manage Mid-Rise Wood Frame Construction during the Construction Stage

Owners and contractors are required to comply with the requirements of the BCFC (5.6) (development, implementation and maintenance) [8] of an approved fire department construction fire safety plan that applies to construction and demolition sites. To this end, the Surrey Fire Service has produced a safety plan bulletin that provides a detailed overview of the components of an effective strategy to managing these buildings during these vulnerable phases [9].

The Impact of the BCBC Amendments and the Genesis of the BC Fire Chiefs' Association Position on these Structures

As Fedeli explains [2], these amendments to the BCBC have had immediate positive impacts for the BC economy:

> *BC enacted the Wood First Act in 2009, and fast-tracked changes to its Building Code in 2009 to allow wood-frame construction up to six storeys. Since then, 11 projects have either been completed or are under construction, 98 projects are at the design, permit, or construction stage, and the BC Government has recently issued a request for proposal for a 10-storey wood-frame building. On a market scale, introducing a wood-frame option has made building mid-rise structures considerably more cost-effective.*

It is also important to briefly outline the genesis of the position that the BC Fire Chiefs' Association (BCFCA) has taken towards these 6-storey wood frame structures. In response to the suggested amendments to the BCBC to enable mid-rise wood-frame construction to proceed in BC, the Fire Service Liaison Group (FSLG) released a positional statement. The FSLG is "comprised of the five associations whose members are directly involved in fire service delivery in the province of BC – Fire Chiefs' Association of BC, Volunteer Firefighters' Association of BC, BC Fire Training Officers; Fire Prevention Officers' of BC; Professional Fire Fighters' Association of BC, and a representative of the Union of BC Municipalities" [10] and this positional statement took the form of a document entitled *Fire Service Liaison Group comments re: amending BC Building Code to allow for 6 story wood-frame construction*. To summarize the positional statement content, the major concerns raised included:

- Potential for shrinkage in the thickness of floor joists, which tends to compound with each additional storey;
- The time required to escape higher buildings during a fire incident will increase with the aging population;

- The different set of firefighting tactics required to combat high-rise structure fires;
- The equipment challenges associated with reaching balconies if they are higher than 3 stories from the ground;
- The equipment challenges associated with availability of infrared cameras to detect hotspots in wall cavities should a fire spread beyond the room or floor of origin; and
- The resourcing concerns with respect to level of service required to respond to an incident in a mid-rise wood-frame building;

It was also expressed within the FSLG document that, "it is an issue of more property loss and greater risk for occupants and firefighters in the event of fire, as wood is more combustible than concrete and steel" [10: 3]. This concern was expanded to encompass the potential for exposure to civil litigation should a fire department not perform interior attacks on fires in high-rise constructions, while facing the prospect of being under-resourced, under-trained, and-under staffed to address these incidents in a safe manner. When addressing the viability of such proposed changes to the Building Code, the FSLG report restates the position of Sean Tracey, who at the time of comment was the Canadian Regional Manager, NFPA, in suggesting that "a worst case scenario in analyzing the fire scenarios must be used. The building proposal must assume that the building will be constructed in a community with a volunteer response with limited resources and training" [10: 4]. The FSLG paper concluded by stating the two key items of concern from their perspective involved "mandatory inspections of buildings in regional [BC] and the ability for local governments to implement sprinkler bylaws in their jurisdictions" [10: 6]. Overall, the major concerns can be summarized with respect to:

(a) Fire risk, with the assumed greater risk that these buildings necessarily pose;

(b) Resourcing strain, with an emphasis on the 'worst-case scenario' involving a high-rise construction fire in a community with a volunteer department that has limited resources and training, and

(c) Infrequent approaches to fire safety inspections and the maintenance of safety systems, based on the known variation to fire safety inspection across BC. There is also some reference to the increased risk of these buildings during the construction phase.

This initial position statement from the BCFCA motivated a review of the differential fire performance of existing wood framed, multi-residential buildings as a function of their sprinkler protection status (completely protected vs. completely without protection). This analysis initially examined fires that occurred in Surrey, BC, and then expanded to examine the entire BC provincial database over a 5-year period [11]. The findings of this review are discussed below. The end result of this review process has been the withdrawal from the initial position adopted by the BCFCA, in favour of ongoing construction of these mid-rise wood frame buildings provided they comply with the additional safety requirements specified under the amended BCBC.

OBC Mid-Rise Wood Frame Construction – Potential Changes

Current provisions for Code requirements in Ontario that would be maintained as a minimum following the implementation of Bill 52 include [6]:

- One hour fire separations (e.g., between residential suites and around fire exits).

- Fire hose cabinets and standpipes to the NFPA 14 standard.
- Two means of exiting.
- Fire detectors in exit stairs and corridors.
- Smoke alarms in apartments.

In addition to these existing minimum code requirements, the Ontario Ministry of Municipal Affairs and Housing has released details of the potential changes to the OBC that may be implemented should the proposed six-storey structures be permitted. Unlike the BCBC amendments, which primarily address residential occupancy, the proposals in Ontario would allow for wood buildings up to six storeys in height of residential, office, and mercantile occupancies. These six-storey wood buildings would also be available for "mixed use" (a combination of residential and mercantile/office use). The OBC proposed changes would also allow wood construction to be constructed on top of one and two storey concrete construction ("podium portion" of a building) to a maximum of six storeys. This proposal is highly similar to the wood frame construction that already exists in Seattle, WA, USA. "Consistent with the [OBC]'s objectives of fire safety and structural sufficiency, potential changes to allow six storey wood frame buildings would have to meet all the requirements of four storey wood frame buildings plus a number of additional measures" [6]. As detailed by the Ontario Ministry of Municipal Affairs and Housing [6], the proposed amendments would include:

- Limiting building height to 18 meters between the average grade and the floor level of the top story.
- A more stringent fire sprinkler standard (NFPA 13 versus NFPA 13R), resulting in greater installation of sprinklers in concealed spaces such as crawl spaces and attics, as well as mandating sprinkler protection of all combustible balconies and decks covered with a roof.
- Limitations on exterior cladding combustibility or all exterior walls in addition to those walls near or at property lines, in accordance with the current code requirements for non-combustible sprinkler-protected buildings up to six stories.
- Clarification of fire blocking requirements in concealed spaces and crawl spaces, which will apply to all buildings subject to NFPA 13 requirements.
- Increased structural load factors and a requirement for the alignment of shear walls resisting horizontal loads.
- Clarification that a large building divided into smaller buildings by fire walls must have fire department access to each of the smaller buildings.
- Guidance on the proper design and construction of fire rated assemblies.
- Addressing potential wood shrinkage after construction in order to take into account matters potentially affected by wood shrinkage, e.g. continuity of fire separations, etc.

Under the existing OBC, there is a maximum building area and a maximum gross floor area for four storey wood frame buildings. Following the implementation of Bill 52, the maximum gross floor area that currently applies to four storey wood frame construction would continue to apply to six storey wood frame buildings.

Ontario Ministry of Labour – Managing Mid-Rise Wood Frame Construction during the Construction Stage

Rather than being under the jurisdiction of the Ontario Office of the Fire Marshal (OFM) and enforced by the fire services, construction site safety is regulated by the Ontario Ministry of Labour – under the Occupational Health and Safety Act (OHSA) there is a complete regulation for construction projects – and it is enforced by the Ministry of Labor's inspectors. Fire safety provisions are included in the many topics covered by the regulation. In addition to this, if the proposed changes outlined in Bill 52 are adopted, the Ontario Professional Engineers Act and the Ontario Architects Act both require that these buildings be designed by an engineer or an architect.

The Intent of the National Building Code with Respect to Fire Safety

The 2010 National Building Code of Canada (NBC) "addresses the design and construction of new buildings and the substantial renovation of existing buildings" [12]. This is an objective-based code format, with all requirements linked to at least one of the following four objectives:

- Safety
- Health
- Accessibility
- Fire and structural protection of buildings

With respect to Safety and of relevance to the current research question, the NBC lists the following objectives [12]:

> *An objective of this Code is to limit the probability that, as a result of the design, construction or demolition of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury.*
>
> ***OS1 Fire Safety***
>
> *An objective of this Code is to limit the probability that, as a result of the design or construction of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to fire.*
>
> ***OS2 Structural Safety***
>
> *An objective of this Code is to limit the probability that, as a result of the design or construction of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to structural failure.*
>
> ***OS3 Safety in Use***
>
> *An objective of this Code is to limit the probability that, as a result of the design or construction of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to hazards.*
>
> ***OS4 Resistance to Unwanted Entry***
>
> *An objective of this Code is to limit the probability that, as a result of the design or construction of the building, a person in the building will be exposed to an unacceptable risk of injury due to the building's low level of resistance to unwanted entry.*

OS5 Safety at Construction and Demolition Sites

An objective of this Code is to limit the probability that, as a result of the construction or demolition of the building, the public adjacent to a construction or demolition site will be exposed to an unacceptable risk of injury due to hazards.

With respect to Fire and Structural Protection of Buildings, the NBC specifies the following objectives [12]:

An objective of this Code is to limit the probability that, as a result of the design, construction or demolition of the building, the building or adjacent buildings will be exposed to an unacceptable risk of damage due to fire or structural insufficiency, or the building or part thereof will be exposed to an unacceptable risk of loss of use also due to structural insufficiency.

OP1 Fire Protection of the Building

An objective of this Code is to limit the probability that, as a result of its design or construction, the building will be exposed to an unacceptable risk of damage due to fire.

OP2 Structural Sufficiency of the Building

An objective of this Code is to limit the probability that, as a result of its design or construction, the building or part thereof will be exposed to an unacceptable risk of damage or loss of use due to structural failure or lack of structural serviceability.

OP3 Protection of Adjacent Buildings from Fire

An objective of this Code is to limit the probability that, as a result of the design or construction of the building, adjacent buildings will be exposed to an unacceptable risk of damage due to fire.

OP4 Protection of Adjacent Buildings from Structural Damage

An objective of this Code is to limit the probability that, as a result of the design, construction or demolition of the building, adjacent buildings will be exposed to an unacceptable risk of structural damage.

The Intent of Current Safety Systems with Respect to Building Egress

The US National Institute of Standards and Technology (NIST), which is one of the oldest physical science laboratories in North America, explains that:

Currently, systems are designed around an antiquated concept of providing stair capacity for the largest occupant load floor in the building with little or no consideration of occupant behavior, needs of emergency responders, or evolving technologies [13].

To address this issue, NIST is developing a:

[T]echnical foundation for egress provisions that eliminates egress design as a contributor to fire deaths and minimizes the total social cost of the provisions. This includes collection of data from building evacuations, human behavior research, and egress model evaluation [13].

The range of topics that NIST is covering include:

- Design and construction of building exits
- Building occupant evacuation data
- Occupant behaviour
- Infrastructure of building egress

- Use of elevators during fire emergencies
- Review of building egress models

Although the NIST website does provide links to the progress made in this area to date, at the time of writing this report, this research does not provide definitive direction that would suggest anything about the proposed Bill 52 contradicts the current best-practices with respect to managing building egress.

Significance of these Potential Changes for the Concerns with Bill 52

Overall, therefore, the proposed changes in Ontario share a great deal of commonality with the changes that have already been implemented in BC. Overall, the proposed OBC changes include fire safety strategies that have been proven to be effective. Implementation of these suggested amendments would mean that these buildings would likely perform at least as well as buildings currently permitted under the existing building code. These strategies include:

- Compartmentalization
- Fire-resistant assemblies
- More stringent sprinkler protection
- Control of moisture content of wood products
- Construction risk mitigation

In reference to the technical concerns identified with the proposed Bill 52, discussed above, these proposed amendments appear to alleviate some and refute others. First, the concerns about the combustibility of cladding and roofing systems are not substantiated from inspection of the proposed amendments. Next, with respect to combustibility of stairwells and moisture content of wood/quality of workmanship, it appears that there will be provisions in the amended OBC to ensure these are not issues.

Relevant Research Findings

This section provides an overview of a series of research findings that have direct relevance to the concerns that have been identified with respect to Bill 52. In broad terms, the following topics will be examined, and their relevance to the concerns outlined above explained:

- Outcomes from National Research Council simulation modeling that explored the impact of fire sprinklers on life safety.
- Findings from retrospective analysis of a large number of relevant fires in BC that examined (a) the impact of sprinkler systems on fire outcomes in multi-residential buildings, (b) the relationship between fire safety inspections and fire outcomes, and (c) the significance of the area of fire origin in multi-residential buildings for fire outcomes.
- The lessons-learned from two case studies: (a) from a volunteer fire department (Pitt Meadows, BC), which examined the impact of sprinkler systems on the required response times for the local volunteer fire service, and (b) from Seattle, WA, looking at the performance of fire and safety systems in existing mid-rise wood frame buildings.

- The outcomes of controlled, shake-table research that examines the structural performance of wood frame buildings in response to extreme seismic activity.

Fire Simulation Models and the Impact of Sprinklers on Life Safety

The National Research Council of Canada has developed a fire simulation model, FiRECAM™ (Fire Risk Evaluation and Cost Assessment Model), which is described as follows [14]:

> *FiRECAM™ (Fire Risk Evaluation and Cost Assessment Model) is a computer program that can be used to assess the level of fire safety that is provided to the occupants in an apartment or office building by a particular fire safety design. In addition, the model can assess the associated fire costs that include capital expenditures, maintenance of the fire protection system and expected fire losses. By comparison to the explicit or implied performance of a building code-compliant design, the model can assess whether a proposed design meets the performance requirements, or is equivalent or better in life risk performance to the building code-compliant design. This allows a designer to identify cost-effective fire safety designs that provide at least the required level of fire safety.*[1]

In order to evaluate fire risk and fire loss, this simulation tool models a range of ignition points in a building, and considers the way that the fire would develop, how smoke and fire would spread, what the likely building occupants' responses would be, and the likely fire department response [15]. With respect to the relationship between residential sprinkler systems and life safety, two FiRECAM™ studies have revealed modeling results that are directly relevant to the concerns raised in response to the proposed Bill 52. These relate to fire department response times and to the loss and damage associated with fires, both with and without sprinkler protection.

Impact of Fire Department Response and Mandatory Sprinkler Protection on Life Risks

A report by Bénichou and colleagues [16] from the National Research Council of Canada used FiRECAM™ to examine the significance of sprinkler protection and fire department response time on the level of fire safety building occupants experience in a 3-storey apartment building. The findings of this analysis with respect to relative expected risk to life are displayed in Figure 1, below (reproduced exactly from Bénichou *et al.*'s paper).

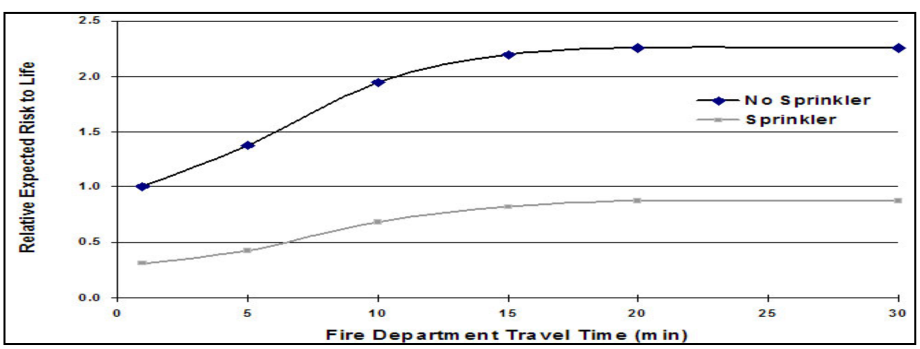


Figure 1. Relative expected risk to life as a function of fire department travel time and with and without sprinkler protection (replicated from [16] – Figure 7 in the original publication)

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[1] FiRECAM™ is a research tool and its use in supporting a design for regulatory approval is in no way endorsed by the Canadian Commission on Building and Fire Codes or by the Canadian Codes Center. Acceptance of the results obtained using this tool is entirely up to the Authority Having Jurisdiction.

As can be seen, the results of the FiRECAM™ simulation in this case demonstrates that, "the provision of sprinkler protection and the existing fire department response time (i.e., no new fire stations) provides a level of fire safety that is better than the case without sprinkler protection but with a shorter fire department response time (i.e., with new fire stations)" [16].

Impact of Sprinkler Protection and Fire Resistance Rating of Assemblies on Life Risks

In 2003, Hadjisophocleous published the outcomes of a study undertaken in partnership between Robidoux and Associates and the National Research Council of Canada, working on behalf of the American Forest and Paper Association [15]. This study involved the use of FiRECAM™ to evaluate the impact of sprinkler protection and fire resistance ratings of building assemblies on the relative expected risk to life for fires in a typical four-storey multi-family building.

FiRECAM™ was used to calculate the relative expected risk to life and expected losses for five different options:

1. 60-minute wall/floor/ceiling assembly without automatic fire sprinklers,
2. 60-minute wall/floor/ceiling assembly with automatic fire sprinklers in accordance with NFPA 13R,
3. 45-minute wall/floor/ceiling assembly with automatic fire sprinklers in accordance with NFPA 13R,
4. 60-minute wall, 45 minute floor/ceiling assembly with automatic fire sprinklers in accordance with NFPA 13R, and
5. 30-minute wall/floor/ceiling assembly with automatic fire sprinklers in accordance with NFPA 13R.

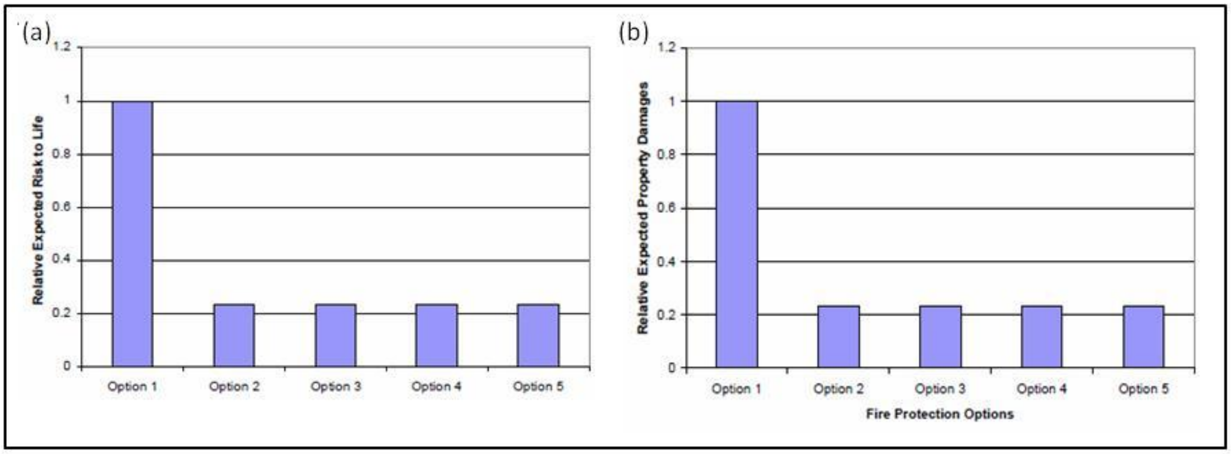

Figure 2. Relative expected (a) risk to life values, and (b) property damages for the five modeling options (replicated from Hadjisophocleous, 2003, Figure 2 and Figure 3, respectively)

Overall, as can be seen from Figure 2, regardless of the fire resistance rating of the building materials, this modeling indicates that providing there is a sprinkler system in the building reduces the risk to life to about 23 percent of the risk within the same building without sprinklers. Hadjisophocleous explains that these potential life savings are comparable to actual observed differences in casualties in the USA and Australia, where statistics demonstrate a death rate of 9 fatalities per 1,000 fires for apartment buildings without sprinklers and 2.7 fatalities in buildings with sprinklers. BC data also demonstrated a similar magnitude of difference [11]: 21.1 deaths per 1,000 fires in multi-residential buildings without sprinklers compared to 1.8 deaths per 1,000 fires in buildings with sprinkler protection. In addition to this, the modeling results also demonstrate a significant reduction in property losses for buildings that have sprinkler systems.[2]

Sprinkler Systems and Fire Outcomes in Multi-Level Residential Buildings in BC

Garis and Clare evaluated 1,942 fire incidents that occurred in BC between October 2006 and October 2011 [11].[3] Cases were analyzed if they occurred in apartment/townhouse structures that were either completely protected by sprinklers or completely without sprinkler protection. The key findings from this research are:

- Due to variations in the nature of size and spread of the fire, it was not always the case that the sprinkler system was required to activate to control the fires in buildings with sprinkler protection. It is important to emphasize that this does not reflect a failure of the sprinkler system as there are a range of broad types of fire control mechanisms, including burn-out, removal of fuel, use of make-shift aids, and use of hand-held extinguishers, which could be employed to prevent the fire expanding to the extent that the sprinkler system would activate.
- As a result of these factors, the sprinkler protection systems were only required to control fires in buildings with sprinkler protection for 21.6% (n = 122) of the fire incidents. In addition to this, the Fire Department was required significantly less often to control fires in buildings with sprinklers (19.5% of fires, compared to 39.0% in buildings with no sprinkler protection). Furthermore, when the Fire Department did respond to fires in buildings with sprinkler protection, significantly fewer resources were deployed, with multiple hose lines utilised in only 3.9% of cases, compared with 14.4% of cases in buildings without sprinklers.
- The 21.6% of fires in buildings with sprinklers that were controlled by the sprinkler systems **never extended beyond the floor of origin**, and were contained to the room of origin 96.2% of the time. In comparison, 18.8% of the fires in buildings without sprinklers extended beyond the room of origin, and 12.7% extended beyond the floor of origin.
- Death and injury were significantly less frequent in buildings with sprinklers. The odds of a fire-related death in a building without sprinkler protection (21.1 deaths per 1,000 fires) was 11.9 times greater than for fires in sprinkler protected buildings (death rates of 1.8 deaths per 1,000 fires).[4] Similarly, the odds of a fire-related injury in a building without sprinkler protection (127.1 injuries per 1,000 fires) was 2.9 times greater than for fires in sprinkler protected buildings (44.2 per 1,000 fires).
- Career and composite Fire Departments responded to 96.8% of these fire incidents. There was no indication of a rural/urban distinction in the performance of sprinkler systems, as fires in sprinkler protected buildings responded to by volunteer/paid-on-call and unclassified fire services were contained to the room of origin 100% of the time.

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[2] The economic calculations do not consider the additional cost for the installation and maintenance of the sprinkler systems.

3 Full report available for download at: http://www.ufv.ca/Assets/CCJR/Reports+and+Publications/Research+Note+Series+-+Sprinkler+Systems+and+Fire+Outcomes+2012.pdf

[4] None of these fatalities were firefighters.

Relationship between Timing of Fire Safety Inspections and the Outcomes of Fire Incidents

Garis and Clare undertook a recent evaluation of 4,084 fire incidents that occurred in BC between 1999 and 2003 [17].[5] The purpose of this study was to explore the relationship between the most recent fire safety inspection that occurred at each property and the outcome of the fire incident (with respect to property loss and fire-related casualty). The key findings from this research are:

- The majority of fires (74%), injuries (81%), and deaths (74%) occurred within 1 year of the most recent inspections. The frequency of all of these declined with duration between inspection and fire event, up until the inspection was over 36 months prior to the fire. There was no meaningful distinction between the duration since last inspection and the frequency of fires at residential and non-residential properties.
- The timing of the most recent inspection did not influence the extent of fire spread. For those buildings that were inspected on a regular basis (at least once every 3 years), the timing of inspection (greater or less than every 12 months) had no significant effect on the extent of fire spread.
- For the 335 injuries included in the dataset, the injury rate per 1,000 fires was significantly greater for residential properties compared to non-residential ones. When looking within these occupancy classes, there was no indication that the rate of injury increased as a consequence with the duration between most recent inspection and fire incident. In fact, the only indication was the counter-intuitive finding the injury rate per 1,000 fires declined for those fires that occurred more than 1 year after the most recent inspection.

This research **was not** intended to suggest that fire safety inspections should not be done. Instead, the purpose of this research was to demonstrate that elapsed time since last inspection does not seem to influence fire outcomes with respect to extent of fire and fire related casualty.

Significance of Area of Origin of Fires that Commence on Balconies of Multi-Residential Buildings

Garis and Clare [18] are currently completing an analysis of the significance of the area of origin for fires that commence on balconies of multi-residential buildings. A sample of BC data was examined, which looked at residential structure fires in multi-residential buildings that occurred between October 2006 and October 2011 (n = 1,942 fires). For the purposes of this analysis fires that occurred in an “outside area” of the building (“court/patio/terrace area” and “exterior balcony,” n = 165 cases) were compared with fires that occurred in all other locations (n = 1,777 cases).

Regardless of whether buildings were protected by sprinkler systems or not, the following relevant patterns were observed:[6]

- With respect to how fires were initially detected, fires that commenced on the outside area of interest were 7.4 times less likely to be detected by a smoke alarm, and were 1.5 times more likely to be detected by visual sighting.

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[5] Full report available for download at: http://www.ufv.ca/Assets/CCJR/Reports+and+Publications/Fire_Safety_Inspections.pdf

[6] All differences discussed here were statistically significant, $Z > |1.96|$.

- With respect to the extent of fire spread, fires originating in these outside areas were 2.4 times as likely to extend to the entire building and beyond the property as those that originated elsewhere.
- With respect to the method of fire control, fires that started in these outside areas were 1.5 times more likely to require fire department intervention to control the situation. Simultaneously, fires that did not occur in these outside areas were 5.2 times more likely to burn out on their own and were 3.7 times more likely to have been controlled by sprinklers.

Overall, this analysis revealed that fires that originated from either “court/patio/terrace area” or “exterior balcony” areas outside of the building were:

- More likely to have required visual sighting or personal detection (vs. smoke alarm).
- More likely to have extended to the building and beyond.
- More likely to have required the fire department to extinguish the fire.

Case Study: A Volunteer Fire Experience, Pitt Meadows Fire Department, BC

With strategic vision in the early 1990s, Pitt Meadows Volunteer Fire Department worked in partnership with the local council to implement a local sprinkler bylaw that required sprinkler systems to be installed in all new residential construction in the area [19]. This was done to achieve the best protection for the residents in the most cost effective manner possible. The outcomes of this process indicate significant reductions in extent of damage. One specific case study that is supportive of this contribution is outlined below [20: p.15]:

> *The Fire Department attended 12020 Harris Road to an apartment fire on January 16, 1992, at 01:15 hours. The occupant and his son had gone to bed at about 11:00 hours and left a large ham simmering on the stove. At 01:00 hours the pot boiled dry and the grease from the ham ignited and flashed over the ceiling of the kitchen, activating the sprinkler which in turn extinguished the fire. The sprinkler system not only alerted the residents of the suite, it activated fire alarm bells to ring throughout the building alerting all other tenants. The sprinkler system also summoned the Fire Department. The Fire Department arrived with twenty-two fire fighters to find the fire extinguished; all that was required for them to do was to shut off the sprinkler system and vacuum the water from the suite. (An interesting point in this incident is that the smoke alarm in the suite of the fire had been disconnected by the occupant as he frequently had false alarms due to his cooking habits.) The Fire Department was able to return 18 fire fighters within eighteen minutes after arriving to the fire, while another four fire fighters stayed for restoration purposes for another two hours. Typically, this type of incident would have taken all night, leaving the occupants without a home and possibly without life. The Fire Department believes that the effectiveness of sprinklers in terms of the life safety (for civilians and fire fighters), reduced manpower requirements, apparatus, and fire department growth, more than justifies the cost of installation of sprinklers.*

Case Study: Seattle Fire Service, WA

In order to examine the impact of 6 storey multi-residential wood frame buildings from another perspective, the authors contacted the Seattle Fire Department (WA), as this is an area that has allowed construction of these types of structures for twenty years. In response to the concerns surrounding this issue, the two responders provided the following summaries:

Seattle Deputy Fire Chief Fire Marshal

Following comments might be helpful, most from our Senior Fire Protection Engineer. Wood Frame Apartment Buildings are allowed to be 5 stories per Seattle Building Code when fully sprinklered per NFPA 13. Although classified as 5 stories, you can stack it on top of type one construction (basements / pedestal with three hour separation. When built on a slope this can look like a 7 or 8 story buildings where multiple basements are provided. They are fully sprinklered , all wood is covered with 5/8 type x gwb for a one hour rating, have stand pipes, fire alarms, exits, access, and not more than 75 feet to the highest level. We have been allowing this in Seattle for roughly 20 years and although we may have hundreds of buildings like this we have not seen large losses.

Seattle Battalion Chief

The fires I have had in these buildings have been controlled by sprinklers and confined to the room of origin. In one case, an occupant attempted to commit suicide by igniting a couch with gasoline and had more than one container of gas in the room – the occupant was burned but the fire was controlled by a sprinkler and never got big enough to be considered significant. Food on stove, combustibles left on stove, and such things as microwave fires all were easily controlled with sprinklers. SFD mandates fast response residential sprinklers in these kinds of occupancies and they are very effective.

Experimental Seismic Response of a Full-Scale Six-Story Light-Frame Wood Building

In two separate studies, van de Lindt and colleagues [21, 22] examined the outcomes of controlled, shake-table research that examines the structural performance of wood frame buildings in response to extreme seismic activity. Utilizing a full-scale mid-rise light-frame 6 storey apartment model, these researchers subjected the building to a series of earthquakes at the world's largest shake table in Miki, Japan. The building was made up of 1,350 m^2 of living space and had 23 apartment units. During testing, the building was exposed to three earthquakes ranging from seismic intensities corresponding to a once in every 72-years event to a once in every 2,500-years event (which equated to the Los Angeles earthquake). Overall, the researchers concluded that the building performed excellently, and sustained little damage across all trials. Video footage of these trials is available at: http://www.strongtie.com/about/research/capstone-media.html#videos.

Overview of the Significance of these Research Findings for the Concerns with Bill 52

In combination, these research findings appear to alleviate many of the major concerns identified with respect to the proposed amendments related to Bill 52.

- The simulation modeling results demonstrate that sprinkler protection simultaneously reduces the risk to life and property damage in the event of a fire, and achieves these results without the requirement of additional fire department resourcing. Furthermore, the fire resistance rating of the building materials involved did not impact on the fire performance of these structures when modeled in this way.
- Retrospective analysis of a large provincial dataset indicated that sprinkler systems reduce the loss of life and property damage in the event of a fire. Fire department resources are put under less strain in sprinkler protected buildings, and the fires are contained to a much smaller area.

- The timing of fire safety inspections does not directly influence the fire risk posed at these properties. This is not to say inspections should not be done. Instead it argues for a restructure of the current approach to inspections.
- One area of vulnerability that is clearly identified involves fires that originate on balconies of wood frame buildings. Under the proposed amendments to the OBC, with full sprinkler protection on buildings, non-combustible exteriors, additional fire separations in roof spaces, and sprinklers within most building cavities, the proposed amendments to the OBC appear to address all of these known limitations and weaknesses which have combined to make balcony fires so destructive in the past.
- The volunteer fire department case study experience provides support for the effectiveness of sprinklers in all buildings, regardless of the location and career status of the local fire service.
- The retrospective case study from the US provides support for the ongoing effectiveness of the life safety additions that will be implemented in these mid-rise wood frame buildings under the proposed changes for Bill 52.
- The findings from the shake table research support the seismic stability of these structures, ameliorating concerns raised with respect to performance of these mid-rise structures in the event of an earthquake.

Ideological Shift for the Fire Service

In view of the concerns that have been raised towards the proposed Bill 52, and in addition to the research evidence already outlined, this section briefly summarizes the logic of two recent reports, both of which make a case for an ideological shift for the fire service away from current norms and expectations. The first of these reports examines the factors that are driving the increasing total cost of fire in the US. The second outlines the logic for adopting a systems approach to managing fire risk within the community.

Understanding What is Driving the Increasing Total Cost of Fire

Frazier [23] explains that it is "important to estimate and track trends in the magnitude of the main components of the total cost of fire to assist in fire protection policy trade-offs. Moreover, the apparent and hidden costs of fire protection need to be compared to the losses averted and losses incurred." Understanding the total cost of the fire problem is crucial in order to raise the awareness of the public and decision-makers to the economic magnitude of an often underestimated cost.

The most recent estimates for the total cost of fire in the US was produced by Hall [24],[7] released in 2010. The take home messages of this analysis have important implications for the response to concerns as raised in this report. Overall, Hall estimated that in 2007 the total cost of fire represented approximately 2.5% of the US gross domestic product ($347 billion). Deconstructing this total revealed that economic loss (property damage) due to fire (direct and indirect, reported and unreported) was estimated at $18.6

[7] Hall explains that it is critically important "to understand that most methods used to estimate the total cost of fire are "soft," and few would stand up to the rigors of detailed analyses,-if indeed the necessary data to perform such analyses were available. Efforts to date have most likely achieved an understanding of the order of magnitude of the problem and of the relative importance of each component. To effectively use this information in policy decisions, it is necessary to establish good quantitative means to derive estimates."

billion, which represented a 13% decrease compared to 1980 estimates (when adjusted for inflation using CPI).

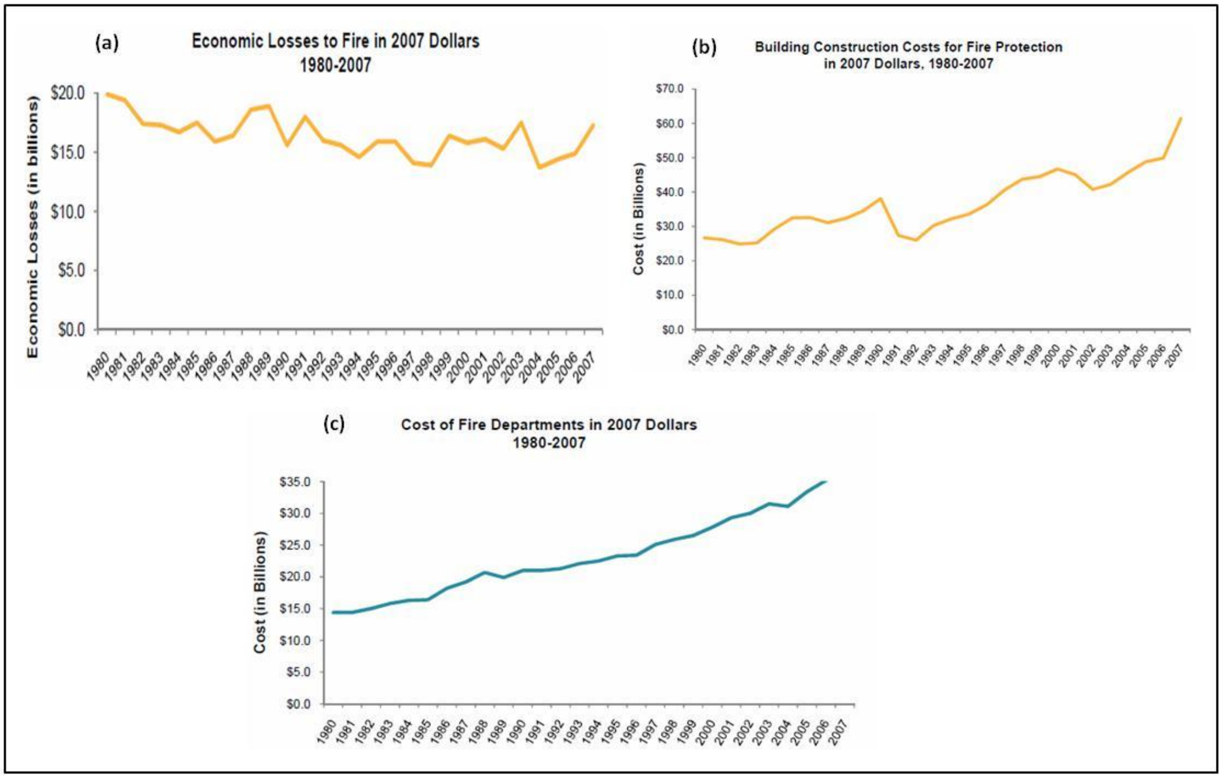

Figure 3. 2010 US-based estimates of (a) economic losses to fire, (b) building construction costs for fire protection, and (c) costs of fire departments, all in 2007 US dollars, indexed relative to 1980 values (replicated from Hall [18])

However, this improvement came at the expense of: (a) a 156% increase in the cost of career fire departments, (b) a 67% increase in the net difference between fire-related insurance premiums paid and estimated insurable economic losses, and (c) a 130% increase in the costs of new building construction for fire protection. These results are displayed in Figure 3, above (direct extracts from Figures displayed in the Hall [18] report). "These building construction costs include passive protection, such as compartmentation, and active protection, such as detection and sprinkler systems" [24: iv]. As a consequence of these findings, Hall [24] discusses why there is a dual interest in reducing fire losses on the one hand, while achieving this at lower costs. This is because the growth in total costs of fire that has been observed in the US over the last three decades has been driven by increased protection costs rather than greater fire losses. Hall discusses that these trends clearly indicate there is a need for product innovations and other programs (including education) that can simultaneously improve fire safety but at a lower cost.

The Systems Approach to Managing Fire Risk

In 2008, Jennings [25] produced a report for Surrey Fire Services, BC, that examined the local response to high-rise fires. As a consequence of this review, Jennings proposed that a systems approach be adopted to managing fire incidence and fire loss in residential structures. A system, in this context, can be conceived of as a larger group of components operating with some degree of interdependence (structure) to achieve some outcome. The rules for a system are:

1. A system does something.
2. Addition or removal of components changes the system.
3. A component is affected by its inclusion in the system.
4. Components are perceived to be related in hierarchical structures.
5. There are means for control and communication which promote system survival.
6. The system has emergent properties, some of which are difficult to predict.
7. The system has a boundary.
8. Outside the boundary is a system environment which affects the system.
9. A system is owned or valued by someone.

The key to embracing a systems approach within the fire service actually requires a broad shift in focus. The typical role that the fire service has taken is suppression-focused, with reaction and response the key. In contrast, the systems approach requires the fire service to view themselves as one of three components that interact, and all of which play a role in mitigating risk of fire. The three elements of any building that influence fire risk are essentially (a) the occupant, (b) the responsible person (owner, manager, etc.), and (c) the fire service. The goal of these three elements is identical, but their responsibilities are distinct. For fire incidents in mid-rise buildings, this systems approach can be modified such that the three components are:

- (The Occupants) Public Education: The occupants must be trained to leave the building when the alarms activate – this is the role of the buildings management and must be strictly enforced.
- (The Responsible Persons) Building Construction/Code Enforcement: The buildings' safety systems must be maintained in a state of readiness both during construction and once construction is complete, by building contractors and owners/operators.
- (The Fire Service) Fire Suppression: The role of the fire department can then be staged to meet the priorities of the fire incident that primarily focuses on fire suppression.

An additional contribution that the systems model makes to managing fire risk within residential buildings is to emphasize the distinction between fire initiation and fire loss. Fire initiation is a fire starting – for example through careless cooking. Fire loss is the toll of death, injuries, and dollar loss caused by the fire. We can compare two fires with an identical fire initiation and end up with two totally different fire losses because of a number of mitigating factors. These factors include the building stock (is the fire in a single family dwelling or apartment), and social and demographic variables (numbers of people present, type of housing unit, etc.). We can use the conceptual model to design interventions to reduce the toll of fires. Public education can be targeted at reduction of incidence (general fire prevention) or reduction of losses (home escape planning), for example. We can conceive of the mid-rise fire problem in the same fashion. Policies or programs can be thought of as interventions in the system that will influence the outcomes in terms of losses from mid-rise fires.

Each element **must** be addressed in order to be effective. Any single area in isolation cannot achieve success by itself. Overall, a systems approach to fire risk mitigation in mid-rise buildings can guide the development of interventions to reduce the fire problem. To achieve this goal it is crucial that interventions are balanced against the limited resources available to address them, as well as their likelihood of success given regulatory, legal, and technical constraints.

Significance of these Findings for the Concerns with Bill 52

This review of the factors that are driving the overall cost of fire do not support arguments that (a) career fire department resourcing and (b) improvements to building safety systems are the only ways to protect against fire losses in these (or any) types of buildings. Instead, fire services need to be mindful of the rate of return on their investment – potentially measured through dollar loss estimates or lives saved – carefully considering these factors when advocating for additional building safety features. Furthermore, conceptualizing fire risk management within a system provides additional strategies for approaching risk in multi-residential buildings that maximize efficiency and minimize the complete dependence on the fire service.

Conclusions

The researchers wish to conclude by acknowledging that they are aware there are objections to the proposed Bill 52 in Ontario, largely stemming from perceptions within the fire service that these buildings will present significantly greater risk to life and property than those currently allowed under the existing building code. The researchers have examined these concerns and are unable to find any fact or any evidence to substantiate these concerns that have been presented with respect to Bill 52.

This examination has been extensive from the researchers' perspectives. A range of simulation research, retrospective quantitative analysis , and case studies has been considered. The overwhelmingly consistent theme that emerges from this process is that although fire services typically have responded to these types of proposed changes with concerns, all available information suggests that these types of structures will perform at least as well from a safety perspective as those that are already permitted. This opinion is based on the evidence presented in its entirety. No contrary information has been knowingly excluded in the production of this report. This said, the research has identified two major vulnerabilities with mid-rise wood frame buildings. The first concerns these buildings while under construction. The second, concerns fires that originate from the exteriors of these buildings (most typically from balconies). Having noted this, it is also important to acknowledge that the proposed Bill 52, in conjunction with the 2011 proposed OBC changes, makes provisions that would address both of these weaknesses.

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Acknowledgements

Special thanks to Rebecca Denlinger, BC Fire Commissioner and her staff for the provision of the BC data discussed in this report. This work would not have been possible without the contributions of these individuals.

The Centre for Research and Innovation in the Bio-economy (CRIBE) has announced a $350,000 contribution to the Laurentian School of Architecture to build a demo building that incorporates cross-laminated timber. At the announcement were (from left) Terrance Galvin, founding director of the Laurentian School of Architecture; Rick Bartolucci, Sudbury MPP and northern development and mines minister; Carol McAulay, vice-presdient of administration at Laurentian University; David Warne, a partner and project architect with Levitt Goodman Architects; Marianne Bérubé, executive director of WoodWORKS!; and Lorne Morrow, CEO at CRIBE. (PHOTO BY LINDSAY KELLY)

Wood wins out

Architecture school embraces wood construction

By LINDSAY KELLY
Northern Ontario Business

Construction of Sudbury's Laurentian School of Architecture is providing an opportunity to introduce a new material, cross-laminated timber (CLT), into Ontario building practices.

In August, the Thunder Bay-based Centre for Research and Innovation in the Bio-Economy (CRIBE) announced it is contributing $350,000 to fund the construction of a demonstration building at the school that will incorporate CLT into its design.

It would be the first major use of CLT, an emerging building material, in Ontario. Research gleaned from the demonstration building would be used to encourage more construction with CLT throughout the province, with the added bonus of boosting its latent forestry industry.

"What we're seeing is a slow and steady recovery, and we're beginning to form an understanding of the critical role projects such as this play in assisting our industry to change and adapt," said Lorne Morrow, the CEO of CRIBE, a non-profit agency created to support the commercial end of the forestry industry.

Comprised of 2X4s and 2X6s pressed together to form large solid blocks or sheets of wood, CLT is strong, fire resistant and can be used as walls, floors or roof panels. It is now being widely used across Europe, in buildings as tall as 11 storeys.

In Canada, CLT is only produced in British Columbia and Quebec, but Morrow believes that could change once people see

Expressing optimism that the building would illustrate the potential of CLT in Ontario construction, he suggested it may have a hand in evolving the building code to encompass a greater use of wood.

"I think this demonstration project situated here at the school of architecture is going to change the perception of the potential of wood," Bartolucci said. "I'm convinced this will create a whole new market for Ontario's wood."

Canada has fallen behind in innovative building design and is now playing catch-up to Europe, said David Warne, a partner and project architect with Levitt Goodman Architects, the Toronto-based firm that has been hired to design the school.

Europeans' progressive views about conservation and reducing their carbon footprint have meant advances in their building practices that Canada hasn't yet seen, he said. But the introduction of CLT provides Ontario with an opportunity to explore innovation design with cutting-edge techniques.

Concrete, a popular construction material, requires energy to produce and evaporates carbon into the atmosphere, Warne said. Rather than have CLT built in B.C. and shipped to Ontario, it makes more environmental and financial sense to use the resources available in Ontario to make them here.

It also fits in with the school's three-cornered philosophy, which is to incorporate Northern culture, the Northern environment and sustainable design into its creation, he said.

"Wood makes imminent sense in a project like this because wood is a sustainable

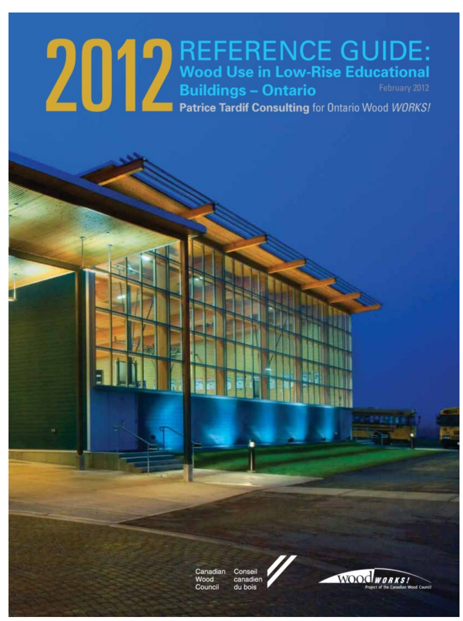
Conference Speakers (L– R): Michelle Maybee, P. Eng (Technical Director, Wood *WORKS!*), Witmar Abele MAIBC, MRAIC, LEED AP (Principal, KMBR Architects Planners), Judy Jeske, P. Eng (Principal, Senior Code Consultant & Fire Protection Engineer, Morrison Hershfield), Marianne Berube (Executive Director, Ontario Wood *WORKS!*)

Wood Use in Low-Rise Educational Buildings

May 23rd, Fairmont Chateau Laurier, Ottawa Conference Summary Report

Wood-frame construction is an important option for school buildings in the province of Ontario. Wood buildings meet code requirements, deliver speed and savings, and result in a warmer, more natural environment that benefits students, faculty and support staff. Wood is also the only major building material that is renewable and therefore truly sustainable. From an economic standpoint, by building with sustainably harvested Ontario wood products, communities and school boards help support the 185,000 people and 260 communities in the province that depend on the forest products industry.

In 2011 Ontario Wood *WORKS!* identified the educational buildings sector as a key audience for educational outreach initiatives and began work on a reference guide containing relevant code and case study data to support efforts in this sector. This conference series was hosted to support the release of the 2012 Reference Guide WOOD USE IN LOW-RISE EDUCATIONAL BUILDINGS - ONTARIO. The conclusions and recommendations from an extensive review of the Ontario Building Code, conducted by Morrison Hershfield, as it pertains to wood use in low-rise educational buildings was presented at this seminar in Ottawa.



Event Overview:

- 150 Participants
- 3 Guest Speakers
- Estimated 525 ConEd Hours Delivered *(150 x 3.5 hrs = 525)*

Feedback:

"Judy Jeske understood the audience and the caliber of information delivered was excellent. "

– Architect

"It was great how much detail Abele gave for the earlier projects. Architects are interested in this level of detail, which is sometimes hard to obtain otherwise."

– Architect

2012 REFERENCE GUIDE: Wood Use in Low-Rise Educational Buildings – Ontario

February 2012

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Robert Stefanowicz
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Acknowledgement

Ontario Wood *WORKS!* wishes to thank the Province of Ontario (Ministry of Natural Resources) whose financial contribution made this document possible.

Executive summary

Wood-frame construction is an important option for school buildings as well as an important choice toward meeting a sustainable future for Ontario. The facts behind this statement are demonstrated by first exploring how wood-frame construction addresses the three major components of sustainable development: what is best for the environment, what is best for the economy, and what is best for society. Factors that owners, funding partners and design teams must consider when developing a project will then be identified, above and beyond sustainability objectives. In practical terms, the impact of building code requirements, geography, and climate on budget and construction scheduling are explored.

Wood construction systems and their components available for use in low-rise school buildings in Ontario are introduced. Site-built and pre-fabricated options, including the innovative cross-laminated timber system, are explained along with the benefits that can be expected from each. The requirements of the Ontario Building Code (OBC) as they pertain to wood construction are elaborated upon.

All references to the Ontario Building Code are based on an extensive review of the OBC as it pertains to wood use in low-rise educational buildings undertaken by code experts Morrison Hershfield for Ontario Wood *WORKS!* Parts 3, 4 and 5 of the OBC were reviewed to identify pertinent conditions, limitations or restrictions. The report of their analysis is attached in its entirety as Appendix B *(page 33)*.

Unsprinklered one and two-storey school buildings up to 2,400 m^2 can be built entirely with wood construction systems, provided certain requirements are met; adding sprinklers to these buildings brings that maximum area up to 4,800 m^2. With the use of firewalls to compartmentalize a larger building into a series of connected smaller buildings, this maximum area can be considerably increased.

A requirement for non-combustible construction does not necessarily imply that school buildings must miss out completely on the benefits of wood construction systems, such as heavy timber roof systems or wood interior elements and finishes. There are also alternative options for complying with OBC requirements which allow for the use of developing wood technologies.

The importance of a wood construction system in terms of benefits to building users and to the environment is explored in detail. Beneficial attributes of wood as a building material include its renewability and its natural ability to capture CO_2 from the atmosphere and lock it away in its fibres; that it is sourced from sustainably managed Ontario forests; that manufacturing efficiencies result in a more responsible use of energy and reduced pollutants to the atmosphere when compared with other major building materials; these attributes all help to mitigate climate change.

The benefits of a wood construction system during the construction phase, in terms of material delivery times and optimized construction scheduling are also explored, along with benefits during the life of the building. Some of these benefits are a result of wood's natural thermal and acoustical properties; others, such as durability and adaptability, result from wood's natural properties combined with the correct use of the products. There are also less quantifiable though equally important effects, such as the warmth of a natural system and its impact on the learning environment. Five case studies, four schools across the country, and one in the United States, are included to help demonstrate these benefits.

Table of Contents

Introduction

Deer Lake Community School, Deer Lake ON Kindergarten – Grade 10
Photo: Smith Carter Architects & Engineers Inc.

The province of Ontario boasts an important inventory of publically funded school buildings – 4,900 of them. Elementary and middle schools account for 4,000 of these, with secondary schools making up the difference. These school buildings are owned by their respective school boards, of which there are over 70 across Ontario. Whether in downtown cores, the suburbs, small towns, or northern Ontario and First Nations communities, these buildings fulfill an important function – that of educating Ontario's future generations. Low-rise school buildings are the staple of communities, particularly in city suburbs and small towns throughout Ontario. They are often important to their neighbourhoods as a location for community activities and potentially even as post-disaster shelters.

Educational buildings need to respond to the rigors imposed by school and community activities; they must be built *within the budget*, and last as long as possible. To insure this, they need to be durable and adaptable to changing needs and shifting populations; they need to be easy and affordable to maintain; they need to make sense in the context of Ontario's building fabric and economic reality.

Wood-frame construction is an important construction option for school buildings as well as an important choice toward meeting a sustainable future. The Ontario Ministry of Education has itself revised school curricula to include environmental education in an effort to impart to its students the importance of sustainability concepts such as responsible stewardship.[1] In 2010, 7% of Ontario's total capital expenditures went to the construction of educational infrastructure.[2] Over $1 billion is slated for school improvements and capital projects over three years starting in 2011. It will be important to insure the best use of those funds in the creation of sustainable learning environments for Ontario's students. The use of wood construction systems in school buildings is a means to that end.

Buildings Covered by this Guide

This guide has been prepared particularly with low-rise school buildings in mind, that is to say elementary, middle and secondary schools found throughout Ontario. It was not prepared with university buildings in mind, per se, although much of the information contained herein is applicable to low-rise school buildings found on university campuses. In fact, the information is applicable to a broad range of low-rise educational buildings, including those found in remote communities which serve multiple functions, such as schools with combined community centres or adult education complexes and municipal libraries. Informed decisions on construction systems for these and other buildings start with an understanding of the underlying theme in any present-day endeavour, sustainable development.

Haliburton School of the Arts, Fleming College, Haliburton, ON
Photo: Diamond & Schmitt Architects Inc.

1 Ontario Ministry of Education, **Shaping our Schools, Shaping our Future**, 2007
2 **Statistics Canada data**, February 2011.

Sustainable Development

One cannot make any decision in today's business climate without taking into consideration the concept of sustainable development, which considers the use of resources for human consumption in such a way as to insure ample resources for future generations.[3] The importance of sustainable development in the context of making decisions on construction systems is made all the more significant when considering the fact that 50% of all resources taken from nature are used in the construction of the world's structures.[4]

True sustainable development requires making decisions that consider three important aspects, often referred to as the triple bottom line of sustainable development: what is best for the environment, what is best for the economy, and what is best for society. Wood-frame construction addresses all three of these components.

Brittney Dawney, Queen's University Student
Photo: The Working Forest

What's best for the environment?

What's best for the environment in the context of constructing low-rise school buildings? The responsible use of resources is one obvious answer. Responsible stewardship tenets espoused by Canada's education sector recommend the use of renewable resources whenever possible.[5] Wood is the only major renewable resource used in construction systems.

Nearly 90% of Ontario's forest land is Crown land (publically owned). All Crown forestland is required to be sustainably managed according to the 1994 **Crown Forest Sustainability Act**,[6] thereby assuring the "protection and sustained use" of Ontario's forest lands. This insures a healthy and viable forest resource for future generations.

It is also important to consider the impact of buildings on the natural environment, often referred to as *environmental footprint*. When considering the environmental footprint of materials manufactured for use in the construction of buildings, wood products have been scientifically shown, using life cycle assessments,[7] to yield clear advantages over other construction products. More environmental benefits from the use of wood can be found in the section entitled ***The Benefits of Wood Buildings*** *(page 14)*.

Mar-Span Truss Inc., Drayton, ON
Photo: Steven Street

What's best for the economy?

What's best for the economy in the context of constructing low-rise school buildings? There is no argument that insuring a healthy and sustainable economy in any region requires the validation of local industry. Ontario's forest sector is a key component of the province's economy, valued at $12 billion. Statistics from 2009 show that nearly $3 billion of this amount is attributed to lumber, engineered wood and other manufactured products, and another $1.8 billion to the value-added sector, which includes such products as furniture and cabinet manufacturing.[8] Making use of local industries and their products in the construction of school buildings keeps the Ontario economy strong.

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3 Development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" is the definition coined by the Brundtland Commission. See the United Nations **Report of the World Commission on Environment and Development**, General Assembly Resolution 42/187, 11 December 1987.
4 Source: United Nations Environment Programme
5 Ontario Institute for Studies in Education, **Climate Change & Sustainable Development: The Response from Education in Canada**. 2009
6 The Act requires that Ontario's forests be managed as per the **Forest Management Planning Manual** (2009) which lists forest sustainability as the primary objective of forest management.
7 A scientific measure of the environmental impact of a product throughout its entire life.
8 For more information, go to **Ontario Wood**.

What's best for society?

What's best for society in the context of constructing low-rise school buildings? For a strong society, people need to be engaged – both at work and at home. When local industries are not validated, the result is a workforce that migrates out of our communities thereby eroding the very fabric needed for a strong society. The Ontario forest industry supports more than 200,000 direct and indirect jobs in over 260 Ontario communities.[9] Of these communities, 40 depend primarily on the forest sector for their survival and another 63 would be severely affected should it disappear. The use of local industries in the construction of school buildings not only keeps the Ontario economy strong, it employs its citizens and helps to create the strong communities that are needed to sustain Ontario's society.

Microtel Inn & Suites, Parry Sound, ON
Photo: Henry B. Lowry

Deciding on the Construction System

Sustainable development tenets help to direct the decision making process, but many other factors must be considered when embarking on the design of a building, any one of which could impact on the decision of construction system.

Regulatory Considerations

Of paramount importance when entertaining a construction project are the requirements of local building codes. In Ontario, buildings must meet the requirements of the 2006 Ontario Building Code (OBC).[10] Low-rise educational buildings fall under the Assembly Occupancy, Group A – Division 2 of the OBC. The construction system chosen must assure the safety of students, teachers and the public as they move through the building.

The minimum requirements set out in the OBC for safety in buildings help project owners and designers determine what construction systems are appropriate and allowable. There are two methods for complying with OBC requirements, either through acceptable solutions as defined in the main part of the code, Division B, or through alternative compliance paths. In using the latter method, solutions proposed must be shown to meet the intents of the acceptable solutions outlined in Division B. All aspects relating to permissible structural wood use in educational buildings are elaborated upon in the section entitled ***Wood and the Ontario Building Code*** *(page 10)*.

Geographic Considerations

Where a school building will be located may affect the choices that need to be made with respect to a construction system. Construction materials are typically more readily accessible and quickly delivered in urban centres, no matter what the construction system chosen. For areas at a considerable distance from major urban centres or far north, however, modes of transportation and timelines for the delivery of materials, and the availability of local labour, can have an impact on a project.

Whether delivered by road, rail, water, or as is the case with the far north, ice roads during the winter months, material delivery can affect the construction schedule of a school building. The facility of sourcing and working with wood construction systems has proven that it is often quicker and easier to build with wood, regardless of the season or the location, even in those locations where the construction season is shorter and colder temperatures prevail. In addition, local labour capable of erecting wood structures can be found in all regions of the province.

Certain geographical characteristics which could potentially affect construction system choices for a project include soil properties and the importance of seismic activity in the area. The weight bearing capacity of the soil in certain areas can dictate the height of a building and the area it can occupy; it can even preclude the

9 Ibid.
10 The **Ontario Building Regulation 350/06**.

Angus Glen Community Centre – Aquatics Centre, Markham, ON

Even at an RH of 80%, the moisture content (MC) of wood products remains well below the MC that would result in mould growth or decay. Unlike other materials, wood is not affected by water purification chemicals used in pools.

Photo: A-Frame Studio

use of heavy construction systems. Areas subjected to seismic activity have an important impact on the requirements imposed on structures as well, particularly the engineering details. Lightweight, flexible wood construction systems provide the optimal solutions in myriad applications, especially when faced with such complex circumstances.

Budgetary Considerations and *The Program*

It is primarily the budget that determines the scope of any project. The choice of construction system, the complexity of the design and the time needed for its completion will be in large part dictated by budgetary considerations. The program of a school building, however, can be quite predictable.

Whether publically or privately owned, most school buildings must meet a very similar program. All need classrooms, auditoria, cafeterias and often a kitchen; they need gymnasiums, lockers, washroom facilities, and administrative offices, including staff quarters; there are often libraries and laboratories associated. Specialty schools could require more specialized spaces such as sound insulated music practice studios or dance studios, or even pools or hazardous material laboratories.

School buildings often need to accommodate the public, whether during a sports event, for recitals or for various community activities. Certain sports programs in secondary schools may require large indoor arenas, e.g. for football, soccer or hockey. The beauty of a wood construction system is its ability to meet the needs of smaller spaces, such as classrooms and offices, combined with its flexibility to accommodate the needs for uses requiring larger spans, such as gymnasiums or arenas.

What should not be ignored are operating and maintenance costs once the building is delivered. Although not a part of the construction budget, the building design and materials choices have a direct impact on how a building will "age." The costs associated with the maintenance and repairs for a building once it is in use can be optimized by making the right materials choices up front.

Richmond Christian School, Richmond, BC

Wood construction systems have the flexibility to meet the needs of smaller spaces as well as the clear-span requirements of larger spaces.

Photo: Robert Stefanowicz

The Design / Construction process

Construction systems are typically chosen early in the design phase of a project. The decision made may be based on a recommendation from the architect or it may be dictated by the client. The program, including all the potential uses of schools buildings, is also a big factor in the choice of construction systems. School buildings accommodate a lot of people, consistently, probably more than in any other type of facility. Movement through the building must be optimized and the necessary sight lines created to assure the safety of users, whether students, teachers or the public, no matter what the activity.

Design teams must take into account all potential uses of a school project in the context of the budget, the building code, the proposed location of the building and when delivery is needed. The decision on which construction system to use must be made early in the process as that decision will have consequences for the design itself, as well as on construction scheduling and the allocation of funds to different aspects of the project.

Material delivery lead times and how many trades may be needed on a site will have an effect on construction scheduling and costing. Longer lead-times for material deliveries engender greater risk for falling prey to price fluctuations. The coordination of numerous trades on a site has the potential of severely complicating construction scheduling. The season or seasons during which the project will be undertaken will impact on site protection needs and energy costs during construction.

All things being equal, even if the cost of the materials for two different acceptable construction systems were equal, inherent material properties can have an impact on the funding allocation to different aspects of a project. The weight of a system is a good example. Heavier superstructures require more robust foundations and footings than lighter superstructures. Extra time is needed for added reinforcement in the more robust foundations; added materials and more time lead to added costs. The extra funding needed for the foundations to support the superstructure must be taken from another aspect of the project.

The construction system chosen can actually have a positive effect on construction scheduling. Pre-fabricated wood construction systems described in the next section can reduce construction times and lead to significant savings. Heavy timber systems, also described in the next section, can be left apparent and hence reduce the time and costs required for finishing materials and future maintenance.

The quicker a project is completed and the building occupied, the more positive is the impact on the budget.

The quicker a project is completed and the building occupied, the better it is for the owner's pocketbook, yet choices made before construction even starts will have an impact on the building's use, such as the replacement of materials over time, the ease of maintenance and operating energy costs. Design considerations need to take these factors into account when making a choice of construction system as durable choices will lead to long-term benefits long after the construction phase is completed.

Wood Construction Systems for Low-Rise Educational Buildings

There are several options to consider when choosing a wood construction system. Whether a light wood-frame, heavy timber, pre-fabricated or other specialty system is chosen, the structural design values of each product is established by the design standard for wood construction, CAN/CSA-O86, *Engineering Design in Wood*, as cited in Section 4.3 of the OBC, *Design Requirements for Structural Materials*. Each wood construction system is comprised of wood elements or systems that are assembled in such a way as to meet the requirements set out in the OBC. Individual elements are governed by product-specific standards, most of which are also cited in the OBC.[11]

Structural Wood Products

Structural wood products can be divided into several categories, each with their specific characteristics.

Structural Wood Product Categories

Category	Definition	Examples/Uses
Dimension Lumber	lumber elements that are no less than 38 mm and no more than 102 mm in their smallest dimension	studs, joists, rafters, decking or planks
Non-Proprietary Engineered Wood Products	products having undergone processes which impart enhanced or more predictable properties for which recognized standards are cited in building codes	glued-laminated timber (glulam), plywood, oriented strand board (OSB), light-frame trusses
Proprietary Engineered Wood Products	engineered wood products that require additional testing to demonstrate compliance[12]	I-joists, parallel strand lumber (PSL), laminated veneer lumber (LVL), cross-laminated timber (CLT), laminated strand lumber (LSL)
Heavy Timber	lumber elements or engineered wood products (such as glulam, PSL or CLT) that are no less than 140 mm in their smallest dimension	columns, beams, heavy timber trusses; wall, floor or roof slabs (CLT)

11 Standards for wood products used in environmental separations can be found in Division B, Section 5.10 of the OBC. Other standards referenced throughout the OBC are also cited in Section 1.3., *Referenced Documents and Organizations*.

12 Compliance is typically sought through the evaluation service of the Canadian Construction Materials Centre (CCMC).

The various products listed above, among others, are used in combination to detail wood construction systems and are all readily available in the Ontario marketplace. Engineered wood products (EWPs) are the result of advancements in manufacturing technologies and merit a special introduction. They represent an efficient use of resources as they use more of the tree and can use smaller, faster-growing trees, even species that wouldn't typically be used in structural applications. With excellent dimensional stability and load-carrying capacities, EWPs can span longer distances than similarly sized elements in dimension lumber and, since they are manufactured to a specific size, site waste is reduced. EWPs are increasingly prevalent components in wood construction systems.

Wood Construction Systems

The particulars of a project identified prior to and during the design phase may point to one construction system over another. There are several wood construction systems to choose from that meet the needs of most, if not all, low-rise school buildings. While it is true that buildings can be built using only one construction system, more often than not combinations of the following systems form the basis for design solutions.

Timmins Library, Timmins, ON
Light wood-frame construction
Photo: Claude J. Gagnon

Light Wood-Frame Construction

Light wood-frame construction is defined by the use of small wood members (typically dimension lumber framing elements, I-joists and pre-fabricated wood trusses) that are relatively closely spaced, in combination with sheathing or decking, a combination which provides the strength and rigidity needed for the structure to withstand loads and forces. This economical system's success in the North American housing industry is well accepted. Its strength and flexibility, however, make it suitable for much larger construction projects.

There are two principal approaches to light wood-frame construction; the more commonly used platform framing and the seldom used balloon framing. With platform framing, floor assemblies are built separately from wall assemblies. With balloon framing, vertical load-bearing elements are continuous from the top of the basement wall to the underside of the roof structure. Both systems use elements that are easy to handle and which create a space for the installation of insulation, as well as sturdy surfaces for the application of exterior and interior finishing materials. Pre-fabricated wood trusses used for roofs with these construction systems allow for an endless variety of roof forms. Major advantages to consider with light wood-frame construction include: the availability of a very experienced work force in virtually every corner of the province, shorter lead-times for materials and a better buffer against cost fluctuations.

North Bay Regional Health Centre, North Bay, ON
Heavy timber roof in a non-combustible building
Photo: Ed Eng

Post and Beam Construction

Post and beam construction, often referred to as heavy-timber construction, is defined by the use of heavy timber elements that are spaced far apart, thereby creating large, barrier-free spaces. These elements can be joined using traditional wood to wood joinery, although to achieve higher capacity connections mechanical metal connectors can be installed (either exposed or concealed). The construction method for roof and floor systems in heavy-timber construction is similar in arrangement to steel construction, using various levels of wood elements to create the planar surfaces.

One of the beauty's of post and beam construction is just that, its beauty. The structure can be left exposed thereby acting as the construction system *and* the finishing system at the same time. There is no need to bring in drywall and other finishes which can result in significant cost savings. Another advantage includes the obvious ability to create large clear spans, as are needed in gymnasiums and auditoriums. The space created is also easily adaptable when flexibility is needed. Should a school's needs change, partitions can be added or removed and repositioned without needing to modify the structure.

A significant advantage of a heavy timber construction system lies in its inherent ability to remain structurally intact for a certain period when exposed to fire. It is for this reason that model building codes, like the OBC, accord fire resistance ratings (FRR) to large wood elements that meet the heavy timber minimum size requirements, without any additional treatment. This fact actually allows for the use of heavy timber roof systems in certain buildings required to be of non-combustible construction. This will be expanded upon in the code section of this document.

Microtel Inn & Suites, Parry Sound, ON
Factory-built panelized wall systems allowed framing to be completed in 60 days without compromising quality, consistency or cost effectiveness.
Photo: Henry B. Lowry

Pre-manufactured and Pre- fabricated Construction

Components or systems that are constructed off-site in controlled environments are referred to as *pre-manufactured* or *pre-fabricated*. These construction techniques result in reduced exposure to rain, snow, and excessive heat or cold, not only for the materials but for the workers as well, and also result in enhanced detailing. On site, waste is reduced and there is a greater control over the construction schedule.

Engineered wood products (EWPs) are technically pre-manufactured elements; they have become staples in wood construction. Products such as I-joists, glulam, LVL and light wood-frame trusses are made of smaller elements that are fashioned together in a manufacturing setting under very controlled conditions which impart to those products the very properties that they are revered for: dimensional stability, increased strength to weight ratios, and ease and speed of erection, with very little waste since they require only minor adjustments on site.

Pre-manufacturing taken to the next level, that of pre-fabricated systems, results in some of the self-same benefits as those found with EWPs, only on a larger scale. Pre-fabricated systems are quicker and easier to install which often results in an earlier occupation date. Entire buildings can be built using one pre-fabrication technique, or a combination of standard framing practices, pre-manufactured components and pre-fabricated systems can be used. The nature of a project's particularities will help to identify optimum solutions.

Panelized Systems

Complete walls, floors and roofs can be pre-fabricated or *panelized* in a controlled environment. These pre-fabricated systems are essentially light wood-frame construction with all of its benefits – light-weight, easy and quick to install, economical – taken in out of the rain. Weather is eliminated as a factor to contend with so quality control and detailing are enhanced. Panelized components can be fabricated to virtually any size or shape thereby creating a limitless potential for architectural expression.

5-Storey Apartment Block
Pre-fabricated floor system installation
Photo: Boise Cascade EWP and Carronvale Timber Frame

Winter Games. 2010 Olympic Legacy Affordable Housing Program:
Initial Use: Whistler Village Temporary Accommodations. Single-storey modules, each containing 3 to 4 bedrooms, hotel style, were combined and assembled to house officials during the 2010 Olympic and Paralympic games.

Once panelized components are delivered on site, they can be swiftly lifted into place and assembled. Work then progresses much as on any conventional construction site, only the building can be closed and protected nearly from the onset. This has a big impact on the moisture exposure for the building during construction but also addresses another common problem on construction sites – the theft of materials. Since panelized components are pre-fabricated off-site, there is no need to stockpile construction materials on-site and organize for their protection, either from the weather or from looters.

The use of panelized components succeeds in condensing the time needed on the construction site. This can have a positive impact on a project's financing costs and can also speed up building occupation.

Modular Systems

Pre-fabrication can be taken to yet another level, that of whole systems, thereby maximizing the benefits of a controlled environment, such as better quality control measures for environmental separations and improved construction detailing. These systems are pre-fabricated entirely off-site and delivered as completed *modular* units. These units will define the architectural character of a building and can be combined into any configuration. Modular systems were perfected in the housing industry but now the non-residential sector is benefiting from the expertise that was developed.

By their very nature, modular systems lend themselves to phased construction. Units come complete with rough wiring and plumbing installations, plus the outside walls bear all the loads so the interior spaces are ultimately flexible. Each unit can be self-sustaining and construction can proceed in stages. Another benefit is the ability to reconfigure the units for change of use at a future date. An example of this is the temporary accommodations provided for athletes, officials and team representatives at the 2010 Olympic Winter Games in Whistler, BC

Second Use: Permanent Social Housing Facilities (Surrey Social Housing)
Single-storey modules were disassembled and relocated following the Olympic Games to six BC communities where they were reconfigured to form six different housing projects, from 1 to 4 storeys in height.
Photos: WEQ Britco LP

Modular systems are particularly suited to short timelines or to areas where labour is difficult to find. In remote communities where the delivery of materials is a challenge and labourers are at a premium, time and ease of erection are of utmost importance. In the far north, foundations can be built during the summer season and modular units brought in once the ice roads are operational. Very little time is needed on-site; once the foundations are in place, the modular units are simply installed, electrical and plumbing services are hooked up and finishing can commence; quick installation and finishing means quicker occupancy.

The newest and possibly the most innovative pre-fabricated system uses cross-laminated timbers. This system is described in the following section.

Cross-Laminated Timbers

Cross-laminated timbers (CLTs) are an innovative wood product developed in Europe during the last two decades and now available and manufactured in Canada. They are composed of alternating layers of boards (typically from 3 to 7) stacked at 90º to each other, much as plywood veneers are, and subsequently either glued together or mechanically fastened to form large panels. Panels are available in various thicknesses up to 245 mm, and up to 3 m high and 15 m long. They are combined to form the basis of a pre-fabricated building system.

Due to the nature of the manufacturing process, CLTs have improved dimensional stability with increased strength and stiffness in both directions, giving the panels a 2-way action much like is found with pre-stressed concrete slabs, only with less weight. CLT panels are used as wall, floor and roof slabs. The typical benefits of pre-manufacturing combined with CLT systems' particular advantages, such as good thermal and sound insulation and excellent behaviour under seismic loading, create a fast and effective building system with immense possibilities. CLT buildings have already been built in England in record time with minimal site waste.

Open Academy, Norwich, England
The CLT structure for the 3-storey Open Academy building was erected in 17 weeks and saved the program 18 to 20 weeks overall. The sports hall was erected in 4 days.
Photos: Ramboll UK (left) and Kier Eastern (right)

With a CLT construction system, all major structural aspects are completed before the panels arrive on site. Computer controlled precision using Computer Numerical Controlled (CNC) machines for cutting openings in wall components makes it possible to start installing doors and windows as soon as the panels are assembled and levelled, thereby greatly reducing the operational time of the construction site. In addition, since no concrete works are needed after the foundation is poured, work during the winter months is facilitated. With a CLT construction system, site waste is reduced to a minimum and building occupation is timely.

Several CLT buildings have already been built in Canada and several are under construction in various jurisdictions across the country; all used the alternative compliance path of the pertinent building codes. Code and standard provisions are currently under development for CLT in Canada based on the European experience and extensive Canadian research.

Permanent Wood Foundations

Permanent wood foundations (PWFs), referred to as "preserved wood foundations" in the OBC, are a complete load-bearing wood-frame alternative for foundations in low-rise light wood-frame construction. They can be used for full basements or when only a crawl-space is required. PWFs, whether site-built or pre-fabricated, use pressure treated dimension lumber and plywood panels for their fabrication.

Elkford Community Centre, Elkford, BC
The first commercial application of CLT tall wall panels in North America.
Photo: Associated Engineering Ltd.

PWFs are installed on a granular drainage layer which results in improved moisture control around and beneath the foundation with no need for drainage (weeping) tiles. In addition, the moisture barrier detailing used contributes to a dry interior which can be easily insulated for maximum energy savings. The floors for basements using PWFs are typically pressure-treated wood floor systems or concrete floor slabs.

PWFs provide a cost-effective alternative for foundation systems in conjunction with light wood-frame construction systems. They are easily installed in winter and, since only one trade is required on-site, construction scheduling is more efficient. PWF materials can also be easily transported, making this form of foundation a good choice for remote communities. Proper detailing is of paramount importance, however, and the expertise of installers must be assured. A reference book entitled *Permanent Wood Foundations* is available from the Canadian Wood Council.

Technical Resources

The **Canadian Wood Council** (CWC) has been Secretariat to the CSA-O86 Committee responsible for maintaining and updating the wood design standard since it was first developed in the 1950's. The CWC develops technical information related to the design and construction of wood structures in Canada and produces technical publications as well as design software to assist the design community in detailing wood components and construction systems. **Ontario Wood *WORKS!***, an industry-led CWC initiative, has technical personnel available to assist owners and design teams in realizing wood construction projects in the non-residential construction sector in Ontario. The Wood *WORKS!* team provides information on wood and wood use in buildings through workshops, seminars and case studies.

Wood and the Ontario Building Code

All school buildings fall under the Assembly Major Occupancy classification in the OBC, more precisely, under Group A, Division 2.

The *Ontario Building Code* (OBC) governs the design and construction of buildings, including school buildings, within the province of Ontario. Aspects of the OBC that are pertinent to wood use in structural applications for low-rise school buildings are explored in this section. The Morrison Hershfield (MH) report entitled *Use of Wood in Educational Buildings – Application of the Ontario Building Code*, Appendix B *(page 33)*, provides more detailed information on intent of the OBC requirements as regards the use of wood in school buildings. For definitive information, refer to the OBC documents.

The current iteration of the OBC, with pertinent amendments to date, came into force December 31st, 2006; it sets out the minimum requirements pertaining primarily to health, safety and accessibility issues for buildings and their use. All school buildings fall under the *Assembly Major Occupancy* classification in the OBC, more precisely, under Group A, Division 2 – *Assembly Occupancies not Elsewhere Classified in Group A*. The parts of the OBC governing wood use in Group A, Division 2 school buildings, whether a new building or an addition to an existing building, fall under the following sections:

- **Part 3:** *Fire Protection, Occupant Safety and Accessibility*;
- **Part 4:** *Structural Design*; and
- **Part 5:** *Environmental Separation*.

Renovations and modifications to existing school buildings are handled slightly differently. The extent to which Parts 3, 4 and 5 govern such works is defined in Part 11 of the OBC, *Renovations*.[13]

School Buildings Allowed to be Built Using a Wood Construction System

Part 3 of the OBC lays out the governing factors for the admissibility of wood construction systems in Group A, Division 2 school buildings. These factors deal primarily with the size of the building (building area) and the number of storeys (building height), as well as street access [14] for firefighting and whether automatic sprinkler systems are installed. The incidence of basements and/or mezzanines also has some repercussions on the minimum requirements. The requirements for fire-resistance rating (FRR) of any major assembly (floors, walls, roofs) will be as a consequence of these various factors.

Since wood products fall under the OBC definition of *combustible* materials, i.e. products that do not meet the requirements of CAN4-S114, the *Standard Method of Test for Determination of Non-Combustibility in Building Materials*, combustible construction requirements elaborated upon in the OBC shape the use of wood products as primary structural components in school buildings. This being said, when non-combustible construction is required, the OBC does not preclude the use of combustible components outright, as the terminology might suggest.

Combustible construction allows for the unlimited use of structural wood framing as well as wood-based interior finishing, exterior cladding, and partitions or blocking materials provided certain requirements are met, such as specified levels for flame spread ratings. Many combustible elements are allowed in non-combustible buildings as well, provided certain requirements are met. Some of these permitted elements are not limited in their use, such as finished flooring and millwork.

13 Part 11 of the OBC was not evaluated in detail for this document.

14 A *street* is defined by the OBC as a highway, road or other type of thoroughfare that is at least 9 m wide and is accessible to "fire department vehicles and equipment."

Combustible Construction Requirements

Individual school buildings are permitted in combustible construction up to 2,400 m^2 for an un-sprinklered building, and up to 4,800 m^2 for a sprinklered building, with relevant conditions and requirements. According to the OBC, however, buildings with a larger footprint area can be divided into separate portions or *compartments*, with each compartment being considered as a separate building, through the use of firewalls. This allows each of the resultant buildings to be considered independently. If the area of the resultant *buildings* meets the area requirements for combustible construction noted above, each can be built using wood-frame construction.

Fire-resistance ratings (FRR) are sometimes required for major assemblies. The maximum FRR for such assemblies, when required, is 45 minutes. Heavy timber construction can be substituted for any such fire-rated assembly. Floors above basements, and their supports, always require a minimum 45-minute FRR, and fire-retardant treated wood roof assemblies are allowed in unsprinklered school buildings in lieu of a 45-minute FRR for the roof assembly when certain height and area limits are met. Unsprinklered buildings require firefighting access to be provided from 1 to 3 facing streets, depending on their size. For sprinklered buildings, the principal entrance is required to be within 15 metres of a street or access route without any other facing street requirements, no matter what the size of the building.

Aside from the major occupancy requirements affecting permissible building size and FRR requirements, the OBC includes other provisions intended to limit the spread of fire in buildings. For example, whenever non-combustible fire separations are used to compartmentalize a combustible building into smaller area units or to separate major occupancies, combustible construction elements that abut or are supported by the fire separation must not compromise the structural integrity of the fire separation under fire conditions. Foamed plastics used in buildings, typically in the form of insulation, require thermal barrier protection if they would otherwise be exposed to an occupied space. Certain wood-based panels, such as plywood and oriented strand board (among others), can be used for such protection in buildings permitted to be of combustible construction.[15]

The OBC includes detailed requirements for fire stops or blocks in partition walls and fire-retardant treatment of various elements. There may be restrictions on combustible projections to the exterior depending on site conditions, and the fire-protection ratings of wood fire doors are dependent on building height and/or the FRR of walls or partitions in which they are installed. Flame-spread ratings of interior finish materials are specified for all finish materials to be used on walls or ceilings in a building. Nearly all wood products used as finish materials meet the maximum flame spread rating requirements.

Details on the above-mentioned requirements as well as requirements for minor components are outlined in the MH report *(page 33)*; the definitive reference is the OBC.

Individual school buildings are permitted in combustible construction up to 2,400 m^2 for an un-sprinklered building, and up to 4,800 m^2 for a sprinklered building, with relevant conditions and requirements. Constructing firewalls between such buildings of combustible construction, when joined together, allows for even larger schools to be built using wood-frame construction.

Non-Combustible Construction Requirements

Non-combustible construction, according to the OBC, refers to a type of construction that uses "non-combustible materials for structural members and other building assemblies." Notwithstanding, many wood components or systems are permitted in buildings required to be built using non-combustible construction systems. Worthy of specific mention is the permissibility of using a heavy timber roof system along with its supports (e.g. columns and beams) in any building, regardless of construction type, that is no higher than two storeys and is sprinklered (with certain provisos). Ground-level open walkways projecting from or between non-combustible buildings are also permitted in heavy timber (with certain provisos).

All building materials have restrictions placed on their use by the OBC. In the case of wood components or systems in non-combustible construction, their use is sometimes restricted by building height, the minimum dimension of a component element and the importance of the immediate area of its intended

According to the OBC, one and two-storey schools required to be of non-combustible construction can use heavy timber construction for the roof system and its supports if the building is sprinklered.

15 Wood-based panel thermal barriers must pass a standard fire test for at least 10 minutes in order to be allowed to protect foam insulation used in non-combustible construction.

The Royal Conservatory, Koerner Concert Hall, Toronto, ON
Wood interior finish in a non-combustible building
Photo: Tom Arban Photography

use as a means of egress. Use can also be affected by whether the building is sprinklered and pertinent fire-protection and fire-resistance ratings of adjacent building elements, as well as by distance to the property line. There are flame-spread rating requirements for interior finishes, walls, ceiling and sometimes floors, among other specified restrictions. Most wood finish materials can meet flame-spread rating requirements for walls and floors. The restrictive flame-spread ratings for ceilings limit the use of wood ceiling finishes, however, and often require the use of fire-retardant treated wood.

The following combustible elements are permitted in non-combustible school buildings, as are various minor components (not listed here), with restrictions as specified in the OBC and outlined in the MH report:

- **interior uses:** partitions, fire-stopping in wall assemblies, doors, finished flooring, stage flooring, raised platforms (need fire-stopping) and their subfloors, wall and ceiling finishes, wood trim and millwork;
- **roof systems:** roof sheathing and supports, roof shingles, and other roof shakes and components such as cant strips and nailing strips;
- **exterior uses:** exterior fire-retardant treated cladding, window frames, wood canopies over building entrances, walls and ceilings of exterior exit passageways, heavy timber projections.

It is important to understand all requirements for the permissible use of the combustible elements mentioned above. Detailed requirements can be found in the MH report, Appendix B *(page 33)*; the OBC is the definitive reference.

Structural Requirements for a Wood Construction System

Part 4 of the OBC lays out the requirements for the structural components of buildings in order to assure their capacity for resisting expected loads and effects for their intended use and occupancy. The design loads are based on geographic location and exposure effects such as climatic conditions or seismic potential; they are not material specific. All buildings, no matter what construction system is used, must be designed to meet the same design loads. Each of the major building materials (wood, concrete and steel) is governed by a material-specific design standard – for wood, that standard is CAN/CSA-O86 *Engineering Design in Wood*.

In the case of a major event when people must leave their homes, school buildings are often used as post-disaster centres. For this reason, elementary, middle or secondary schools are classified under the High Importance Category in the OBC. This category requires that buildings be designed to withstand higher loads than would buildings classified under the Normal Importance Category. This holds true no matter what construction system is used.

The OBC has specific requirements for the use of construction materials, including wood, as components in seismic force resisting systems. Shear walls may have height and width restrictions imposed based on

Laurentian University – Vale Living With Lakes Centre, Sudbury, ON
Exterior wood cladding
Photo: Terence Hayes Photography

the building type, the seismic considerations and the resistance required. Typically, wood construction systems are not limited by seismic considerations in 2-storey buildings and often demonstrate superior performance, even in higher structures, when subjected to such forces.

Certain specialty structural wood products are allowed by the OBC. Preserved wood foundations (PWF) are permitted for buildings using light wood-frame construction. Treatment of the materials in the PWF system must follow the requirements of CSA-O80 Series *Wood Preservation*.

Environmental Separations

Part 5 of the OBC lays out the requirements for building elements or systems that are used to separate different environments to which a building might be subjected. These elements and systems are referred to as environmental separations. Examples of such elements are wall or roof systems, and doors and windows that separate the inside environment of a building from the outside; or wall and floor systems that separate different major occupancies within the same building. The requirements deal primarily with the migration of heat, air or moisture through these separations.

All wood products used in environmental separations, along with their method of installation, must meet the applicable standards specified in the OBC under Section 5.10 *Standards*.

Alternative Solutions

As previously mentioned, there are two acceptable methods for complying with OBC requirements. Division B defines *acceptable* solutions. The second option, through alternative compliance paths, is a project-specific option. Each option is equally valid to demonstrate compliance to the objectives of the OBC. Division C of the OBC contains information on documentation requirements for submission of an alternative solution for consideration.

For an innovative or a proprietary wood product or process to be accepted for alternative compliance as it relates to structural design, the requirements of CAN/CSA-O86 Clause 13, P*roprietary Structural Wood Products – Design*, and Clause 14, *Proprietary Structural Wood Products – Materials and Evaluation*, must be met and acceptance granted by the authority having jurisdiction.

Édifice Fondaction CSN, Quebec City, QC
The only 6-storey office building of post and beam construction in North America, allowed using the alternative compliance path of the National Building Code of Canada.
Photo: Gilles Huot architecte

Clause 13 of CAN/CSA-O86 outlines how to demonstrate an equivalent level of performance when compared with the acceptable solution outlined in Division B. This includes demonstrating that the product meets the requirements of OBC Part 4, *Structural Design*, as well as the pertinent sections of CAN/CSA-O86. The equivalence of a proposed solution is predicated on the following: the solution must be shown to meet the requirements of a recognized standard, it must subscribe to on-going re-evaluation and quality control activities that demonstrate consistent compliance, and it must adhere to an independent third-party quality assurance program.[16]

Clause 14 of CAN/CSA-O86 applies to the derivation of design values for proprietary structural products based on applicable standards. The design values derivation methods are directed at manufacturers and their engineers to provide assurance that the proprietary design values are consistent with the intent of Part 4 of the OBC.

The Morrison Hershfield report (Section 4.2.1 *page 49*) outlines a successful alternative solution application in another jurisdiction for an exterior cladding product. It is a practical example of compliance strategies and the limitations that may be imposed to confer acceptance. A hypothetical alternative solution for demonstrating compliance to flame-spread ratings of interior finishes is described to demonstrate the various strategies than can be employed to demonstrate compliance (Section 4.2.2 *page 49*).

Several complex alternative solutions have been successfully challenged in other jurisdictions. These alternatives were not for introducing an innovative product per se but for introducing an innovative concept, that of exceeding building size and height restrictions for combustible construction. The province of British Columbia evaluated and subsequently made changes to the BC Building Code to permit the use of wood-frame construction in 6-storey residential buildings (2009). In the province of Quebec, a 6-storey wood post and beam commercial office building was awarded an alternative compliance path.

Demonstrating compliance for alternative structural solutions is a complex process, as it requires consideration of several fundamental factors for occupant and building safety. It can also be quite costly.[17] Research is currently underway on the fire and structural performance of large wood buildings. This is expected to result in future building code changes across Canada that will likely affect many building types, including educational buildings.

Future Considerations

The process is currently underway for two relevant proposed changes to the National Building Code of Canada (NBCC) on which the OBC is based. One proposed change deals with the allowance for fire-retardant treated wood cladding using a different testing method than is currently specified in the OBC to demonstrate compliance. Another proposed change deals with a relaxation of the thickness requirements for wood finishes in specific applications where the product already meets the flame-spread rating requirements. Changes will potentially be proposed for the permissible height of heavy timber construction and the NBCC is currently evaluating increasing permissible storeys for wood-frame construction above the current four storeys. See MH report Section 5 *(page 51)* for more details on these activities.

NAHB Research Center Study – 2002
Data was collected for one year on two identical unoccupied houses, one in steel-frame one in wood-frame. Although the steel house had more insulation, the wood house was more economical to heat. For more information, refer to the ***NAHB Study****.*
Graphic: NAHB Research Center

The Benefits of Wood Buildings

Aside from meeting building code requirements, the choice of a building system can also bring about certain benefits. The effect that the choice of a wood construction system has on the overall project budget and advancement of works can be easily recognized. Wood products are readily available and competitively priced in the Ontario marketplace. Shorter lead-times for material delivery, along with the ease and speed of erection help to optimize the construction schedule thereby shortening the time needed for delivery of the project. Shorter construction schedules result in cost savings.

16 Division C has provisions for some exceptions under OBC Part 5. Refer to the MH report Section 4.1 *(page 48)* for more information.
17 Refer to MH report Section 4.2.3 *(page 50)* for more information.

There are other less intuitive benefits that can arise from the choice of any particular building system that are no less important. The choice of a wood construction system brings with it many unseen benefits, even before the wood products get delivered to the construction site.

Renewable – Naturally

Inherent characteristics of wood fibres translate into benefits for the environment, for wood products and for any building in which they are ultimately used. Benefits start in the forest. As trees grow, they naturally absorb carbon dioxide through photosynthesis. When a tree is harvested, the absorbed carbon is locked away in the wood products made from that tree for the life of the products. Sustainable forestry practices to which Ontario forests adhere insure a continuation of that cycle and, in so doing, help to offset climate change.

Manufacturing Efficiencies

A typical 216 m^2 wood-frame house sequesters 28.5 tonnes of carbon dioxide, an amount equal to the emissions of a small car over 7 years.[18]

The harvesting and processing of trees for the manufacture of wood products requires less energy and is less polluting to the air and to water than resource extraction and manufacturing processes are for any other of the major construction materials. This can be demonstrated using the scientific method of life cycle assessment which evaluates the impact through all stages of a material's life in an effort to quantify the impacts on the environment.[19]

The sustainable harvest of forest resources insures a continued supply of wood products into the future. Wood waste at the manufacturing level is burned to generate energy during the manufacturing process, which in-turn reduces the demand on finite fossil fuel reserves. By the time a wood product makes it to the construction site, it has helped to reduce carbon emissions to the atmosphere by having sequestered carbon in its fibres, by having used less energy during its manufacture and by having a cleaner manufacturing process, plus it has helped to conserve fossil fuels.

Climate change and energy conservation are important if somewhat intangible and less immediate benefits. Wood products also have many benefits that can be understood on a more practical level.

Wood Properties and Their Benefits

Certain properties of wood as a material translate into tangible benefits for the user of wood products. One positive attribute of wood is that it is a poor thermal conductor, for example. Wood fibres can be compared to a box of straws – they are filled with air. Since air is a poor conductor, so then are wood products. This leads to the low thermal conductivity of wood products and a reduction in thermal bridging, a contributor to heat loss in buildings. These inherent insulating properties of wood products, combined with the ease of insulating wood structures, results in lowered energy costs during the life of a building – a very practical benefit.

The cellular structure of wood fibres leads to another beneficial property for wood products: enhanced acoustical performance. Air-filled wood fibres act as attenuators to sound transmission making wood products desirable in situations where acoustics play an important role. This cellular structure also leads to the hygroscopic nature of wood products and their ability to handle fluctuations in moisture without affecting structural characteristics. This is particularly beneficial in facilities with swimming pools or ice rinks.

Bill Barber Complex, Callander, ON
Wood roof structure over an exterior rink
Photo: Evans Bertrand Hill Wheeler Architecture Inc.

18 The basis for this calculation is average U.S. car and light truck gas mileage and average U.S. annual driving distances. The variability in how many years of driving 3,200 gallons of gas is worth varies from approximately three years for the largest SUV to 11 years for a small hybrid. Source: FPInnovations.

19 For more information on life cycle assessment of building products and systems, go to the **Athena Sustainable Materials Institute** website.

When a wood building is properly designed and detailed, and is appropriately maintained, its life-span can be limited only by the changes in use that it may be subjected to over its lifetime.

The fire resistance properties of heavy timber are of particular significance. Minimum thicknesses for heavy timber construction specified in the OBC are based on the char rate of wood. The char layer created when a heavy timber element burns actually acts as a barrier and helps to maintain the strength and structural integrity of the wood within that layer. For this reason, heavy timber elements meeting the minimum thickness requirements receive a 45-minute fire resistance rating, and require no added treatment.

There are added benefits to using a wood construction system that are brought to light during the construction phase of a project.

Construction Benefits

As previously mentioned, material lead-times are important to construction scheduling. The ready availability of wood products, combined with the relative ease and speed of construction for wood construction systems often have a positive impact on the final delivery date of a project. These benefits are compounded when pre-manufactured and pre-fabricated elements and systems are used. The use of engineered wood products and pre-fabricated systems also leads to reduced waste on-site. The coordination and disposal of construction waste can be a timely and costly endeavour.

The benefits of wood construction systems do not end when the building is delivered to the owner for its intended use. The choice of a wood construction system continues to garner benefits throughout the useful life of a building.

Following Delivery

Lee Valley Tools, Toronto, ON
Turn of the century wood building located on King Street in Toronto.
Photo: Max Torossi

Lower operating costs afforded by wood buildings are of obvious interest to building owners. Owners also want to be assured that their building will last and fulfill its intended purpose for years to come. When a wood building is properly designed and detailed, and is appropriately maintained, its life-span can be limited only by the changes in use that it may be subjected to over its lifetime. The durability of wood buildings is evidenced by the myriad of centuries-old buildings found around the globe. There is no need to look further than North America, however, where wood buildings, whether residential or non-residential, have longer life-spans than buildings built using any other construction system. The ease with which a wood building can be adapted for changing needs is in large part the reason for this longevity.

In the case of school buildings, changes in population and the number of students that a school district will need to serve can change over time. The adaptability of wood structures makes it possible to expand or make modifications to the existing structure to more easily accommodate for a changing student population. In this way, a wood building can be given a new life long after its originally intended purpose disappears. When that end does arrive, however, elements of wood construction systems can be reclaimed, recycled and reused in other buildings or re-manufactured into other useable wood products.

A less tangible but no less important benefit of a wood building and its use is the potential for creating warm and inviting environments, especially when wood elements can be left exposed. The atmospheres created in school buildings using such systems are reported to be conducive to learning. Students' concentration and even grades are said to be improved in environments where natural wood elements are present.

Case Studies

On the following pages are five brief reports on school projects built using a wood construction system. These projects, found primarily in Canada, help to demonstrate the many benefits to owners and users of making the choice to use wood for the primary construction system.

The five case studies are:

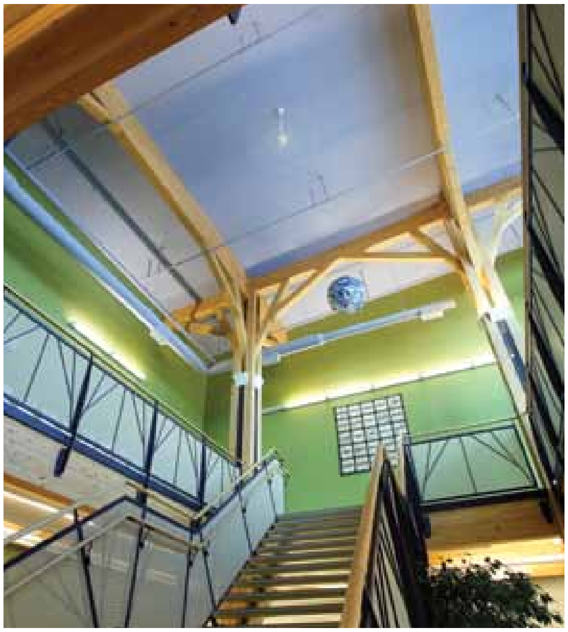
- **École secondaire catholique de la Vérendrye** *(page 18)* in Thunder Bay, Ontario;
- **Richmond Christian School** *(page 20)* in Richmond, British Columbia;
- **Crawford Bay Elementary-Secondary School** *(page 22)* in Crawford Bay, British Columbia;
- **Centre de formation et de transfert technologique sur les pratiques forestières** *(page 24)* in Dolbeau-Mistassini, Quebec;
- **El Dorado High School** *(page 26)* in El Dorado, Arkansas, United States.

CASE STUDIES

École secondaire de la Vérendrye

The École secondaire catholique de la Vérendrye was completed in 2004 for the Conseil scolaire de district catholique des Aurores Boréales, a District School Board serving the francophone community in Thunder Bay, Ontario. The $9.4 million secondary school (grades 7 through 12), which also houses the School Board's offices,[20] came in on budget and was awarded the *Canadian Wood Council – Ontario* Wood *WORKS! 2004 Green by Design Award*.

The Vérendrye school is a 2-storey, 4,830 m^2 sprinklered building. It is primarily a heavy timber glulam structure in combination with light wood-frame construction. The principal architect, Michelle Gibson at FORM Architecture, made the decision to go with wood in large part to cut down on the thermal bridging in exterior walls, a main advantage of wood construction systems, and the ease with which extra insulation could be added to the 2"x8" wood-frame construction system. The use of wood framing for wood and roof systems and interior partitions also added to the sound performance of the facility.



A major benefit of the wood construction system was the speed with which the project could be completed. Fast material delivery allowed for an expedited construction schedule. The framing proceeded without delay and the building enclosure, or *shell*, was completed faster than would have been possible had a traditional steel construction system been used. Plans to expand the school in the future made the choice of wood construction all the more appropriate as it would facilitate the building's adaptability for the eventual expansion.

20 The School Board offices are considered as a second major occupancy, *Group D Business and Personal Services*, since they are not subsidiary to the school major occupancy.

The only non-combustible structural element in the school is a 2-hour masonry fire wall which serves a dual purpose. It separates the two major occupancies of the building, the administrative School Board section and the school itself. It also acts to compartmentalize the building, thereby bringing the building area down to what is permissible for combustible construction according to the Ontario Building Code.

The school qualified for Natural Resources Canada's Commercial Building Incentive Program (CBIP).[21] The School Board received financial compensation for the project by reducing energy consumption needs for the facility to 25% lower than specified in the Model National Energy Code for Buildings, as well as by meeting other requirements set out in the CBIP Technical Guide.

This school building is a true expression of sustainable development's three main tenets:

- the use of local renewable materials – a responsible and sustainable environmental choice;
- the use of local manufacturing promoting sustainability of the area's economy;
- the use of local labour fostering pride in community needed for a strong society.

École secondaire de la Vérendrye
Photos courtesy of: FORM Architecture Engineering

Special Features:

- 2-storey atrium with tree-like heavy timber support structures
- all maple handrails and trim in the building
- exterior decorative wood frieze (fir plywood backing, cedar trim)

21 CIBP was a national financial incentive program in place from April 1998 to March 2007.

Richmond Christian School

The Richmond Christian School in Richmond, British Columbia was completed in 2008 and serves 300 secondary school students in grades 7 through 12. The $6.15 million school project received a Citation Award at the *2009 CEFPI*[22] *Pacific Northwest Region Pinnacle Awards*.

The Richmond School is a single-storey, 3,500 m^2 sprinklered building with a mezzanine. It is primarily a glulam post and beam structure and light wood-frame techniques were used as infill for the walls and roof. The design team at KMBR Architects Planners Inc., who worked on the project in collaboration with Allen + Maurer Architects, felt it important to go with wood as it was an environmentally sustainable material that would help to control costs as well as the construction schedule.

Although the design team did not register for any formal certification through green building rating programs, design strategies used were consistent with the intent of these programs. The use of wood as a local material with low embodied energy[23] was a conscious and important choice for the design team. The solid wood and MDF interior finishing materials were chosen for durability and low VOC[24] emissions. The structure is left partially exposed in the classrooms and fully exposed in the gymnasium and entrance, which helped to create the non-institutional character desired by the design team.

The added benefit sought with the use of wood for the structure and finish materials was the creation of an aesthetically pleasing and healthy environment, seen as vital in fostering a sense of well-being in its students and staff.

22 Council of Educational Facility Planners International
23 The embodied energy of a product refers to all of the energy required, both direct and indirect, for raw resource extraction, manufacturing and installation.
24 Volatile organic compounds.

CASE STUDIES

Special features:

- ➤ The building's multi-purpose gymnasium and assembly hall form a central feature of the Richmond Christian School building. The full-height translucent wall on the north side of the space provides all the lighting needed for daytime activities.
- ➤ The school also includes drama studios, technical shops and a library.

Richmond Christian School, Richmond, BC
Photos courtesy of: KMBR Architects Planners Inc.

CASE STUDIES

Crawford Bay Elementary-Secondary School

The Crawford Bay Elementary-Secondary School was completed in 2009 for School District # 8 in Kootenay Lake, British Columbia. The $12.7 million combined elementary and secondary school project (kindergarten through grade 12) replaced the existing school which had served the small 500-person community since the 1940's. The Crawford Bay School has won several awards, including the *2009 SAB*[25] *Canadian Green Building Award*, the *2009 Fortis BC PowerSense Conservation Excellence Award*, and the *2010 Canadian Wood Council – BC* Wood *WORKS! Wood Design Award*.

The 3,170 m² single-storey sprinklered building was the first school to receive a LEED® Gold rating[26] in the province. It is primarily a glulam post and beam structure in combination with light wood-frame techniques used in much the same way as in the Richmond Christian School, for infill of wall and roof structures. The design team at KMBR Architects Planners Inc. wanted a sustainable project that would be economically feasible and socially responsible while demonstrating environmental stewardship. A wood construction system, using locally grown and milled wood materials whenever possible, made the most sense, particularly when considering the historic importance of forestry to this rural community. Wood had the structural qualities needed with the aesthetic appeal desired.

The simplicity of the post and beam structure facilitated the use of local labour and expertise. Many of the wood elements perform double duty, both as a structural member and as a finish material, which had a two-fold impact on costs. Extra finishing materials and the labour required to install them were not necessary in those areas where the structure was left exposed. In addition, the use of non load-bearing partitions within the post and beam grid rendered the interior space ultimately flexible should future needs require.

Schools are important facilities in small communities and Crawford Bay residents wanted more out of theirs. The community took the initiative to raise funds so that their new school's program could be

25 Sustainable Architecture and Building
26 Leadership in Energy and Environmental Design green building rating program

expanded to include a community fitness centre, a pre-school and day care facility, and a number of multi-purpose rooms. The building has become a hub for community activities, with facilities in use not only during the day, but evenings and weekends as well. This wood building served to mobilize a community; residents became involved on many levels. It has become for them a source of pride and is contributing to a sustainable future for Crawford Bay.

Special features:

- Bolted connections of the building's timber superstructure allow for disassembly and reuse of components in the future. This is an excellent way of assuring a continued life for materials long after the useful life of the building in which they were originally installed.

Crawford Bay Elementary-Secondary School, Crawford Bay, BC
Photos courtesy of: KMBR Architects Planners Inc.

CASE STUDIES

CASE STUDIES

Centre de formation et de transfert technologique sur les pratiques forestières (CFTTPF)

The Centre de formation et de transfert technologique sur les pratiques forestières (CFTTPF) was completed in 2011 for the Commission scolaire du Pays-des-Bleuets in Dolbeau-Mistassini, Quebec. The $1.98 million vocational college was a finalist for two different 2011 cecobois[27] awards of excellence, *Institutional Project Greater Than 600 m²* and *Exterior Cladding*. The School Board wanted a wood building for the school as members felt it was important to promote the use of wood for a school that would be training the forest industry's future workforce. The architectural consortium of Emond Kozina Mulvey architectes (EKM) and Le Groupe D.P.A. saw wood as the environmentally responsible choice and needed no convincing.

The CFTTPF is a 684 m^2 single-storey unsprinklered building. A heavy timber glulam construction system was chosen, with a "baked" or "torrefied" [28] wood exterior cladding, a product that requires less maintenance than most wood sidings.[29] All of the wood used in the project was locally harvested and all wood products were locally manufactured. The design team wished to emphasize the importance of using local renewable building products that had less of an impact on the environment than other building materials.

The possibility of using the structure as the finished material was used to advantage; suspended ceilings and drywall finishes were omitted allowing for full expression of the wood structure and additional cost savings. The design team took full advantage of passive solar benefits in order to reduce operational energy requirements in this northern Quebec community. They optimized building massing and orientation thereby maximizing wind protection and natural lighting.

The torrefied wood cladding was chosen for the building because of its durable characteristics, comparable with that of Western Red Cedar. It was a local product and would require maintenance on a 5-year cycle to protect the colour from UV ray degradation. Although aluminum or vinyl sidings may have required less maintenance, their environmental footprint was seen as an undesirable *cost* by the design team.

27 Centre d'expertise sur la construction commerciale en bois – the Centre for Expertise in Non-Residential Wood Construction (unofficial translation)

28 Torrefied wood refers to a high heat treatment used to enhance certain characteristics of wood without the need for chemical treatments. Information can be found from individual manufacturers.

29 Western Red Cedar appears to have similar characteristics to that of torrefied wood.

Wood is the material of choice for Andrew Kozina, principal architect for the project at EKM architectes. He states: "I would be happy to design only wood buildings. To the extent that the code permits, I recommend wood structures for all construction projects. It is the most environmentally responsible choice and its use results in an energy efficient structure that has unparalleled warmth and beauty."

CASE STUDIES

Special features:

- At nearly 500 m^2, the large four-bay garage is the school's primary classroom – a mechanics training workshop where students are taught how to maintain and repair the machinery used in forestry operations. The 2-hour firewall between the garage and the rest of the building provides the required compartmentalization to allow for an unsprinklered wood construction system for the school.

Centre de formation et de transfert technologique sur les pratiques forestières (CFTTPF), Dolbeau-Mistassini, QC
Photos courtesy of:
Emond, Kozina, Mulvey, architectes – DPA Daniel Paiement architecte

El Dorado High School

When the El Dorado High School was completed in 2011 it was the largest wood school in Arkansas and one of the first to make extensive use of wood in the State's history. This is significant as Arkansas did not allow wood in schools until a policy change in 2008. The original steel and concrete design for the 29,960 m^2 secondary school came in at over $60 million (US) which created a problem for the El Dorado School District. This estimate would not allow them to meet their target budget as it would have curtailed the State's funding contributions for the project. Richard Brown, principal engineer at Engineering Consultants in Little Rock, proposed the wood structure that would eventually result in a $44 million budget. This was a 26% cost savings when compared with the steel and concrete solution typically used in such a large complex.

The 2-storey fully sprinklered building has an exposed heavy timber glulam structure in all the large and open public spaces. Once the decision was made to go with heavy timber, Blakely Dunn, principal at CADM Architecture, wanted the structure to remain apparent; forestry is an important part of the economy in this area of Arkansas, and local manufacturing was used whenever possible. Initial thinking was that they would still use steel for the floor and roof systems, however; it was what they knew. While working with the construction managers at Baldwin & Shell during the pre-construction stages, more economies were discovered by going with wood framing throughout the building, even for those areas that would not be visible. The use of light wood-frame systems for the interior and exterior load bearing partitions, plus I-joists systems for the second floor and roof shaved $2.7 million off the original budget.

They were also able to get the fire resistance rating required and maintain the acoustical performance of the floor by topping the wood system with concrete, while still maintaining a cost savings.

Special Features:

The El Dorado High School has many "wow" factors, a term used repeatedly by Superintendent Bob Watson, all which create a safe and warm environment for the 1,350 students and staff.

- There are 7.3 metre-wide, 2-storey high "Main Street" corridors running down each of the four arms of the building that are lit by huge skylights. These "arms" meet at a 16.5 metre-diameter, 2-storey octagonal circulation area, the exposed glulam structure for which is topped by a five-metre-diameter skylight.
- The school has a 2,200 seat, 2,800 m^2 basketball arena that is spanned by open glulam bowstring trusses which create a dramatic interior. The change from steel to wood in the arena roof alone saved the budget $60,000 and according to Dunn, "we got a huge aesthetic benefit."
- The school also has a 450-seat performing arts theatre. Maple deflector panels are used throughout the theatre to acquire the desired acoustical performance. Wood is given expression in the structure as well as the finishing materials throughout the school creating an atmosphere where students want to be.

There may not be many schools as large as the El Dorado example with such a varied program. What is significant, however, is the cost savings that can be expected by going with a wood construction system, whether the building is modest or not so modest. Couple this with being able to validate local industries and thereby have an effect on local economies and community support and it makes even more sense.

El Dorado High School, El Dorado, Arkansas
Photos: Dennis Ivy, courtesy Wood Works

Summary

An increased use of wood construction systems in Ontario schools would benefit users and owners alike. The options for wood construction systems available in the Ontario marketplace should be used to advantage. It has been demonstrated that these systems make sound economic and environmental sense. The Ontario Building Code allows for the use of wood construction systems in low-rise school buildings and their use is in the best interest of Ontarians for a sustainable future.

Although this document concentrated predominantly on the use of wood construction systems in low-rise school buildings, benefits can be gleaned from the use of such systems in many different educational facilities, from university buildings to community colleges, from student dormitories to learning centres, from research facilities to sports arenas.

The environmental benefits to the planet that are inherent with the use of renewable wood products cannot be ignored but it could be argued that the students and staff of school facilities built with a wood construction system are the real winners. They get a healthy, warm, and natural environment in which to learn and grow.

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Acknowledgements

My thanks and appreciation go out to all those whose contributions made this document possible. Marianne Berube and Michelle Maybee at Ontario Wood *WORKS!* were indispensible in helping to define the project, source information, and for their essential feedback throughout the process. Thank you also to Steven Street and Max Torossi at Ontario Wood *WORKS!,* and to Robert Jonkman, Rodney McPhee, Ineke Van Zeeland, Jasmine Wang and Etienne Lalonde at the Canadian Wood Council, for time out of their busy schedules. Thanks also to Johanna, Education Officer at the Ontario Ministry of Education for her clarifications. Hank Starno at MHI, Jeff Armstrong at DAC International and Tom Faliszewski at Britco were all generous in sharing their knowledge. Information on the school case studies was graciously supplied by Michelle Gibson and Crystal Porteous at FORM Architecture, Brandi Abele at KMBR Architects Planners Inc., Andy Kozina at EKM architectes and U.S. Wood Works. Thank you to Terry Knee, Richard Desjardins and Sylvain Gagnon at FPInnovations for facilitating access to information on CLTs.

Appendix A – Web References

Here are the web references in sequential order, as they appear in the document.

Reference Name	Web Address
Shaping our Schools, Shaping our Future	www.edu.gov.on.ca/eng/teachers/enviroed/shapingSchools.pdf
Statistics Canada data	www40.statcan.gc.ca/l01/cst01/busi01g-eng.htm
Report of the World Commission on Environment and Development	www.un.org/documents/ga/res/42/ares42-187.htm
Climate Change & Sustainable Development: A Response from Education in Canada	www.hilaryinwood.ca/pdfs/research/ESD%20in%20Canada%202009.pdf
Crown Forest Sustainability Act 1994	www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_94c25_e.htm
Forest Management Planning Manual 2009	www.mnr.gov.on.ca/en/Business/Forests/2ColumnSubPage/286583.html
Ontario Wood website	ontariowood.ca/en/forest-industry
Ontario Building Regulation 350/06	www.e-laws.gov.on.ca/html/regs/english/elaws_regs_060350_e.htm
Canadian Wood Council Homepage	www.cwc.ca
Ontario Wood WORKS! Homepage	www.wood-works.org/Ontario%20Wood%20WORKS/?Language=EN
Athena Sustainable Materials Institute website	www.athenasmi.org/
NAHB Steel vs. Wood Study	www.toolbase.org/PDF/CaseStudies/steel_vs_wood1.pdf
Crawford Bay & Richmond Christian Schools – Case Studies	cwc.ca/documents/case_studies/BC_Schools.pdf
FORM Architecture, Ésc. de la Vérendrye	www.formarchitecture.ca/#/home/education/la_verendrye
FPL Wood Handbook, Chapter 18	www.fpl.fs.fed.us/documnts/fplgtr/fplgtr190/chapter_18.pdf
Ontario Building Regulation 350/06	www.e-laws.gov.on.ca/html/regs/english/elaws_regs_060350_e.htm
El Dorado High School Case Study	woodworks.org/files/PDF/publications/Case_Studies_and_Design_Examples/El-Dorado.pdf

Appendix B

Morrison Hershfield

Use of Wood in Educational Buildings
Application of the Ontario Building Code

For:

Ontario Wood *WORKS!*

Proposal No. 2123039.00 January 27, 2012

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Morrison Hershfield

1. Introduction

1.1 Introduction

Morrison Hershfield Limited (MH) has been retained by the Canadian Wood Council on behalf of Ontario Wood *WORKS!* to document the application of the Ontario Building Code for use of wood in educational buildings and identify limitations, conditions or restrictions on the use of wood in educational buildings. In addition, opportunities for alternative solutions or changes to future editions of the Ontario Building Code have been explored.

1.2 Scope and Methodology

This report presents the provisions of the 2006 Ontario Building Code (as amended to date) which are relevant to the use of wood in educational buildings and the limitations, conditions and limitations on the use of wood in such buildings. Our understanding of the project is based on the request for proposal for the project and discussions with Woodworks.

This report is based on a review of applicable Parts 3, 4, 5 and 6 of the Building Code and MH's experience in interpreting and applying the Building Code.

1.3 Limitations

Comments and conclusions within this report represent our opinion, which is based on an examination of the documents provided, our Code analysis and our past experience. In issuing this report, Morrison Hershfield does not assume any of the duties or liabilities of the designers, builders, owner or operators who may use the information herein for the design or construction of a building. Persons who use or rely on the contents of this report do so with the understanding of the limitations of the documents examined. Such persons understand that Morrison Hershfield cannot be held liable for damages they may suffer in respect to the design, construction, purchase, ownership, use or operation of a subject property.

2. Ontario Building Code

2.1 General

The Ontario Building Code (O.Reg. 350/06) is a set of regulations made under the Building Code Act (1992) (Ontario) and sets out the technical requirements for construction of buildings. The Ontario Building Code is a set of minimum requirements for safety in buildings that address objectives of safety, health, accessibility, property protection, resource conservation, environmental integrity and conservation of buildings.

The 2006 Ontario Building Code (OBC) came into force December 31, 2006. Several amendments to the Code have come into effect since this time. All references to the OBC in this report are to the 2006 edition including all amendments to the date of this report. A new edition of the Ontario Building Code is expected in 2012.

The Code references and paraphrases in this report are for convenience only. For the authoritative text of the Building Code regulations the official version of Ontario Regulation 350/06 as amended should be referenced. Official copies of Ontario's regulations can be found on the Government of Ontario e-laws website.

2.2 Application to Educational Buildings

The provisions identified in this report are specific to the use of wood in educational buildings.

Educational buildings are part of the assembly major occupancy (Group A) which is defined as "*the occupancy or the use of a building or part of a building by a gathering of persons for civic, political, travel, religious, social, educational, recreational or similar purposes or for the consumption of food or drink*". An educational building containing classrooms, lecture halls, library, gymnasium etc. is considered an assembly building. It is noted that teacher and administration offices within an educational building are considered a subsidiary occupancy (Group D, business and personal services occupancy) if they are integral to the principal occupancy.

Schools or educational buildings are considered to be a general type of assembly occupancy referred to as Group A, Division 2 major occupancy. Regardless of the size of building, a new educational building or an addition to an educational building will be governed by life safety provisions of Part 3 "Fire Protection, Occupant Safety and Accessibility". Part 9 of the OBC "Housing and Small Buildings" does not apply to educational buildings of any size.

Part 4 "Structural Design" and Part 5 "Environmental Separation" will also apply to educational buildings. Other Parts of the OBC will apply to educational buildings, however these Parts do not influence the use of wood.

Renovations and modifications to an existing building of educational use is subject to Part 11 "Renovations" which defines the extent to which other Parts of the Code apply to that renovation or modification. Renovation projects governed by Part 11 require careful evaluation to determine the extent to which wood structural and construction materials can be retained or extended. Under Part 11, it is possible to reuse, relocate or extend the use of wood materials when the renovation is considered a "basic renovation". A basic renovation is considered one where it is intended to retain the existing character, structural uniqueness, heritage value, or aesthetic appearance of all or part of the building, and where the construction will not adversely affect the early warning and evacuation systems, fire separations, the structural adequacy or create an unhealthy environment in the building. Under Part 11, a building of wood construction over 3 storeys in building height that is changed from another major occupancy to a school or educational building is required to be sprinklered. The requirements of Part 3 will be applicable to an addition to an existing educational building. Compliance alternatives under Section 11.5 provide for the continued use of existing wood building elements to be retained under certain conditions and subject to the approval of the Chief Building Official.

3. OBC Provisions for Wood in Educational Buildings

3.1 Introduction

Provisions that influence the use of wood in educational buildings with respect to fire protection, occupant safety and accessibility, as well as structural design and environmental separations, in new construction are contained in Parts 3, 4 and 5 of Division B of the OBC.

3.2 Fire Protection, Occupant Safety and Accessibility (Part 3)

The OBC contains requirements that govern construction (including floors, mezzanines, roofs, and loadbearing walls, columns and arches) as well as the use of wood as an interior finish, cladding, and for use as a partition or blocking material.

Permission to be Combustible Construction

Generally, the OBC permits combustible (wood) construction for educational buildings up to a certain size based on criteria such as building height, building area, sprinkler protection, and number of streets the building faces (if unsprinklered). Floor, mezzanine and roof assemblies, and their loadbearing supporting structure of either combustible or noncombustible construction may be required to have a fire resistance rating depending on building size.

Where combustible construction is permitted for the loadbearing supporting structure, wood is generally permitted as an interior finish, cladding, partition or blocking material provided other requirements are satisfied. For example, wood interior finish is subject to maximum flame spread ratings. However, in some cases, specific conditions of the building location relative to property line or other buildings may influence the extent to which wood is permitted for cladding or as a construction material of an exterior wall. For example, an exterior wall in close proximity to a property line may be required to be noncombustible depending on the size of interior compartments and extent of sprinkler protection.

Requirement to be Noncombustible Construction

Educational buildings over a certain size are required to be of noncombustible construction for the loadbearing structure. Even so, heavy timber is permitted for a roof and its supports in a building otherwise required to be noncombustible for any 2 storey sprinklered building.

However, the OBC permits many combustible elements in these buildings. For example, combustible millwork and finished flooring are always permitted without exception in buildings otherwise required to be of noncombustible construction.

Combustible versus Noncombustible Construction

The requirements that govern construction in Section 3.2.2. set the context for the permission to use wood elsewhere in a building. If a building is permitted to be of combustible construction under Section 3.2.2., then there are less restrictions on the use of wood elsewhere (such as an interior finish or exterior cladding) than if the building is required to be of noncombustible construction under Section 3.2.2. This is an important starting point since it determines the extent of the use of wood even if the loadbearing structure of the building is voluntarily constructed of noncombustible materials.

Prohibition on Use of Wood

Wood is specifically prohibited in the following applications:

- Supporting an assembly that is required to be noncombustible and that is required to have a fire resistance rating
- Construction of firewalls
- Projections extending across a firewall
- Construction, as well as wall and ceiling finishes of underground walkways
- Underground covered vehicular passageways

3.3 Structural Design Using Wood (Part 4)

The 2006 Ontario Building Code (OBC) generally permits the use of wood as a structural material. The application and use of wood as a structural material in the OBC is subject to limitations based on the building size and occupancy as defined by Part 4 (Structural Design) and Part 9 (Small Buildings). In the case of educational facilities, the use of wood as a structural material is governed by Part 4 on the basis of the occupancy of these buildings, regardless of the size of the building.

Part 4 of the OBC provides a framework of procedures and requirements for determining the minimum structural loads and design standards to be applied to ensure that buildings and their structural members have sufficient structural capacity and structural integrity to safely and effectively resist all loads and effects. Parameters to be considered include structural strength, serviceability and reliability. The minimum loads specified in the OBC are primarily based on the use and occupancy of the building, as well as the building's geographic location and exposure (e.g., climatic and seismic influences). Part 4 of the OBC does not provide structural loads based on the type of materials to be used. The Code does require, however, that the design be completed in accordance with the corresponding material design standard. As such, the design loads defined by Part 4 will be the same regardless of whether wood, masonry, concrete or steel is to be used. However the design of the structure will be governed by the applicable design standard (such as CSA O86 in the case of wood design). This essentially provides the designer with the freedom to select and utilize the material(s) of their choice, subject to the physical properties and limitations inherent with that material.

Educational buildings that are likely to be used as post-disaster shelters are assigned an Importance Category of "High" according to Table 4.1.2.1.B. The OBC specifically references elementary, middle or secondary schools, however this is applicable to any educational building that is likely to be used as a post-disaster shelter. The Importance Category is applied to the calculation of specified snow, wind and earthquake loads, and generally results in higher loads relative to buildings in the "Normal" Importance Category.

In general, Part 4 of the OBC does not contain restrictions on the use of wood or timber structures, with the exception that in certain cases it does not permit the use of wood as structural components intended to act as the seismic force resisting system (SFRS). The SFRS is the part of the structural system that is designed to provide the required resistance to earthquake forces and effects (Article 4.1.8.9). Under the OBC the SFRS can be designed using wood, subject to height restrictions that are imposed in certain cases based on design parameters such as the geographic seismic zone in which the building is located, and the type of SFRS utilized. The OBC presents the allowable usages for wood in tabular form (Table 4.1.8.9) for the most common SFRS's (e.g., shear walls, moment resisting frames), with imposed height restrictions varying from 'not limited' to values ranging from 15 to 30 meters. Similar types of restrictions exist for the other common structural materials (i.e., steel, concrete, and masonry), again based on design parameters such as geographic seismic zone in which the building is located, and the type of SFRS utilized.

Part 4 of the OBC contains a provision for the use of wood in foundations or structures supporting soil and rock. This provision is outlined in Article 4.2.3.1. which permits wood as a material used in foundations provided that it conforms to the applicable requirements of CAN/CSA-O86. Article 4.2.3.2. provides requirements for the preservation treatment of wood used in foundations, generally stating that it must be treated with preservation in conformance with CSA O80 Series, "Wood Preservation".

Composite lumber and panel products are permitted for use as structural members, provided that they are design and fabricated in accordance with the requirements of CAN/CSA-O86. This Standard specifically deals with two types of composite building products; glue panel web beams (box or I-section) and stress skin panels (for floor or roof constructions), provided that they are not manufactured by a proprietary process.

3.4 Use of Wood in Environmental Separations (Part 5)

Part 5 “Environmental Separation” of the OBC applies to all buildings except those within the scope of Part 9 or the scope of the National Farm Building Code of Canada. Under this context, Part 5 applies to building elements (e.g., walls, floors, roofs, windows, doors) that separate dissimilar environments. This includes both the separation between indoors (i.e., conditioned space) and outdoors (including the ground), as well as between interior spaces that have significantly different environments (e.g., between an indoor pool and classroom space).

In general terms, Part 5 deals primarily with the control of heat, air and moisture, where moisture includes the control of vapour, precipitation, surface water and ground water. Part 5 of the OBC generally does not restrict the use of wood (or other materials) provided that the materials or assemblies fulfill the prescriptive requirements for their intended function within the building envelope (i.e., control of heat, air, and/or moisture), and that any of the applicable reference standards are satisfied. The ability of a material or assembly to achieve the required performance related to the transfer of heat, air and moisture must be determined based on sound engineering principles and practices.

In the case of educational facilities, one possible application of wood in the building envelope would be as a cladding. For this example, the wood cladding must be designed and installed to provide the required protection from precipitation (Article 5.6.1.1) by,

a) minimizing the ingress of precipitation into the component or assembly, and

b) preventing the ingress of precipitation into interior space.

c) Additionally, the cladding would be required to provide a resistance to the mechanisms of deterioration (Article 5.1.4.2) that may reasonably be expected given the nature, function and exposure of the materials.

3.5 OBC Provisions for Use of Wood in Educational Buildings

The Tables in this Section document the OBC provisions for wood in educational buildings.

Part 3 provisions have been sorted into the following categories:

- Loadbearing Construction
- Envelope and Exterior Components
- Interior Walls and Doors
- Interior Finishes
- Minor Components

Part 4 and 5 provisions are listed as separate categories.

The table columns are as follows:

- Building Component: Each building component has a short identifier.
- Code Reference: The Article or Sentence containing the provision is identified.
- Paraphrase of the Provision: The paraphrase is written for maximum readability while retaining the key words of the Code provision. Detailed requirements such as tables are not repeated. The Code should be referenced for exact wording and application of requirements.
- Applicable to Buildings Required to be of Noncombustible Construction: This indicates if the provision applies to a building where noncombustible construction is required under Section 3.2.2.
- Applicable to Buildings Permitted to be of Combustible Construction: This indicates if the provision applies to a building where combustible construction is permitted under Section 3.2.2.
- Comments: Comments are provided on the application or implications of the provision.

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings…		Comments
			Required to be Noncombustible Construction	Permitted to be Combustible Construction	
PART 3 – COMBUSTIBLE CONSTRUCTION[1,2,3,4,5]					
1 Storey Building Unsprinklered	3.2.2.28.	• Maximum area of 800 m^2/ 1000 m^2/ 1200 m^2 facing 1/ 2/ 3 streets respectively if there is no basement • Maximum area of 400 m^2/ 500 m^2/ 600 m^2 facing 1/ 2/ 3 streets respectively if there is a basement • Rating not required for roof assembly		✔	
1 Storey Building Unsprinklered	3.2.2.25.	• Maximum area of 1600 m^2/ 2000 m^2/ 2400 m^2 facing 1/ 2/ 3 streets respectively • Mezzanines require a 45 minute fire resistance rating • Roof assembly requires a 45 minute rating • If not more than half the maximum permitted building area then a fire-retardant treated wood roof assembly is permitted (see 3.1.14.1. for fire-retardant treated roof requirements) and the fire resistance rating is waived		✔	
1 Storey Building Sprinklered	3.2.2.27.	• Maximum area of 2400 m^2 if there is no basement, no street limits • Maximum area of 1200 m^2 if there is a basement, no street limits • Rating not required for roof assembly • Rating not required for mezzanines		✔	
1 Storey Building Sprinklered	3.2.2.26.	• Maximum area of 4800 m^2, no street limits • Mezzanines require a 45 minute fire resistance rating • Rating not required for roof assembly		✔	
2 Storey Building Unsprinklered	3.2.2.25.	• Maximum area of 800 m^2/ 1000 m^2/ 1200 m^2 facing 1, 2 or 3 streets respectively • Floor assemblies and mezzanines require a 45 minute rating • Roof assembly requires a 45 minute rating		✔	
2 Storey Building Sprinklered	3.2.2.27.	• Maximum area of 600 m^2, no street limits • Rating not required for floor assemblies, mezzanines or roof assembly		✔	
2 Storey Building Sprinklered	3.2.2.26.	• Maximum area of 2400 m^2, no street limits • Floor assemblies and mezzanines require a 45 minute rating • Rating not required for roof assembly		✔	

1 Area is "building area" as defined in the OBC in all Subsection 3.2.2. provisions referenced in this table.

2 Applicable to all buildings: every floor assembly over a basement (and any loadbearing elements supporting the basement floor assembly) requires at least a 45 minute fire resistance rating (3.2.1.4.)

3 Applicable to all buildings: loadbearing elements (such as walls, beams, columns) require the same fire resistance rating as the supported assembly unless the Article specifically permits unrated noncombustible construction for the loadbearing elements.

4 Sprinklered buildings are not required to have a minimum percentage of the building perimeter facing a street, except the principal entrance must be within 3 – 15 metres of a street.

5 Wood elements are not required to meet minimum size requirements of Article 3.1.4.6. if a fire resistance rating is not required by Subsection 3.2.2.

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings… Required to be Noncombustible Construction	Provision Applicable to Buildings… Permitted to be Combustible Construction	Comments
Heavy Timber Roof Construction	3.2.2.16.	Heavy timber roof is permitted in a building up to 2 storeys in building height unless otherwise permitted by Article 3.2.2.25. to 3.2.2.28. if the building is sprinklered, regardless of the type of construction specified by Subsection 3.2.2. Structural members of the storey below the roof assembly are permitted to be of heavy timber construction.	✔	✔	Any 2 storey building can have a heavy timber roof regardless of building area or type of construction required.
Heavy Timber Construction	3.1.4.5.	If combustible construction is permitted and is not required to have a fire resistance rating more than 45 min, heavy timber construction is permitted.		✔	No additional structural fire protection is required in heavy timber construction, so wood can perform as the structure and interior finish at the same time.
Heavy Timber Construction	3.1.4.6.	Heavy timber construction is defined with respect to minimum dimensions and installation details. Minimum dimensions are provided for columns, beams, girders, trusses and arches, floor and roof elements.		✔	Wood elements are not required to meet minimum size requirements of Article 3.1.4.6. if a fire resistance rating is not required by Subsection 3.2.2. for the structural element or supported assembly.
Fire-Retardant Treated Wood	3.1.4.4.	Where fire-retardant treated wood is used to satisfy the Code, the wood is required to be pressure impregnated with fire-retardant chemicals in conformance with CAN/CSA-080 Series-M, "Wood Preservation", and have a maximum flame-spread rating of 25	✔	✔	This Article clarifies that fire-retardant treated wood requires more than surface treatment.
Combustible construction support	3.1.8.2.	Combustible construction that abuts or is supported by a noncombustible fire separation shall be constructed so that its collapse under fire conditions will not cause the collapse of the fire separation	✔	✔	There is no equivalent provision to govern the collapse of non-combustible construction abuts or supports of a noncombustible fire separation.
Protection of structural members outside the exterior face of a building	3.2.3.9.	Beams, columns and arches of heavy timber construction, placed wholly or partially outside an exterior face of a building and 3 metres of more from a property line or centreline of a public thoroughfare are not required to be covered with noncombustible cladding	✔	✔	
Heavy Timber Walkway between Buildings	3.2.3.19.	A walkway connected to a building required to be noncombustible can be of heavy timber construction if a minimum of 50% of the area of any enclosing perimeter walls is open to the outdoors and the walkway is at ground level. However, walkway would be required to conform to 3.2.3.14. (wall exposed to another wall requirements) and 3.2.3.15. (wall exposed to adjoining roof requirements)	✔		Heavy timber permitted for open walkways even if the buildings served are required to be noncombustible.
PART 3 – ENVELOPE AND EXTERIOR COMPONENTS					
Roof covering	3.1.5.3.(1)	Combustible roof covering that has an A, B, or C classification determined in conformance with Subsection 3.1.15. is permitted on a building required to be of noncombustible construction	✔		Wood shingles that meet the ULC S107 test are permitted as a roof covering on a building required to be of noncombustible construction.

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings…		Comments
			Required to be Noncombustible Construction	Permitted to be Combustible Construction	
Roof covering	3.1.15.2.(1)	Every roof covering requires a Class A, B, or C classification determined in conformance with Subsection 3.1.15. on every building unless exempted by Sentence 3.1.15.2.(2)		✔	Wood shingles that meet the ULC S107 test are permitted as a roof covering on a building permitted to be of combustible construction.
Wood shingles	3.1.15.2.(2)	A roof covering is not required to have a Class A, B or C classification for a Group A, Division 2 occupancy (e.g. a school) not more than 2 storeys in building height and not more than 1000 m^2 in building area provided the roof covering is underlaid with noncombustible material	✔	✔	Wood shingle roofs that do not demonstrate the Class A, B, or C classification are permitted on small assembly buildings such as schools etc.
Roof sheathing	3.1.5.3.(2)	Combustible roof sheathing and roof sheathing supports are permitted to be installed on a building required to be of noncombustible construction (certain conditions apply such as the presence of a concrete deck, maximum height 1 m, noncombustible parapet etc.)	✔		This permits a false wood roof to be constructed above a concrete deck.
Fire-Retardant Treated Wood Roof Systems	3.1.14.1.	If a fire-retardant treated wood roof system is permitted then the roof deck assembly is required to meet CAN/ULC-S126-M "Test for Fire Spread Under Roof-Deck Assemblies". Supports for the roof deck assembly must be either fire-retardant treated wood, heavy timber construction, noncombustible construction, or a combination of these.		✔	
Roof components	3.1.5.3.(3)	Combustible cant strips, roof curbs, nailing strips, and similar components used for roofing are permitted.	✔		Standard minor wood components for roof construction are permitted in a building required to be of noncombustible construction.
Roof nailer facings	3.1.5.3.(4)	Wood nailer facings to parapets (max 600 mm high) are permitted if facings and any roof membranes covering the facing are protected by sheet metal	✔		Standard minor wood components for roof construction are permitted in a building required to be of noncombustible construction.
Wood Window Frames	3.1.5.4.(5)	Combustible window sashes and frames are permitted in non-combustible buildings if certain conditions are satisfied. Conditions related to aggregate window opening area and separation of windows by non-combustible construction.	✔		This is typically applied to vinyl window sashes and frames in non-combustible buildings, but can equally be used to permit wood window sashes and frames.
Exterior Cladding	3.1.5.5.(4)	Combustible cladding of fire-retardant treated wood is permitted in a building required to be noncombustible construction provided • Building is not more than 3 storeys in building height • Building is not more than 6 storeys in building height if sprinklered Wood cladding must be subjected to accelerated weathering test before being tested to CAN/ULC-S134 "Fire Test of Exterior Wall Assemblies".	✔		
Wood canopies over building entrances	3.1.5.23.	Wood marquees up to 7.5 metres height are permitted for noncombustible buildings. No additional protection is necessary if the building is sprinklered. Unsprinklered buildings require openings in the wall above the marquee in proximity to the marquee to be protected with wired glass.	✔		This Article permits decorative wood canopies for noncombustible buildings.

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings… Required to be Noncombustible Construction	Provision Applicable to Buildings… Permitted to be Combustible Construction	Comments
Decorative cladding	3.1.5.25.	Decorative wood cladding is permitted for noncombustible buildings if the building face has firefighting access and the cladding is fire-retardant-treated wood suitable for exterior exposure. Wood cladding must be subjected to accelerated weathering test before being tested to CAN/ULC-S102 "Test for Surface Burning Characteristics of Building Materials and Assemblies".	✔		
Combustible Projections at Firewalls	3.1.10.7.	Combustible projections such as balconies, canopies, eave projections and stairs are not permitted within 2400 mm of combustible projections or door or window openings on the adjacent building.		✔	This provision limits wood balconies, stairs, eaves etc. in close proximity to firewalls.
Combustible projections	3.2.3.6.	Combustible projections on the exterior of a wall that could expose an adjacent building to fire spread and are more than 1000 mm above ground level, including balconies, platforms, canopies, eave projections and stairs are not permitted within 1200 mm of the property line or the centreline of a public way of within 2400 mm of a combustible projection on another building on the same property		✔	Wood not permitted as cladding or as a structural material in certain circumstances in densely constructed areas.
Construction of exposing building face	3.2.3.7.	Walls that are close to property lines (i.e. that create a potential fire exposure condition to adjacent properties or buildings) may require noncombustible construction and/or cladding, wood is not permitted in these walls even if the remainder of the structure is wood.	✔	✔	The most restrictive requirements for walls at or very close to the property line are noncombustible construction, 1 hour rating and noncombustible cladding. The next category of wall construction requires a 1 hour rating and noncombustible cladding for the exterior wall.
Fire stopping in wall assemblies	3.1.11.2.	See Minor Components.	✔	✔	
PART 3 – INTERIOR WALLS AND DOORS					
Wood Elements in Partitions	3.1.5.13.(1)	Solid lumber partitions, minimum 38 mm thick and wood framing in a fire compartment with max area of 600 m² is permitted	✔		Wood framing can be used for interior partitions in small fire compartments in educational buildings required to be of noncombustible construction.
Wood Elements in Partitions	3.1.5.13.(2)	Partitions in a building of noncombustible construction are permitted to contain wood framing if: • Maximum 3 storeys • Partitions are not used as enclosures for exits or vertical service spaces	✔		Wood framing can be used for interior partitions in small educational buildings required to be of noncombustible construction.
Wood Elements in Partitions	3.1.5.13.(3)	Partitions that contain wood framing are permitted in a non-combustible building if: • The building is sprinklered throughout • Partitions are not used as enclosures for exits or vertical service spaces • Partitions are not used as to extend floor fire separations around high volume spaces	✔		Wood framing can be used for interior partitions in larger educational buildings required to be of noncombustible construction.

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings…		Comments
			Required to be Noncombustible Construction	Permitted to be Combustible Construction	
Wood Doors as 20 Minute Closures	3.1.8.10.(1)	Wood doors with a 20 minute fire protection rating are permitted in: • a 1 hour rated (or less) fire separation between a corridor and adjacent classrooms, offices and libraries in educational buildings • a 45 minute rated (or less) fire separation in a building not more than 3 storeys	✔	✔	Doors into classrooms, offices and libraries are generally permitted to be wood construction.
Sill and Floor coverings under Door as 20 Minute Closures	3.1.8.10.(2)	Sills and floor coverings under 20 minute rated doors are permitted to be combustible	✔	✔	
Solid Wood Door as a Closure with an Unrated Wood Door Frame	3.1.8.10.(4)	In an elementary or secondary school, a solid core wood door meeting CAN4-S113 is permitted in a 30 minute rated fire separation. An untested and unrated wood door frame is permitted if it is at least 38 mm thickness.	✔	✔	
PART 3 – INTERIOR FINISHES					
Finished Flooring	3.1.5.8.	Combustible finished flooring is permitted in a building required to be of noncombustible construction.	✔		Combustible flooring materials (wood, carpet) is permitted in buildings of noncombustible construction in most floor areas.
Raised Platforms	3.1.5.8.	Wood members more than 50 mm but not more than 375 mm high are permitted for a raised platform in a building required to be of noncombustible construction • Concealed spaces required to be firestopped • Combustible subfloor and finished flooring is also permitted for the raised platform	✔		
Stage Flooring	3.1.5.8.	Combustible stage flooring supported on noncombustible structural members is permitted	✔		
Combustible Interior Wall Finish in Noncombustible Buildings	3.1.5.10.(2)	Wood interior wall finishes are permitted if a maximum of 25 mm thick with a flame spread rating of maximum 150 (walls) throughout finish material (i.e. not just surface treated)	✔		Wood finishes are permitted in noncombustible buildings, unless other flame spread requirements supercede this permission.
Combustible Interior Ceiling Finish in Noncombustible Buildings	3.1.5.10.(3)	Wood interior ceiling finishes are permitted if • Finishes are a maximum of 25 mm thick except that fire retardant treated battens are not limited in thickness; and • Finish has a maximum flame rating of 25 or is fire retardant treated wood.	✔		Wood finishes are permitted in noncombustible buildings, unless other flame spread requirements supercede this permission depending on location within the building. Up to 10% of the ceiling area of fire compartment is permitted to have a flame spread rating of not more than 150.
Flame-spread rating of interior finishes (general)	3.1.13.2.(1)	Maximum flame-spread rating of 150 for interior wall and ceiling finishes unless otherwise required or permitted elsewhere	✔	✔	These provisions permit untreated wood as a wall and ceiling finish in general floor areas. These are the base requirements for flame spread ratings for wall and ceiling finishes that may be superceded by more strict requirements for buildings of noncombustible construction or requirements for specific areas.

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings… Required to be Noncombustible Construction	Provision Applicable to Buildings… Permitted to be Combustible Construction	Comments
Flame-spread rating of doors	3.1.13.2.(2)	Maximum flame-spread rating of 200 (doors)	✔	✔	
Flame-spread rating of interior finishes of exits and exit lobbies	3.1.13.2.	Maximum flame-spread rating of 25 for walls and ceilings of exits and exit lobbies, regardless of sprinkler protection.	✔	✔	
Flame-spread rating of interior finishes in exits and exit lobbies (exceptions)	3.1.13.2.(4)	• Where interior wall and ceiling finishes are required to have a flame-spread rating less than 150, up to 10% of the total wall area and up to 10% of the total ceiling area is permitted to have a flame spread rating of 150 • In exit lobbies up to 25% of the total wall area is permitted to have a flame spread rating of 150	✔	✔	These exemptions permit untreated wood in small areas on walls and ceilings in areas that otherwise have strict flame-spread requirements that cannot be met by untreated wood.
Flame-spread rating of interior finishes	3.1.13.6.	Interior wall and ceiling finishes have limited flame spread ratings, especially for unsprinklered buildings in specific floor areas: • Maximum flame-spread rating for walls of public corridors, corridors used by the public in an assembly occupancy, corridors serving classroom (75 if not sprinklered, 150 if sprinklered) ○ Permitted to have a flame-spread rating of 25 on the upper part of the wall and 150 on the lower half of the wall • Maximum flame-spread rating for ceilings of public corridors, corridors used by the public in an assembly occupancy, corridors serving classroom (25 if not sprinklered, 150 if sprinklered)	✔	✔	Some untreated wood species have flame spread ratings of 75 or less.
Wood trim, millwork and doors for exits, exit lobbies and corridors in a high building	3.1.13.7.(3)	Trim, millwork and doors for exits and exit lobbies in a high building are permitted to have flame spread rating of 150 and smoke developed classification of 300, provided their aggregate area is not more than 10% of the area of wall or ceiling in which they occur	✔	✔	
Wood interior finish in exits in a non-combustible building	3.1.13.8.	Restrictive flame-spread rating requirements (maximum 25) applies for the full thickness of interior finishes in exits, with the exception of doors, heavy timber construction in a sprinklered building, and fire retardant treated wood	✔	✔	
Exterior exit passageway	3.1.13.10.	The wall and ceiling finishes of an exterior exit passageway that provides the only means of egress from the rooms or suites it serves, including the soffit beneath and the guard on the passageway, is required to have a maximum flame-spread rating of 25, except that a maximum flame-spread rating of 150 is permitted for up to 10% of the total wall area and for up to 10% of the total ceiling area	✔	✔	Wood finishes must be treated for certain exterior exit passageways.
Nailing elements for interior finishes	3.1.5.6	See Minor Components.	✔		

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings…		Comments
			Required to be Noncombustible Construction	Permitted to be Combustible Construction	
Fire stopping for wood ceilings and floors	3.1.11.3.	See Minor Components.	✔	✔	
Fire stopping between vertical and horizontal spaces	3.1.11.4.	See Minor Components.	✔	✔	
PART 3 – MINOR COMPONENTS					
Protection of foamed plastics	3.1.4.2.(1)(a)	In buildings permitted to be of combustible construction, foamed plastic insulation is permitted to be protected by plywood (9.29.6.), hardboard finish (9.29.7.), insulating fibreboard finish (9.29.8.), particle board, OSB or waferboard finish (9.29.9.)		✔	This permits typical wood interior finishes to protect foamed plastic whereas this is typically required to be gypsum board in noncombustible buildings.
Minor components	3.1.5.2.(1) (g) and (h)	Minor combustible components are permitted including wood blocking within wall assemblies intended for the attachment of handrails, fixtures and similar items mounted to the surface of the wall	✔		
Nailing elements for interior finishes	3.1.5.6	Wood nailing elements permitted • Attached directly to or set into noncombustible backing for attaching interior finishes • Concealed space created by the wood elements is a maximum of 50 mm thick	✔		Standard minor wood components for attachment of interior finishes are permitted in a building required to be of noncombustible construction.
Millwork	3.1.5.7.	Combustible millwork permitted (includes interior trim, doors and door frames, show windows together with their frames, aprons and backing, handrails, shelves, cabinets and counters)	✔		This opportunity is applied in most buildings required to be of noncombustible construction.
Fire stopping in wall assemblies	3.1.11.2.	Fire stops are required in cavities of wood wall assemblies at every floor level and to limit maximum horizontal and vertical dimensions	✔	✔	Firestopping of wood assemblies requires additional design detailing and construction effort.
Fire stopping for wood ceilings and floors	3.1.11.3.	Firestopping is required for the concealed spaces created by wood framing members supporting wood ceilings and wood floors	✔	✔	Firestopping of wood assemblies requires additional design detailing and construction effort.
Fire stopping between vertical and horizontal spaces	3.1.11.4.	Firestopping is required at interconnections between concealed spaces in horizontal and vertical wood assemblies	✔	✔	Firestopping of wood assemblies requires additional design detailing and construction effort.
Fire stopping of horizontal concealed spaces	3.1.11.5.	Firestopping is required for horizontal concealed spaces in wood construction such as wood floor or roof assemblies (unsprinklered)	✔	✔	Firestopping of wood assemblies requires additional design detailing and construction effort.
Fire stop materials	3.1.11.7.	Firestop materials to separate concealed spaces into compartments are required to remain in place for a minimum of 15 minutes when subjected to the fire exposure as outlined in CAN/ULC-S101. If a building is permitted to be combustible plywood or solid lumber is permitted as a firestop material.	✔	✔	While firestopping of concealed spaces takes additional design and construction effort, the firestopping can be constructed of standard wood materials.

Building Component	Code Reference	Paraphrase of Provision	Provision Applicable to Buildings… Required to be Noncombustible Construction	Provision Applicable to Buildings… Permitted to be Combustible Construction	Comments
PART 4 – STRUCTURAL DESIGN					
Seismic Force Resisting System	4.1.8.9.	SFRS Force Reduction Factors, System Overstrength Factors, and General Restrictions. – Table 4.1.8.9 provides restrictions for Timber Structures designed and detailed in accordance with CAN/CSA-086 that are imposed in certain cases based on design parameters such as the geographic seismic zone in which the building is located, and the type of SFRS utilized.	✔	✔	
Wood Used in Foundations	4.2.3.1.	Wood used in foundations is required to meet requirements of Subsection 4.3.1., which includes the design standard for wood (CAN/CSA-086), the standard for glue-laminated members and protection against termites (if known to be present).		✔	
Preservation Treatment of Wood	4.2.3.2.(1)	Where wood will be exposed to soil or air above the lowest groundwater table, it shall be treated in conformance with CSA 080 Series "Wood Preservation" and the appropriate commodity standard for the building element.	✔	✔	
Care of Preservative-Treated Wood Products	4.2.3.2.(2)	Where timber has been preservative-treated it shall be cared for as provided in AWPA-M4 "Care of Preservative-Treated Wood Products", as revised by Clause 6 of CSA 080 Series.		✔	
Design Basis for Wood	4.3.1.1.	Buildings and their structural members made of wood shall conform to CAN/CSA-086 "Engineering Design in Wood".		✔	
Design/ Manufacturing Requirements for Glue-Laminated Wood	4.3.1.2.	Glue-Laminated members shall be fabricated in plants conforming to CAN/CSA-0177-M "Qualification Code for Manufacturers of Structural Glue-Laminated Timber".		✔	
PART 5 – ENVIRONMENTAL SEPARATION					
Grade of Cedar Shakes and Shingles	5.6.1.2.	Cedar shakes and shingles installed to provide required protection from precipitation are required to meet certain grades depending on their type (western cedar or eastern white cedar) and their application.	✔	✔	
Standards for Wood Products in Environmental Separators	5.10.1.1.	Materials and components and their installation are required to meet the applicable standards in Table 5.10.1.1. where those materials or components are: incorporated into environmental separators or assemblies exposed to the exterior, and installed to fulfill requirements of Part 5 of the OBC. The table includes standards for wood products such as preservative-treated lumber, plywood, cedar shingles, softwood lumber, construction sheathing, OSB and waferboard.	✔	✔	

4. Opportunities for Alternative Solutions

4.1 Introduction

Compliance with the 2006 OBC can be achieved by complying with the provisions in Division B (referred to as acceptable solutions), or by using an alternative solution. An alternative solution is required to demonstrate the same level of performance as the acceptable solution.

The Code defines the areas that are subject to an evaluation of performance by analysis of functional statements and objectives linked to each Code provision.

Division C sets out documentation requirements for the submission of an alternative solution to the chief building official. It is important to note that compliance via an alternative solution is equally valid as compliance via an acceptable solution.

It is noted that alternative solutions are site specific and are not intended to be treated as a universal design solution. Neither is there a data base of information that documents previous alternative solutions.

Innovative or proprietary structural wood products may be permitted for use as structural members, subject to satisfying the requirements of Clause 13 “Proprietary Structural Wood Products” of CAN/CSA-O86 (and the authority having jurisdiction). Products designed in accordance with Clause 13 must provide equivalent performance characteristics such as strength, serviceability and reliability consistent with the requirements of Part 4 and the applicable sections of CAN/CSA-O86. In order to demonstrate compliance with Clause 13, a number of essential requirements must be satisfied, including the following:

- Conformance with a consensus standard developed by a recognized standards writing organization (e.g., ASTM, CSA)
- Development and implementation of a consistent methodology, based on sound engineering principles, for determining the structural design values and/or capacities of the product. This must include a provision for on-going re-evaluation and quality control.
- Incorporate a manufacturing quality assurance program, verified and supervised by an independent third-party certification organization.

In some cases, exceptions and/or reduced performance characteristics may be permitted under Part 5, provided that it can be shown or demonstrated that it will not adversely affect any of,

d) the health and safety of the building users,

e) the intended use of the building, or

f) the operation of building services.

4.2 Possible Alternative Solutions

All building solutions, including innovative design solutions or alternative materials are able to be analyzed as a possible alternative solution. However, the potential for success of any alternative solution depends on the extent to which the materials and design reflect the performance level that would be achieved by compliance with the corresponding Code provision that otherwise restricts the use of wood or the application. It is often necessary to offer compensating construction or demonstrate a clearly enhanced performance in order to demonstrate performance that is equal to or exceeds that which would be achieved by conforming to the provisions of the OBC. In addition, it may be necessary to demonstrate a measureable performance from testing, modeling or other analysis.

4.2.1 Wood Cladding Alternative Solution

An example of a possible alternative solution which was applied and accepted by an Authority Having Jurisdiction in another jurisdiction for a university research/academic building was the use of a wood cladding that had not been tested to the requirements of CAN/ULC-S134. The alternative solution relied on unique elements of the design of this specific building, including limitations on where the cladding would be used on the exterior building faces so as to avoid the potential for fire exposure from an exterior fire involving the cladding to expose windows opening to the building and doubling of limiting distances to avoid exposure to adjacent buildings.

In this case, the approval was granted on the basis of a scenario analysis, application of first principle fire dynamic analysis available for the homogeneous wood product and radiant heat calculations relative to adjacent buildings.

Approval was granted for the alternative solution on the condition that limitations were clearly noted on the permit file and a restriction on limiting distances was to be noted on title so that future development would not inadvertently undermine the solution and create an exposure condition.

4.2.2 Interior Finish Alternative Solution

An example of a possible alternative solution for wood is as an interior finish material that has a flame spread rating established by a test standard other than the standard recognized in the OBC. For example, a wood paneling product from Europe may be proposed for interior walls of the corridors in a sprinklered school that was required to be of noncombustible construction. The key OBC requirements for wood interior finish in this application are:

- Sentence 3.1.5.10.(2) permits wood interior wall finish in a building required to be of noncombustible construction. The conditions are that the wood is maximum 25 mm thick and has a maximum flame spread rating of 150 throughout the material.
- Article 3.1.13.2. also requires a maximum 150 flame spread rating for the interior finish of walls in corridors serving classrooms.
- Sentence 3.1.12.1.(1) requires that the flame spread rating of a material be determined on the basis of tests conducted in conformance with CAN/ULC-S102-M, "Test for Surface Burning Characteristics of Building Materials and Assemblies".

An acceptable solution (i.e. conforming solution) would require submission of documentation from the manufacturer demonstrating that the wood paneling has a maximum flame spread rating of 150 when tested to CAN/ULC-S102. In an alternative solution, the wood paneling that has been tested to another standard applicable in Europe would have to demonstrate that the performance of the material would be equal to or exceed that which is required by the OBC.

In order to approve the alternative solution, the authority may require analysis that compares the two test standards and demonstrates the correlation of the test results between the European standard and the ULC-S102 standard. This may be able to be demonstrated by analyzing the testing requirements including test chamber, sample configuration, flame exposure to the sample, pass/fail criteria and other conditions which may influence the performance of the material when subjected to flame. An analysis of this nature may be significantly less expensive and faster than submitting the material to an authorized testing agency for tests relative to the CAN/ULC-S102 Standard. However, the analysis may show that any one element of sample size or orientation, flame exposure or pass/fail criteria are uniquely different from the CAN/ULC-S102 test or that the accumulation of minor differences does not allow for a direct comparison. Ultimately the proponent of the alternative solution will need to prove that the flame spread rating under the European standard provides the same level of performance or better than the flame spread rating under the CAN/ULC-S102 standard.

To support the use of innovative products such as interior finishes that have not been subjected to the CAN/ULC-S102 Standard, one possible solution is for an industry advocate to accumulate test data from a variety of manufacturers and assemble a data base of results. Analysis of these industry results may lead to a correlation factor that can be reasonably expected to predict results when tested to the CAN/ULC-S102 Standard. A correlation between interior finish results for materials subjected to ASTM-E84 versus CAN/ULC-S102 is available (with limitations). A similar correlation would assist designers, manufacturers and distributors to introduce materials from other parts of the world to Canada and specifically to Ontario for use in educational buildings.

4.2.3 Wood Construction Alternative Solution

A more challenging example of an alternative solution is proposing a building to be of combustible construction where it exceeds the maximum building size permitted by Subsection 3.2.2.

This is challenging because demonstrating performance level of the building area and height limits of Subsection 3.2.2. requires a holistic exercise considering factors of occupant safety, emergency responder safety, and property protection.

This possible alternative solution requires whole scale computational fire modeling to assess the performance of wood under fire conditions as well as separate analysis of the performance of wood construction under structural loads. Although advanced computation fire models are available and are in wide-spread use as a fire protection engineering tool, significant limitations apply to these models. One of the most significant limitations is the ability to correctly model the effectiveness of sprinklers. Many models rely on overly conservative assumptions that, when compounded, may undermine the analysis as a tool to assess the performance of a material that would otherwise not be permitted by the OBC.

It is noted that extensive investigation and analysis is underway within the research community with respect to the fire performance of a large wood frame building as well as to the seismic and structural performance of wood frame construction.

5. Potential Code Changes to Promote the Use of Wood

MORRISON HERSHFIELD

5.1 Introduction

Potential Code changes to promote the use of wood are not unique to educational buildings. Potential changes such as wood buildings of increased size, or fewer restrictions on the use of wood as an exterior cladding have been contemplated by many Code-writing bodies.

- Recent trends in expanding the use of wood illustrate the potential for Code changes in Ontario and the application to different occupancy types.
- British Columbia Building Code – Change to Permit 6 Storey Wood Frame Residential Building

Quebec – Alternative Solution to Permit an 8 Story Office Building of Mixed Wood and Noncombustible Construction

Other changes are possible for any element of the Code which currently restricts the use of wood or which permits wood but under limitations or restrictions.

5.2 Process

Any change to the Code requires submission of a Proposed Code Change Form, identifying the current provision and the proposed change, as well as supporting documentation to justify the basis for the proposed change.

Justification for a proposed change can be developed from precedents, first principle analysis or fire modeling. A combination of justifications may be required for complex changes.

5.3 Possible Changes to the OBC

The following are examples of possible changes to the OBC to permit the use of wood:

- Modification to Article 3.1.5.5. to specifically permit the use of fire retardant wood cladding, without being tested to CAN/ULC-S134 for wood that would otherwise demonstrate a flame spread rating of less than 25 when tested to conform to CAN/ULC-S102. The material would be required to have been subjected to an accelerated weathering test (ASTM D2898) prior to testing for flame spread. This possible Code change should be supported by test data to confirm that exposure conditions are limited for a variety of wood products that demonstrate the flame spread rating less than 25.
- Removal of restrictions on thickness of interior finish material under Article 3.1.5.10. for solid wood materials that demonstrate flame spread ratings currently applicable in the Code. It may be appropriate to require the installation of sprinklers to support this relaxation. The properties of solid wood support a relaxation of the 25 mm maximum thickness since wood chars when exposed to fire and the char provides a protective layer that reduces the exposure to the full thickness. In combination with sprinkler protection, the extent to which the full thickness of wood would be consumed and contribute to the fuel load is severely reduced.
- Expanded application for the use of heavy timber is another possible change to the OBC. Current limitations on the use of heavy timber can be restrictive. For example, heavy timber roofs and their supporting structure are permitted in a building up to 2 storeys in building height. However, consideration could be given to permitting heavy timber construction for roof elements and their supporting structure for any roof element that is within 2 storeys from grade, regardless of the building height. Sprinklers would be required throughout.

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Wood Use in Low-Rise Educational Buildings – Ontario

an introduction to the 2012 reference guide

Information in this document is excerpted from Wood Use in Low-Rise Educational Buildings – Ontario (February 2012), a reference guide produced for Ontario Wood *WORKS!* by Patrice Tardif Consulting. To obtain a free copy of the full 64-page document, which contains several case studies and a Wood *WORKS!* commissioned report by Morrison Hershfield entitled *Use of Wood in Educational Buildings – Application of the Ontario Building Code*, please contact the Ontario Wood *WORKS!* office.

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Ontario boasts an inventory of 4,900 publically funded elementary, middle and secondary school buildings owned by 70 school boards across the province. Whether in downtown cores, the suburbs, small towns, or northern Ontario and First Nations communities, these buildings fulfill an important function – that of educating Ontario's future generations. The Ontario Ministry of Education has revised school curricula to include environmental education in an effort to impart to its students the importance of sustainability concepts such as responsible stewardship. To demonstrate these principles through action, it is important to insure the best use of public funds in the creation of sustainable learning environments for Ontario's students. The use of wood construction systems in school buildings is a means to that end.

Cover Photo: Richmond Christian School by KMBR Architects Planners Inc + Allen Maurer Architects Ltd, architects in association, photo by Robert Stefanowicz. Interior (CW from top left): École secondaire catholique de la Vérendrye, photo courtesy of FORM Architecture Engineering. Vale Living with Lakes Centre, photo by Terence Hayes Photography. Crawford Bay Elementary-Secondary School, photo courtesy of KMBR Architects Planners Inc. Centre de formation et de transfert technologique sur les pratiques forestières, photo courtesy of Emond, Kozina, Mulvey, architectes and DPA Daniel Paiement architecte. Richmond Christian School, photo by Robert Stefanowicz.

What's best for the environment in the context of constructing low-rise school buildings? The responsible use of resources is one obvious answer. Responsible stewardship tenets espoused by Canada's education sector recommend the use of renewable resources whenever possible (Ontario Institute for Studies in Education, Climate Change & Sustainable Development: The Response from Education in Canada. 2009). Wood is the only major renewable resource used in construction systems.

Wood-frame construction is a strategic option for low-rise educational buildings in Ontario because it is able to meet code and project requirements while simultaneously achieving economic and environmental outcomes that surpass those of competing construction materials.

Put simply, the economic benefits of wood-frame construction in low-rise educational buildings are two-fold. The first set of benefits applies directly to each individual project. In the construction phase of a project, the advantages of wood construction can include: the ready availability of wood products and systems, reduced material lead-times, simplified construction scheduling, the availability of local skilled labour and reduced on-site waste (particularly when pre-fabricated elements are used). These things positively affect the time it takes to complete a building and a shorter construction time will save money up front.

In the occupancy phase, wood has other cost-saving attributes. The natural insulating properties of wood's cellular structure make wood-frame buildings more thermally efficient. They are easier and less costly to insulate, resulting in lower operating costs. In the specific case of school buildings, where the number of students that a school needs to serve can change over time, the ease with which a wood building can be adapted to meet changing needs extends the useful life of the school. The longer a building lasts, the more value it delivers to the owner. When a wood building is properly designed, detailed and maintained, its life-span can be limited only by the school's changing needs. In North America, wood buildings, whether residential or non-residential, have longer life-spans than buildings built using any other construction system and a large part the reason for this longevity is adaptability.

Beyond the immediate economic benefits to the owners of each project are the secondary and equally important benefits to the provincial economy. Ensuring a healthy and sustainable economy in any region requires the validation of local industry. Ontario's forest sector is a key component of the province's economy, valued at $12 billion. Statistics from 2009 show that nearly $3 billion of this amount is attributed to lumber, engineered wood and other manufactured products, and another $1.8 billion to the value-added sector, which includes such products as furniture and cabinet manufacturing. Making use of local industries and their products in the construction of school buildings directly supports both regional and provincial economies.

In addition to making economic sense, pursuing a wood construction option is also the best choice for the environment. As trees grow, they take in CO_2 from the atmosphere and through the process of photosynthesis, lock the carbon away as wood fibre and release oxygen back into the atmosphere. This carbon remains trapped in the wood for the life of the building product. Using wood harvested from sustainably managed forests, like those in Ontario, has the ability to reduce greenhouse gasses and help mitigate climate change. From a purely scientific perspective, the use of wood wherever possible (from managed sources), must be an integral component of all sustainable building strategies because it is the only major building material that is truly sustainable.

Low-rise school buildings are the staple of communities, particularly in city suburbs and small towns throughout Ontario. They are often important to their neighbourhoods as a location for community activities. Educational buildings need to respond to the rigors imposed by school and community activities; they must be built within the budget, and last as long as possible. To insure this, they need to be durable and adaptable to changing needs and shifting populations; they need to be easy and affordable to maintain; they need to make sense in the context of Ontario's building fabric and economic reality. Wood-frame construction is an important option for school buildings as well as an important choice in the pursuit of a more sustainable future.

Heavier superstructures require more robust foundations and footings than lighter superstructures. Extra time is needed for added reinforcement in the more robust foundations; added materials and more time lead to added costs. The lighter foundations required for wood-frame structures are less expensive, saving money that can be allocated to other aspects of the project.

Some timber systems can be left exposed, a strategy that not only improves the aesthetics and warm atmosphere of a school, but also reduces the time and costs required for finishing materials and future maintenance.

Whether delivered by road, rail, water, or as is the case with the far north, ice roads during the winter months, material delivery can affect the construction schedule of a school building. The ease of sourcing and working with wood construction systems has proven that it is often quicker and easier to build with wood, regardless of the season or the location, even in those locations where the construction season is shorter and colder temperatures prevail.

L'immeuble à bureaux de GlaxoSmithKline
dans le parc technologique de Québec

© Photo : Stéphane Groleau

cecobois

Centre d'expertise
sur la construction
commerciale en bois

Une division du
Bureau de promotion des produits
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Le nouvel immeuble à bureaux de la compagnie pharmaceutique belge GlaxoSmithKline (GSK), dans le parc technologique de Québec, ne passe pas inaperçu. Comment ne pas remarquer ce bâtiment aux formes onduleuses, avec sa façade principale entièrement vitrée laissant transparaître une structure en bois tout à fait originale ?


Photo : FPInnovations


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L'édifice est situé juste en face des laboratoires de GSK, où l'on fabrique des vaccins antigrippaux pour le monde entier. Depuis l'installation de l'entreprise à Québec en 2006, quelque 150 employés travaillaient dans des bureaux aménagés à l'intérieur d'un complexe modulaire temporaire près de l'usine. C'est pour mettre fin à cette situation que la compagnie a construit son nouvel immeuble sur un terrain qu'elle possédait de l'autre côté de la rue. En juin 2011, les 150 employés du complexe modulaire y ont été relogés dans un espace fonctionnel, largement conçu pour leur confort et leur performance au travail.

Ce que voulait GSK pour son nouveau bâtiment, c'était une construction « verte » innovante, alliant une structure de bois à une grande efficacité énergétique, procurant un environnement de travail optimum aux employés et se démarquant sur le plan esthétique.

Le résultat, au terme de dix-huit mois de conception et construction, est un bâtiment rectangulaire de 2 700 m^2 sur deux étages hors sol (mais trois niveaux de plancher), qui fait une large part à l'apparence et présente de nombreuses innovations. En attente d'une certification LEED-Or, le projet a été presque carboneutre pendant sa réalisation, tout comme le sera l'édifice au cours de son utilisation.

Le tour du bâtiment

Ce qui frappe d'abord quand on s'approche de l'immeuble, c'est sa façade entièrement vitrée ainsi que sa silhouette particulière avec ses deux extrémités arrondies, dont l'une est plus élevée que l'autre d'environ 3 m (15,7 m hors sol en tout). Cette configuration rappelle un peu le logo de GSK, en même temps qu'elle constitue l'expression architecturale d'une forme organique évoquant les activités pharmaceutiques de l'entreprise. Mais, comme on le verra plus loin, elle a surtout une fonction énergétique bien précise, tout comme l'utilisation de la structure en bois.

La façade sud est constituée d'un grand rideau de verre double peau, muni d'un système de pare-soleil, tandis qu'au nord un deuxième volume un peu plus bas que la partie principale est habillé de verre et d'aluminium, tout comme les façades est et ouest. Les deux extrémités recourbées de la toiture se prolongent à la verticale en écrans solaires (grillage métallique) pour protéger de la surchauffe et de l'éblouissement du matin et de la fin d'après-midi.

À l'extrémité est, une terrasse extérieure surélevée vient s'ajouter aux espaces de détente de l'intérieur. Et tout autour du bâtiment, un aménagement paysager, conçu pour gérer et filtrer l'eau pluviale, redonne son capital écologique à un terrain auparavant dénaturé, tout en protégeant l'immeuble des rigueurs du climat. Par ailleurs, comme une aile d'avion, l'élévation en pente douce d'un bout du bâtiment procure à la toiture un effet de portance qui accélère la vélocité du vent, favorisant ainsi un dégagement naturel de la neige.

Une puissante génératrice située à l'angle nord-ouest du bâtiment, doublée d'un système UPS, assure une autonomie d'énergie complète en cas de panne de courant du réseau public.

De façon surprenante, il n'y a aucun bureau fermé dans ces sections. Les employés se côtoient, installés à de longues tables disposées l'une derrière l'autre dans un espace complètement ouvert. Lorsqu'ils ont besoin de s'isoler, ils peuvent aller dans l'une des douze « bulles » (salles de travail closes) aménagées à cette fin, avec une table, quelques chaises et un téléphone.

À ces bulles s'ajoutent des salles de réunion et de conférence dans la partie centrale, où se trouvent également les toilettes, la salle d'électricité et la téléphonie. Tous les espaces de travail et de détente, incluant bulles et salles de conférence – chacune avec au moins un mur vitré –, bénéficient de la lumière naturelle et offrent une vue sur l'extérieur. Le demi-sous-sol (excavation de 1,5 m rendue possible par le rez-de-chaussée surélevé) héberge la salle de mécanique, le serveur informatique (réseau sans fil dans tout le bâtiment), le vestiaire et quatre douches.

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Photo : FPInnovations

Photo : FPInnovations

Chaleur du bois et lumière naturelle

Le plus remarquable, à l'intérieur, est certainement ce vaste atrium dans lequel on se trouve, sitôt franchi le seuil. Il s'agit d'un espace ouvert sur toute la hauteur de l'édifice, où l'on sent la chaleur du bois omniprésent : platelages, colonnes et poutres de toutes dimensions qui composent un décor somptueux baignant dans la lumière naturelle. Suffisamment grand pour accueillir des rassemblements importants, au besoin, cet espace loge le poste d'accueil, une aire d'attente et de détente ainsi que deux petites salles de réunion. Il donne sur les demi-escaliers conduisant au sous-sol et au rez-de-chaussée surélevé, de même que sur l'ascenseur et le grand escalier ouvert qui mène à l'étage.

Tous les espaces de détente et d'échange pour les employés se trouvent du côté sud de l'immeuble, le long d'un corridor qui longe la façade vitrée et, à l'étage, sur une grande mezzanine qui surplombe l'atrium à l'ouest. Quant aux aires de travail, identiques sur les deux planchers, elles occupent tout le volume nord de l'édifice.

Une structure complexe

La structure du bâtiment est constituée d'un assemblage complexe de poutres et colonnes en bois lamellé-collé Nordic Lam, certifié FSC, de formes et de dimensions variées. Pour les concepteurs, le fournisseur du bois et les équipes de montage, ce chantier s'est avéré l'un des plus techniques sur lesquels ils aient eu à travailler… ce qui n'a pas empêché une érection rapide, en quelques mois. La grande précision des assemblages a été rendue possible grâce à une modélisation 3D complète de la structure, combinée à des techniques d'usinage à la fine pointe de la technologie.

Les colonnes à la fois les plus spectaculaires et les plus inusitées sont situées dans l'atrium et le long de la façade principale. Elles ont une forme cylindrique à diamètre variable, partant de 315 mm aux extrémités, allant jusqu'à 450 mm au centre (dans l'atrium), et de 215 à 350 mm (en façade), pour des longueurs de 9 à 14 m. Le choix de cette forme cylindrique à diamètre variable répond à un objectif esthétique, les architectes ayant voulu alléger et raffiner la structure. Le choix du matériau bois a permis d'obtenir cette grande flexibilité sur le plan du design, ce qui aurait été très difficile à mettre en œuvre avec d'autres matériaux. Cela a notamment permis d'obtenir le profil arrondi des colonnes.

© Photo : Stéphane Groleau

Le long de la façade, les colonnes sont inclinées à environ 70 ° et appuyées en « A », ce qui donne une signature particulière à l'architecture. Il en résulte un effet de contreventement longitudinal qui prend à la fois les efforts verticaux et latéraux. Dans la section haute de la façade, les colonnes s'aboutent pour former de grands « X » bien visibles de l'extérieur à travers le mur de verre. Les connexions qui relient colonnes de bois et d'acier, au-dessus du plancher, sont des assemblages ductiles pouvant dissiper l'énergie d'une éventuelle secousse sismique dans l'ensemble de la charpente, afin d'éviter de surcharger les colonnes inclinées.

Pour assurer la courbure du toit, certaines poutres rectangulaires présentent une forme arquée à double point d'inflexion, s'incurvant dans un sens puis dans l'autre. Elles ont été réalisées grâce à un processus de collage et constituent l'un des premiers cas de poutres à double courbure inversée à rayons variables.

Une ferme 3D

De façon à reprendre les efforts du vent et de potentielles secousses sismiques sur la façade de verre, les ingénieurs ont suggéré d'installer une ferme tridimensionnelle dans le haut de l'atrium. Constituée de treize pièces cylindriques qui s'entrecroisent dans l'espace, cette ferme 3D transfère les charges vers un contreventement situé dans les murs d'un escalier de secours, dans la partie basse de l'immeuble, du côté nord. La ferme vient aussi supporter latéralement les colonnes. L'une des connexions de cette ferme relie pas moins de huit pièces au même point.

Outre les poutres et colonnes de la charpente, l'utilisation du lamellé-collé comprend des platelages de 64 mm d'épaisseur pour la structure du toit, 89 mm pour les planchers et 137 mm pour les planchers de certaines bulles en porte-à-faux, qui nécessitaient plus de résistance et de rigidité.

En tout, quelque 500 m^3 de bois provenant de têtes d'épinettes noires du Québec ont été livrées sur le chantier aux dimensions exactes spécifiées pour l'assemblage, enveloppées de plastique durant le transport et déballées seulement au moment d'être utilisées, ou parfois même après le montage. Et à tout ce lamellé-collé, visible de part en part de l'immeuble, s'ajoutent plusieurs autres éléments en bois d'apparence : marches d'escaliers en érable massif incrusté de céramique, planchers en bois d'ingénierie dans les salles de conférence, chêne massif sur les murs et plafonds de plusieurs bulles et dans l'ascenseur, ainsi que terrasse extérieure en cèdre.

L'un des objectifs est de démontrer la polyvalence du bois comme force motrice du projet et d'en pousser les limites dans son utilisation structurale et architecturale par rapport aux constructions plus traditionnelles en acier ou en béton. Ce projet a donc été rendu possible grâce à des investissements dans des technologies de pointe comme les machines-outils à commandes numériques et les bancs ou presses à froid qui permettent de produire le bois lamellé-collé courbe.

Concept et fonctionnement novateurs

Là où l'immeuble de GSK présente un grand nombre d'innovations, c'est dans sa conception et son fonctionnement, qui minimisent la dépense énergétique tout en maximalisant le confort des occupants.

D'abord, l'orientation du bâtiment offre une protection naturelle à l'enveloppe : les façades étroites sont exposées aux vents dominants et à l'ensoleillement du matin et de la fin d'après-midi. Même pendant la construction, en plein hiver, il n'a pratiquement pas fallu chauffer le bâtiment.

Ensuite, la forme même de l'édifice permet une climatisation naturelle. Pendant que des fenêtres ouvrantes laissent entrer l'air frais dans le bas des murs, l'air chaud – plus léger – s'accumule dans la partie élevée, en haut de l'atrium, d'où il est évacué par l'ouverture

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Photo : FPInnovations

d'autres fenêtres, créant ainsi un effet de cheminée rafraîchissant. Toutes ces fenêtres, motorisées, s'ouvrent et se ferment automatiquement selon les besoins ; elles sont couplées à des senseurs eux-mêmes reliés à une station-météo à l'extérieur du bâtiment.

Le rideau de verre double peau contribue lui aussi de façon importante à l'économie d'énergie et au confort des occupants. Du côté intérieur, le rideau est formé d'une paroi de verre thermos double et, à l'extérieur, d'un verre simple qui fait office de barrière thermique et permet la formation d'une poche d'air entre les deux, distants de 1 m. Encore là, des volets motorisés dans la partie supérieure du mur s'ouvrent ou se ferment automatiquement en fonction de la température de consigne. Grâce à l'effet de serre créé par cette paroi double, aucun chauffage n'est requis dans la partie sud du bâtiment, le jour, en hiver. À l'intérieur de la double peau, des préposés à l'entretien peuvent circuler sur des passerelles métalliques grillagées qui servent en même temps de pare-soleil durant l'été.

Chauffage-refroidissement géothermique

L'une des particularités du bâtiment tient à son système de chauffage-climatisation entièrement géothermique, à planchers radiants et à poutrelles de refroidissement, sans air pulsé.

Situé du côté nord, derrière l'édifice, le champ géothermique se compose de 25 puits de 145 m de profondeur. La combinaison puits thermiques, planchers radiants et poutrelles de refroidissement s'avère idéale puisque c'est le même fluide (glycol) qui circule dans les trois composantes, sans conversion de chaleur du liquide à l'air. En plus de procurer un confort supérieur, ce système offre un gain énergétique de 53 % par rapport à un appareillage de ventilation mécanique, seule une pompe étant nécessaire pour assurer la circulation du liquide plutôt que des ventilateurs pour pousser l'air dans des conduits. L'absence d'encombrants conduits de ventilation présente également un avantage esthétique, d'autant plus important qu'on a voulu laisser apparents les platelages de bois des plafonds.

Les tuyaux de circulation du glycol dans les planchers sont incorporés dans un matelas de mousse isolante recouvert d'une mince chape de béton et d'une membrane acoustique absorbante.

Du côté sud et sur tout le pourtour des aires de travail, un revêtement de céramique couvre cette membrane, question d'esthétisme, mais aussi parce qu'il absorbe la chaleur du soleil en hiver. Dans les espaces de travail, les planchers sont plutôt recouverts de tuiles de tapis – à forte teneur en matériau recyclé postconsommation – qui minimisent le bruit ambiant. Des masqueurs sonores sont aussi installés çà et là aux plafonds pour absorber la réverbération du son.

Assez courante en Europe, l'utilisation de poutrelles de refroidissement pour la climatisation constitue vraisemblablement une première au Canada. Ces poutrelles suspendues, dans lesquelles circule le glycol, refroidissent l'air ambiant des espaces de travail de façon uniforme, tout en s'intégrant harmonieusement à l'architecture intérieure du bâtiment.

Enfin, tout ce système de chauffage-refroidissement est complété par un gros échangeur de chaleur à cassette, situé au sous-sol et permettant jusqu'à 95 % de récupération d'énergie. La salle informatique, également au sous-sol, est munie de son propre système de refroidissement pour éviter la surchauffe du serveur.

Synergie entre les systèmes

Comme le confort du personnel est garant d'une meilleure performance au travail, les concepteurs ont voulu innover dans ce domaine en adaptant au climat et au contexte socioéconomique du Québec les meilleures pratiques internationales.

En plus de recevoir un maximum de lumière naturelle, sans éblouissement et sans besoin de toiles solaires puisque les espaces de travail se trouvent dans la partie nord de l'immeuble, les employés bénéficient d'un système d'éclairage dégradable. Des détecteurs de luminosité ajustent automatiquement l'intensité des luminaires – à lumière indirecte – en fonction des besoins. S'il manque juste un peu d'intensité à l'éclairage naturel, les luminaires fourniront seulement cette quantité manquante, contribuant de la sorte à un confort visuel optimal, tout en évitant une consommation d'électricité inutile et une production de chaleur qu'il faudrait compenser par davantage de climatisation.


© Photo : Stéphane Groleau

En outre, des panneaux inclinés, en forme d'ailes d'oiseaux, ont été suspendus à intervalles réguliers aux plafonds. D'une part, ces « oiseaux » absorbent les réverbérations sonores et, d'autre part, ils réfléchissent la lumière, augmentant encore la qualité de l'éclairage. De plus, grâce à leur inclinaison, ils alimentent un mouvement de convection de l'air, sans ventilateur : les luminaires situés entre les oiseaux dégagent de la chaleur qui pousse l'air vers le haut, pendant que l'air froid produit par les poutrelles, installées entre les ailes des oiseaux, descend naturellement.

Autre avantage des oiseaux, ils camouflent les conduits d'alimentation en air frais et les conduits de retour en air vicié, au-dessus d'eux. Et comme ils sont ponctuels, le bois des plafonds demeure bien apparent. Ces panneaux inclinés constituent un bel exemple de la synergie entre les systèmes que recherchent les concepteurs d'architecture durable.

Résistance thermique et protection incendie

Hormis le fait de produire un effet de serre qui chauffe en partie le bâtiment, la double paroi de verre de la façade principale procure une résistance thermique de 3,84 à ce mur, alors que les autres murs ont des RSI de 3,19 (est et ouest) et 4,35 (mur nord, mieux protégé). Quant à la toiture du volume principal, munie d'une membrane blanche réfléchissante pour minimiser la surchauffe en été, elle offre une résistance thermique de 6,25. Le toit du volume nord, lui, est couvert d'une membrane Soprema et a un RSI de 6,78. Par-dessus le platelage de bois embouveté, les deux toitures se composent d'un panneau de gypse extérieur (demandé par l'assureur), de deux rangs d'isolant polyisocianurate, puis de deux panneaux de fibre de verre compressée DensDeck sous la membrane.


© Photo : Stéphane Groleau

Comme pour tout édifice commercial en matériaux combustibles, plusieurs mesures ont été prises afin de répondre aux exigences en matière de protection contre les incendies. En plus du panneau de gypse pour les toits, ces mesures comprennent un réseau de gicleurs dans toutes les parties du bâtiment, des portes coupe-feu et deux escaliers de secours aux extrémités. De plus, des assemblages métalliques cachés à l'intérieur des éléments de bois ou protégés par une peinture intumescente ont été utilisés pour relier les poutres et colonnes, et ce, dans le but de fournir à l'ensemble de la charpente le degré de résistance au feu requis de 45 minutes.

Aspects environnementaux

De tous les aspects environnementaux qui caractérisent l'immeuble, le plus important, hormis le chauffage-climatisation géothermique, est certainement le choix du matériau pour la charpente. La récolte et la transformation du bois est en effet beaucoup moins énergivore que la fabrication de l'acier et du béton qui auraient été utilisés pour une charpente classique en construction commerciale. Sans compter tout le CO_2 que capturent les arbres durant leur croissance et qui est séquestré par la suite dans le bois de l'édifice.

C'est d'ailleurs en bonne partie grâce à ce choix du bois que la réalisation du projet GSK présente un bilan de carbone presque neutre. Le bois a permis de séquestrer 460 tonnes de CO_2, alors que l'ensemble de la construction a généré des émissions de 545 tonnes. Le déficit de moins de 100 tonnes sera compensé par l'achat de crédits sur le marché international du carbone, ce qui fera donc un projet carboneutre de cette construction.

Par ailleurs, une fois complètement en service, l'édifice émettra 4,4 tonnes de CO_2 par an (moins que la consommation d'une voiture standard !) qui seront également compensées par l'achat de crédits. La dépense énergétique totale du bâtiment représentera un gain de l'ordre de 55 % par rapport au bâtiment de référence du *Code modèle national de l'énergie pour les bâtiments*.

Parmi les autres aspects environnementaux, il faut mentionner la membrane blanche de la toiture, l'utilisation d'un maximum de composantes recyclées ainsi que l'aménagement paysager. En plus de protéger l'immeuble avec des végétaux judicieusement placés, cet aménagement permettra l'infiltration de l'eau de pluie dans le sol par l'intermédiaire d'un petit marais, minimisant ainsi le ruissellement vers l'égout municipal.

De surcroît, l'eau de pluie drainée par le toit sera récupérée dans une citerne et utilisée pour les services sanitaires après un traitement grossier. Ajouté à des toilettes à double chasse, des robinets à faible débit et un système de refroidissement n'utilisant pas l'eau potable, cette récupération d'eau pluviale procurera une économie d'eau potable de 60 % par rapport à la référence LEED.

Un propriétaire satisfait

Pour un investissement de 11 millions de dollars, excluant les frais internes d'architecture et d'ingénierie, GaxoSmithKline s'est donné un bâtiment en bois innovant, qui présente un bel équilibre entre l'apparence, les performances écologiques et un environnement de travail optimal pour le personnel.

Le propriétaire s'est d'ailleurs montré entièrement satisfait du résultat. « Nous apprécions particulièrement l'atrium et l'impression d'espace qui s'en dégage, a dit le porte-parole. L'édifice est magnifique, au-delà de nos attentes, et sera un modèle pour la ville de Québec ».

Principaux aspects environnementaux

- Projet presque carboneutre
- Chauffage-climatisation géothermique
- Bois certifié FSC
- Maximum de composantes recyclées
- Gain énergétique de 55 % par rapport au bâtiment de référence du *Code modèle national de l'énergie pour les bâtiments*
- Réduction de la consommation d'eau potable de 60 % par rapport à la référence LEED
- Résistances thermiques des parois (RSI) de 3,84 (mur sud), 3,19 (est et ouest), 6,25 (toiture sud) et 6,78 (toiture nord)
- Membrane réfléchissante blanche (toit sud)
- Maximalisation de l'éclairage naturel
- Éclairage dégradable selon l'intensité de la lumière naturelle
- Stationnement de vélos et douches

Le bâtiment

- Classe du bâtiment : D
- Aire du bâtiment : 2 700 mù hors sol
- Nombre d'étages hors sol : 2, sur 3 niveaux
- Principaux produits de lamellé-collé utilisés

– éléments rectangulaires : poutres principales, plancher de l'étage : section composée de 2-184 x 546 mm ; poutres principales au toit : section de 184 x 502 mm ; poutres courbes au toit : section de 137 x 457 mm

– éléments ronds : colonnes en façade : diam. 215 mm aux extrémités et 350 mm au centre (6 types de pièces différentes, longueurs entre 9,3 m et 11 m) ; colonnes dans l'atrium : diam. 315 mm aux extrémités et 450 mm au centre (8 types de pièces, longueurs 11,2 m à 14,3 m)

– sections rondes qui composent la ferme tridimensionnelle : diam. 225 mm (14 types de pièces, longueurs 1,5 m à 5,6 m)

– platelages de 64, 89 et 137 mm d'épaisseur

- Coût de la construction excluant les frais internes d'architecture et d'ingénierie : 11 000 000 $ dont 10 % pour la structure en bois
- Ce projet a reçu l'appui financier de Ressources naturelles Canada dans le cadre de son programme de soutien des projets de démonstration du bois à grande échelle.

Équipe de réalisation

Architecture : Coarchitecture (Normand Hudon, César Herrera, Mathieu Castonguay, François Cantin, Marie-Ève Morin)
Génie structural : SDK (Steve Parent, Stephan Blais, Daniel Mongeau)
Entrepreneur : Verreault Construction (Simon Corriveau)
Structure en bois lamellé-collé et assemblages : Nordic Structures Bois
Aménagement paysager : François Courville

Client

GlaxoSmithKline (André-Pierre Ghys).

Cecobois remercie Ressources naturelles Canada et le ministère des Ressources naturelles et de la Faune du Québec pour leur contribution financière à la réalisation de cette étude de cas.

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Mars 2012

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CONSTRUIRE EN BOIS
Le journal de la construction commerciale en bois
cecobois
Centre d'expertise sur la construction commerciale en bois
Volume 4, numéro 2, été 2012
PUBLICATION GRATUITE

Aréna Pierre-Lavoie de l'UQAC

Architecte : Lemay associés Photo : © Stéphane Groleau

SOMMAIRE

Une structure hybride dans le vent !

Construit à l'été 2009, l'aréna Pierre-Lavoie de l'Université du Québec à Chicoutimi (UQAC) est résolument un bâtiment moderne. Mais pas uniquement au niveau de son design architectural ! Le choix d'une structure hybride qui inclut du bois lamellé-collé a permis de diminuer considérablement l'empreinte environnementale du bâtiment au cours de sa construction et continuera de le faire tout au long de sa durée de vie.

En effet, selon une étude réalisée par la Chaire en éco-conseil de l'UQAC et commandée par cecobois, la structure hybride en acier et bois totalisant 111 m³ de bois lamellé-collé aurait contribué à émettre dans l'atmosphère 138 tonnes de CO_2 équivalent. C'est 104 tonnes de CO_2 de moins que si elle avait été entièrement en acier. Rappelons que l'énergie requise pour la fabrication des matériaux est la principale coupable des émissions de gaz à effet de serre.

Le bois lamellé-collé utilisé dans la construction de l'aréna Pierre-Lavoie supporte la toiture au-dessus de la glace, ce qui, en plus de son impact environnemental plus faible que d'autres matériaux, en fait également une composante structurale d'apparence.

Photos : © Stéphane Groleau

Le Regroupement des ingénieurs en structures de bois n'attend que vous !

Vous êtes ingénieur, chercheur ou professeur dans le domaine de la construction commerciale en bois ? Connaissez-vous RISBois ? Ce regroupement, lancé l'an dernier en partenariat avec cecobois, invite présentement les ingénieurs œuvrant dans le domaine de la spécification et du calcul de structures en bois, tels que les ingénieurs-conseils, les ingénieurs de fabricants de composants structuraux en bois, les chercheurs et les professeurs à joindre ses rangs… Avis aux intéressés !

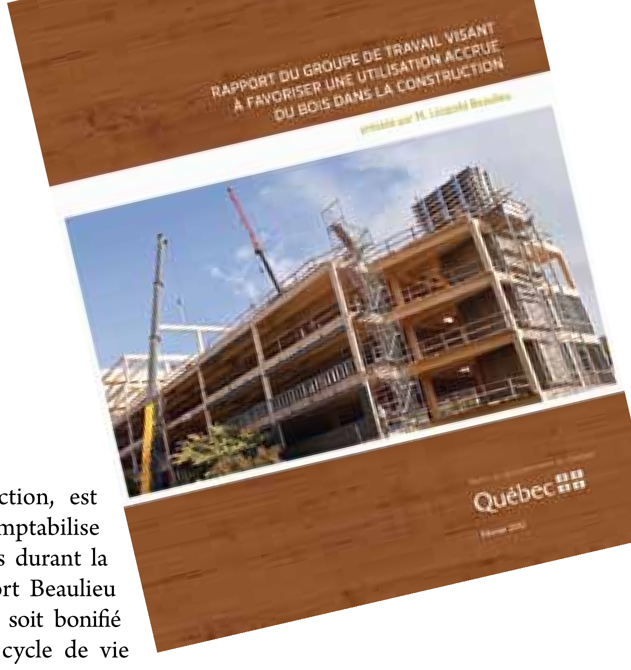
RISBois se veut une réponse à une demande croissante du secteur de la construction non résidentielle. En effet, vu l'utilisation grandissante du matériau bois dans les constructions commerciales, industrielles et institutionnelles, les ingénieurs sont davantage sollicités à cet égard. D'où l'importance du regroupement RISBois qui sert de lieu d'échanges sur la conception des structures en bois dans le but d'accroître le savoir-faire des professionnels dans ce domaine au Québec.

En plus de son tout nouveau site Internet favorisant le partage d'informations, le Regroupement organise des ateliers à l'intention de ses membres, leur permettant de rester à l'affût des avancées technologiques en construction bois ou du cadre réglementaire et normatif relié au calcul des charpentes en bois. Une première rencontre officielle est d'ailleurs prévue au cours de l'automne.

Vous n'êtes pas inscrit à RISBois et désirez devenir membre ? Remplissez le formulaire d'inscription disponible en ligne au www.risbois.com !

Regroupement des ingénieurs en structures de bois RISBois

Environnement



RAPPORT BEAULIEU

Construire en bois, un pas vers le développement durable

Le bois est l'un des matériaux de construction les plus écologiques qui soit. C'est une des conclusions du Rapport Beaulieu, présenté au ministre des Ressources naturelles et de la Faune du Québec, M. Clément Gignac, et rendu public ce printemps.

Créé en mars 2011 dans la foulée du discours sur le budget du ministre des Finances, M. Raymond Bachand, le groupe de travail présidé par M. Léopold Beaulieu, président de Fondaction, avait pour mandat de trouver des pistes de solutions pour favoriser une utilisation accrue du bois dans la construction. Les membres du groupe de travail, dont le président de l'Ordre des architectes du Québec, M. André Bourassa, la présidente de l'Ordre des ingénieurs du Québec, Mme Maud Cohen, le président-directeur général de la Régie du bâtiment du Québec, M. Michel Beaudoin, le président et chef de la direction de la Société immobilière du Québec, M. Richard Verreault, et des ingénieurs de l'Université Laval, de FPInnovations, de cecobois ainsi que des firmes de consultants ayant participé à la conception du bâtiment de six étages de Fondaction à Québec, ont entre autres analysé les bienfaits de la construction en bois en ce qui concerne le développement durable et le bilan carbone.

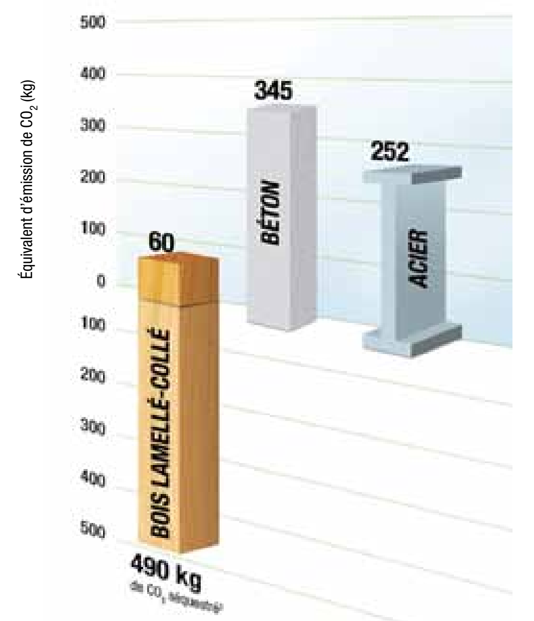
Un allié dans la lutte aux changements climatiques

À la suite de ses analyses et études, le groupe de travail a conclu que le bois s'inscrivait dans la logique de la démarche de développement durable du gouvernement du Québec, notamment en matière de ses bénéfices carbone et de ses attributs environnementaux. D'une part, il est l'un des rares matériaux qui soit à la fois renouvelable, produit localement et recyclable. Le bois s'avère également un bon substitut à d'autres matériaux, permettant ainsi de réduire les émissions de gaz à effets de serre (GES) qui sont à l'origine des changements climatiques.

Le bois contribue également à améliorer le bilan énergétique, autant du point de vue de l'énergie intrinsèque (celle nécessaire à sa fabrication) que de celle requise pour le chauffage du bâtiment tout au long de sa vie utile. Le Rapport Beaulieu recommande d'ailleurs que la règlementation actuelle évolue pour tenir compte de l'énergie intrinsèque et non seulement l'énergie d'utilisation des bâtiments.

Une méta-analyse réalisée en 2010 rend désormais possible la quantification des réductions de gaz à effet de serre découlant de l'utilisation du bois en construction comme substitut à d'autres matériaux plus énergivores à fabriquer. Considérant les résultats de plus de 20 études scientifiques utilisant l'analyse de cycle de vie, cette analyse permet de dire qu'en moyenne, pour chaque mètre cube de bois utilisé en construction, l'émission d'une tonne équivalente de CO_2 est évitée[1]. Ce calcul, utilisé notamment en Grande-Bretagne pour mesurer le bénéfice résultant de l'utilisation du bois en construction, est toutefois réducteur, puisqu'il ne comptabilise pas le carbone séquestré dans le bois durant la durée de vie du bâtiment. Le Rapport Beaulieu recommande que cet indice de calcul soit bonifié par un nombre accru d'analyses de cycle de vie adaptées au contexte québécois et que le Québec continue d'investir dans le développement de bases de données sur les matériaux à cet effet.

Comparaison des émissions de GES dues à la fabrication d'une poutre[1] de 7,3 m supportant une charge de 14,4 kN/m



1. Émissions de GES, calculées lors d'une analyse du cycle de vie à l'aide du logiciel ATHENA ™ 4.1.11
2. Estimé en fonction de la composition du bois pour une masse volumique de 500 kg/m³

« L'utilisation du bois dans les constructions publiques doit être considérée non pas comme une nouvelle contrainte, mais comme un moyen supplémentaire pour atteindre les objectifs de réduction d'émissions de gaz à effet de serre », stipule le rapport Beaulieu. Il recommande d'ailleurs d'inclure dans le Plan d'action 2013-2020 contre les changements climatiques des mesures destinées à reconnaître formellement les bénéfices écologiques du bois dans la construction. « L'utilisation des produits du bois à leur plein potentiel dans ce segment de marché permettrait de contribuer à la lutte contre les changements climatiques, tout en favorisant un climat propice à l'innovation et à l'acquisition d'un savoir-faire éventuellement exportable. Des retombées économiques directes seraient inévitablement générées dans l'industrie des produits du bois présente dans plusieurs régions du Québec. Dans ce contexte, le bois répond aux critères d'un développement durable et son utilisation devrait être accélérée », conclut le Rapport Beaulieu.

Le rapport peut être téléchargé à l'adresse suivante :
www.mrn.gouv.qc.ca/publications/forets/entreprises/rapport-beaulieu.pdf

[1] R. Sathre et J. O'Connor (avril 2010). « Meta-analysis of greenhouse gas displacement factors of wood product substitution », *Environmental Science & Policy*, vol. 13 (2), p. 104-114. R. Sathre et J. O'Connor (octobre 2010). *A Synthesis on Research on Wood Products & Green House Gas Impacts*, 2e edition, Vancouver (C.-B.), FPInnovations, 117 p. (rapport technique TR-19R).

L'utilisation du bois valorisé dans le Plan d'action 2013-2020 du gouvernement québécois contre les changements climatiques

Comme l'environnement bâti joue un rôle prépondérant dans l'économie et dans la vie collective des Québécois, ses infrastructures (institutionnelles, commerciales et industrielles) doivent elles-mêmes aller de l'avant en matière de politique verte. C'est pourquoi le Plan d'action 2013-2020 contre les changements climatiques (PACC 2020) vise entre autres l'adaptation aux changements climatiques en renforçant la résilience des bâtiments et des infrastructures dès l'étape de la conception des nouveaux bâtiments. Plus particulièrement, il s'appuie sur des priorités d'action touchant le matériau bois :

- Priorité 2 : Soutenir les municipalités et les collectivités dans leurs initiatives de réduction des GES, d'adaptation aux changements climatiques et d'aménagement durable du territoire ;
- Priorité 19 : Verdir les normes relatives aux bâtiments ;
- Priorité 28 : Réviser les critères de conception et les modes de gestion et d'entretien des bâtiments et des infrastructures.

« En ce qui concerne les bâtiments, le PACC 2020 sur les changements climatiques contribuera activement à l'émergence de bâtiments écoénergétiques, notamment en favorisant l'efficacité énergétique, les énergies renouvelables et l'utilisation de matériaux à faible empreinte carbone tels que le bois, et ce, dans une perspective de transformation des pratiques et des comportements dans le secteur de la construction. » Déjà, plusieurs initiatives précisent cette volonté :

- **Projet de règlement modifiant le Code de construction pour favoriser l'efficacité énergétique ;**
- **Examen public des modifications proposées au Règlement modifiant le Code de construction pour favoriser l'efficacité énergétique ;**
- **Stratégie d'utilisation du bois dans la construction.**

[1] MDDEP, Plan d'action 2013-2020 sur les changements climatiques, *Le Québec en action vert 2020*, Juin 2012

Photo : © Stéphane Groleau

Photo : © Stéphane Groleau

Réalisations

BMR renoue avec ses racines et choisit le bois

« Nous, on est des gars de bois ! » C'est sur cette phrase lancée en l'air au sein du comité chargé de repenser l'image des magasins BMR que l'idée d'une structure en bois a germé. Après mûre réflexion et consultation auprès de Nordic Structures Bois, le nouveau concept des magasins BMR était né. Comme un retour aux sources, la structure sera en bois. Une première au Québec pour des magasins grande surface.

Une structure simple pour rester compétitif

Les trois premiers magasins BMR en bois ont vu le jour ce printemps, à Saint-André-Avelin, Sainte-Agathe et Saint-Jean-sur-Richelieu. D'une surface allant de 20 000 à 55 000 pi^2, le bâtiment est d'un seul étage avec une mezzanine. La structure se compose de poutres et de colonnes en lamellé-collé et d'un platelage au toit. Au total, de 240 à 560 m^3 de lamellé-collé ont été utilisés selon la taille du magasin. À Sainte-Agathe, les murs sont en ossature légère en bois tandis qu'ils sont en panneaux de béton préfabriqués dans les deux autres magasins. « C'est une trame relativement simple, commente David Croteau, ingénieur chez Nordic. C'est ce qui nous permet de sortir des bâtiments grande surface compétitifs avec l'acier ». Seule petite fantaisie dans la structure, des lanterneaux au plafond laissent entrer la lumière naturelle.

Concernant la protection contre les incendies, l'utilisation de gros bois d'œuvre s'est révélée avantageuse. Dans certaines municipalités, la pression dans les aqueducs n'est pas assez forte pour alimenter des gicleurs. Or, si la pose de gicleurs est obligatoire dans une structure en acier quelle que soit la surface du bâtiment, elle n'est pas exigée pour une structure en gros bois d'œuvre en deçà d'une certaine surface de bâtiment, surface variable selon les municipalités. Ainsi, à Saint-André-Avelin, la surface du magasin n'exigeait pas la pose de gicleurs. À Sainte-Agathe, un mur coupe-feu sépare le bâtiment en deux sections d'une surface inférieure à celle exigeant la pose de gicleurs. Par contre, les gicleurs n'ont pu être évités pour le plus grand des trois magasins, celui de Saint-Jean-sur-Richelieu.

Quant au coût, Geneviève Gagnon, directrice générale des magasins de Saint-André-Avelin et de Saint-Jean-sur-Richelieu, reconnaît que la structure en bois peut présenter un coût supplémentaire par rapport à d'autres matériaux mais que l'impact est minime quand on considère le coût total du bâtiment. « Il faut toujours regarder le projet dans son ensemble », appuie-t-elle. David Croteau exhorte aussi à considérer la valeur ajoutée du bois qui projette l'image d'un matériau vert et rend le magasin plus attrayant.

La valeur ajoutée du bois

Du côté environnemental, les m^3 de bois utilisés ont évité le rejet d'autant de tonnes de CO_2 dans l'atmosphère. Le platelage de bois, en raison des propriétés isolantes du bois, améliore aussi l'efficacité énergétique du bâtiment. Côté magasinage, nul doute que la lumière naturelle éclairant les poutres et colonnes en bois efface l'aspect entrepôt du magasin et le rende plus convivial. Geneviève Gagnon ne le cache pas. « L'expérience du client, c'est très important, avoue-t-elle. Des études en Europe le démontrent. Il y a un impact sur la fréquence des visites et sur la durée de chaque visite. » Et selon elle, la réaction des clients du magasin de Saint-André-Avelin, ouvert depuis le 6 avril, est très positive.

Le concept BMR dans son ensemble

Le concept élaboré par BMR va bien au-delà du bois et du marketing. Si les lanterneaux laissent entrer la lumière naturelle, combinés à des détecteurs de luminosité, ils permettent aussi de restreindre l'éclairage électrique, ce qui améliore encore l'efficacité énergétique du bâtiment. Dans un coin du magasin, un mur végétal assainit l'air. « C'est le poumon du magasin », commente Geneviève Gagnon. En plus d'embellir le magasin, il contribue au confort des employés. De même, la géothermie et le plancher radian procurent une température plus stable et un air moins sec que le chauffage électrique. BMR a aussi opté pour un étiquetage électronique qui évite la consommation de 54 000 étiquettes par année et l'encre correspondante.

« BMR est assez innovateur, reconnaît David Croteau, être vert, ce n'est pas juste un slogan, c'est aussi agir et chez BMR, les bottines ont suivi les babines. »

Photo : Asahi photos

Photo : cecobois

Bientôt d'autres magasins en bois ?

« Ça va s'étendre à d'autres magasins BMR », assure Geneviève Gagnon. Elle sait aussi que BMR ne conservera pas longtemps l'apanage et l'avantage d'une meilleure expérience de magasinage et que les bannières concurrentes de la rénovation adopteront aussi l'ossature en bois. Mais pour la directrice, quand les bonnes idées sont copiées, ce n'est pas vraiment de la concurrence, c'est plutôt de démontrer une position de leader. Le bois pourrait encore s'étendre à d'autres types de commerces. « BMR, c'est un concept standard qui peut être appliqué à beaucoup de bâtiments, observe David Croteau. Tout le monde va chez BMR, ça peut donner des idées aux marchés d'alimentation, aux concessionnaires… »

PROJET EN BREF

Type de bâtiment : Magasin grande surface
Superficie : 1 860 à 5 110 m^2
Nombre d'étages : 1 + mezzanine
Propriétaires : Groupe Yves Gagnon | BMR Saint-André-Avelin et Saint-Jean-sur-Richelieu
Photographies : Stéphane Groleau, Asahi photos, cecobois

Photos : cecobois

Réalisations

Le bois, un choix naturel pour la station Shell de Saint-Jean-Chrysostome

Les résidents de Saint-Jean-Chrysostome, dans la ville de Lévis, pourront bientôt faire leur plein d'essence à la nouvelle station-service Shell, toute de bois construite. Dans la foulée des stations Ultramar récemment construites en bois, cette réalisation vient confirmer l'idée que l'utilisation du matériau bois pour ce type de bâtiments commerciaux est une option à considérer et présentant de nombreux avantages. En fait, de l'avis du propriétaire du bâtiment, de l'architecte, de l'ingénieur et du fournisseur de structures, c'est un choix logique alliant économie, esthétisme, facilité et rapidité.

Justin Quirion, le propriétaire de la station, voulait éviter la forme cubique qui vient trop souvent avec les structures en acier. Le bois s'avérait donc un choix judicieux, puisqu'il se prête aisément à une grande variété de formes. De plus, l'utilisation de ce matériau permettait de réaliser des économies tant au niveau du temps, de l'argent que de l'efficacité énergétique. M. Quirion a tenu à souligner l'avantage de pouvoir modifier le bâtiment facilement en cas de réorganisation ou d'agrandissement du commerce.

Construire la station en bois fut également une recommandation de l'architecte Sylvain Larouche, de la firme Robitaille, Larouche, Dery architectes, qui a participé au projet. Il est d'ailleurs l'homme derrière les stations-services Ultramar en bois. Selon lui, pour des raisons de coûts et de rapidité, l'ossature légère en bois est la meilleure option pour ces petits espaces commerciaux. « Après approbation des données d'atelier, il faut quatre à six semaines pour fabriquer les structures en acier et seulement deux semaines maximum pour les structures en bois. Le travail est aussi plus flexible et plus rapide sur le chantier », estime M. Larouche. Au total, entre la fabrication des structures et l'érection du bâtiment, il estime le gain de temps à quatre semaines.

Aux dires de l'ingénieur, Christian Laroche, de la firme d'ingénierie Axys, l'utilisation du matériau bois pour ce projet était donc toute indiquée et pour Clyvanor, qui a fourni toutes les structures en bois dont les fermes de toit et les murs en panneaux préfabriqués, beaucoup de bâtiments de cette taille optent dorénavant pour une structure en bois. Quant à la prévention des incendies, la seule exigence particulière a été d'augmenter la distance entre les réservoirs d'essence et le bâtiment.

Le bâtiment de 315 m^2 ne comprend qu'un seul étage, en plus du sous-sol. Le plancher est composé de poutrelles de 4,27 m de long sur 381 mm de haut (20' x 15'') et de panneaux de contreplaqués de 16 mm d'épaisseur. Les murs à colombages sont en bois de construction de 2 x 6 munis de panneaux de contreplaqués de 12,5 mm d'épaisseur et isolés avec de la laine minérale. Sur les murs porteurs reposent les fermes de toits de 13,8 m de long sur 3,6 m de haut. Ils sont aussi couverts de panneaux de contreplaqués de 16 mm d'épaisseur.

Ce projet s'inscrit donc dans la lignée des chaînes de commerces tels Ultramar et Tim Horton déjà construites en bois, et démontre une volonté de continuer à considérer l'utilisation du bois dans la construction de commerces de superficie semblable.

PROJET EN BREF

Type de bâtiment : Station-service
Superficie : 315 m^2
Nombre d'étages : 1
Propriétaires : Justin Quirion, Martin Gilbert | Shell
Architecte : Sylvain Larouche | Robitaille Larouche et Déry, architectes
Ingénieur : Christian Laroche | Axys consultants inc.
Chargé de projet : Louis Parent | Entrepreneur M. Grégor
Photographies : cecobois

Agrémentez votre heure de lunch : offrez-vous les midi-conférences cecobois !

Connaissez-vous les midi-conférences offertes par cecobois ? Lors de cette activité offerte gratuitement aux architectes et aux ingénieurs, un conseiller technique de cecobois se rend directement à votre lieu de travail et fait une présentation sur différents sujets touchant l'utilisation du bois en construction : *les possibilités d'utilisation du bois en construction non résidentielle*, *les avantages environnementaux de la construction en bois*, *les produits structuraux et d'apparence disponibles*, *le Code du bâtiment*, ou, encore, *des exemples de projets québécois et internationaux réalisés en bois*. Une présentation a d'ailleurs été préparée spécifiquement pour les architectes afin de leur présenter les outils de calcul de cecobois ; une autre, s'adressant plus spécifiquement aux ingénieurs, traite de la résistance au feu des structures en bois. Une présentation sur les bonnes pratiques pour la construction à poutres et poteaux en gros bois est également disponible.

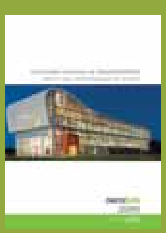
Pour acheminer vos suggestions de thématiques ou pour toute information supplémentaire, veuillez communiquer avec madame Christine Giguère, responsable de l'organisation des midi-conférences de cecobois : cgiguere@cecobois.com

Profitez-en, l'activité est gratuite et le lunch est offert par cecobois !

PROCUREZ-VOUS NOS DEUX NOUVELLES ÉTUDES DE CAS !

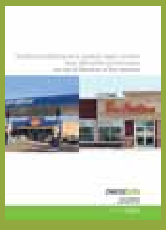
Cecobois vient de publier deux nouvelles études de cas qui vous feront, une fois de plus, découvrir comment le matériau bois peut être utilisé de manière novatrice dans la construction de bâtiments commerciaux.

L'immeuble à bureaux de GlaxoSmithKline



Un exemple de bâtiment novateur qui illustre bien le potentiel d'utilisation du bois dans les bâtiments non résidentiels, en particulier la possibilité d'avoir recours à des concepts qui proposent des géométries complexes et impressionnantes. Ce projet est une démonstration concrète que le matériau bois peut faire partie intégrante des concepts les plus innovateurs et avant-gardistes pour des bâtiments à usage non résidentiel.

Les cas d'Ultramar et de Tim Hortons



Découvrez les raisons qui ont poussé ces deux chaînes de commerces à effectuer un virage complet vers les systèmes structuraux préfabriqués à ossature légère en bois pour la construction de leurs nouveaux bâtiments au Québec.

Bonne lecture !

Bernard Riedl
professeur au département des sciences du bois et de la forêt
Chimie du bois et des adhésifs
Université Laval

Emmanuel Lépine
candidat au Ph. D SBO
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ADHÉSIFS STRUCTURAUX

Les adhésifs : y adhérer, ou pas ?

Les adhésifs, aussi appelés « colles » ou « résines », sont utilisés depuis des millénaires pour assembler des objets ou structures divers en bois. Mais qu'en est-il de leur impact environnemental, de leur résistance au feu et à l'eau ? Quels sont les types d'adhésifs que l'on retrouve aujourd'hui dans les produits de bois structuraux ? Voilà enfin l'occasion d'avoir l'heure juste !

Au temps des pharaons égyptiens et des empereurs chinois, les produits du bois, surtout des placages et des contreplaqués, étaient assemblés à l'aide de colles d'origine naturelle, soit des résidus d'origine animale ou végétale. Il a fallu l'arrivée de la Première Guerre mondiale pour voir l'apparition de colles à base de produits de synthèse, utilisées entre autres dans la fabrication des avions biplans de cette époque qui étaient faits de contreplaqués et devaient être bien plus résistants aux pressions de l'air et à l'humidité. C'est le cas des adhésifs phénol-formaldéhyde (PF), urée-formaldéhyde (UF), résorcine-formaldéhyde (RF), phénol-résorcine-formaldéhyde (PRF) et mélamine-formaldéhyde (MF). Depuis lors, d'autres adhésifs sont également apparus sur le marché dont les isocyanates, les polyuréthanes et les acétates de polyvinyle (PVA).

L'industrie des produits du bois a profité grandement de l'utilisation grandissante de ces nouveaux adhésifs, offrant de nouvelles applications à certaines essences de bois très communes et jadis sous- utilisées. Un bon exemple est le peuplier faux-tremble, une essence qui auparavant se prêtait peu à des applications commerciales. De nos jours, on l'utilise pour faire du bois de placages stratifiés (LVL) ainsi que des panneaux de lamelles orientées (OSB), lesquels sont très utiles dans la construction à ossature de bois et dont les propriétés mécaniques sont équivalentes à celles du contreplaqué. Le cas des panneaux de fibres ou de particules est un autre bon exemple de revalorisation des résidus de bois. Ces panneaux sont faits de fibres récupérées auprès des scieurs et qui, autrement, iraient à l'incinérateur ou à l'enfouissement. Enfin, les bois d'ingénierie, en raison de leur mode de fabrication, maximisent aussi la valeur de la ressource première pour le fabricant. C'est le cas pour les poutrelles, les bois de charpente composites, le bois lamellé-collé et bien d'autres.

La performance des adhésifs sous la loupe

Tout d'abord, il existe deux catégories d'adhésifs utilisés dans la fabrication des bois d'ingénierie : les adhésifs à base de résines phénoliques, généralement de couleur brune, et les autres adhésifs, tels que ceux à base d'isocyanate ou à base de polyuréthane, lesquels sont plutôt de couleur claire. Pour être considéré comme structural, un adhésif doit résister à l'eau et à la chaleur, en plus d'engendrer un taux moyen de 80 % de bris dans le bois plutôt que dans le joint de colle lors des essais de résistance. Ils doivent répondre à des exigences précises de résistance mécanique, de durabilité et de déformation. Ainsi, les adhésifs phénoliques sont régis par les normes CSA O112.6 et O112.7, tandis que les autres colles sont évaluées selon les normes CSA O112.9 ou O112.10, tout dépendamment si les produits pour lesquels elles sont utilisées sont destinés à un usage extérieur ou intérieur. Par ailleurs, les normes CSA O112.9 et O112.10 exigent un essai de résistance aux températures élevées afin de démontrer que les degrés de résistance au feu des assemblages réalisés à partir de bois de sciage traditionnels peuvent être maintenus lorsque ces mêmes assemblages sont réalisés à partir de produits du bois collés.

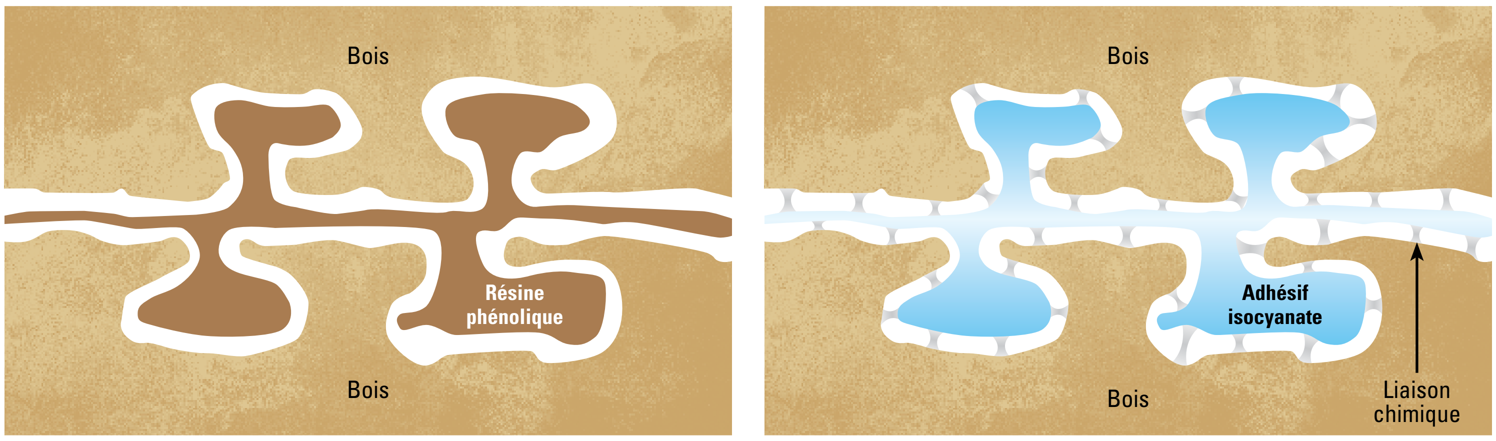
Règle générale, la majorité des adhésifs utilisés dans la construction sont de type thermodurcissable, c'est-à-dire qu'ils durcissent en présence de chaleur, contrairement aux adhésifs de type thermofusible (ou thermoplastique) qui ramollissent lorsqu'ils sont chauffés. Certains additifs peuvent également être ajoutés dans l'adhésif, ce qui permet alors de ralentir la propagation de la flamme lors de la combustion. Les normes canadiennes CSA O112.9, O112.10 et O177 décrivent les procédures permettant de tester mécaniquement un produit en bois encollé en présence de flammes.

Mise au point sur les émissions de formaldéhyde

En raison de la sensibilisation accrue du public face à la qualité de l'air ambiant et aux émissions de formaldéhyde, des inquiétudes ont été soulevées relativement aux adhésifs utilisés dans la fabrication de produits du bois. Il est primordial de préciser qu'heureusement, les panneaux structuraux (contreplaqués et OSB) et autres éléments de bois structuraux (bois lamellé-collé, bois de charpente composite, poutrelles, etc.) n'émettent que des quantités négligeables de formaldéhyde dans l'air ambiant, habituellement moins de 0,1 ppm (parties par million). Ceci s'explique par le fait que l'urée-formaldéhyde (UF), une colle qui libère plus facilement cette substance car elle n'a aucune résistance à l'eau (incluant l'eau contenue dans l'air), n'est pas utilisée dans la fabrication des bois d'ingénierie structuraux. Ceux-ci sont plutôt faits à partir d'adhésifs hydrofuges de type phénolique ou de colles à base d'isocyanate ou de polyuréthane. D'ailleurs, depuis quelques années, des manufacturiers offrent des panneaux de fibres de moyenne densité (MDF) liées par une résine d'isocyanate sans formaldéhyde. Seul le formaldéhyde à l'état naturel contenu dans le bois est alors émis par ces panneaux, à un taux d'environ 0,04 ppm.

Rappelons que le formaldéhyde, un gaz incolore et à forte odeur, se retrouve également en quantité négligeable dans certains produits ménagers, en plus d'être issu du processus de combustion. D'ailleurs, sa concentration dans l'air au-dessus de l'océan est évaluée à environ 0,0001 ppm, et l'air de la plupart des maisons canadiennes contient en moyenne entre 0,02 et 0,03 ppm de formaldéhyde. Selon la sensibilité variable dépendamment des individus, on peut commencer à être incommodé à partir de 1 ppm (toux, yeux rouges, picotements, etc.).

Concernant la réglementation limitant la concentration en composés organiques volatiles (COV), dont le formaldéhyde, seuls les peintures, les teintures, les vernis et les vernis laques sont actuellement réglementés au Canada (www.ec.gc.ca/cov-doc). Quant à la quantité permise de formaldéhyde que les produits composites dérivés du bois peuvent émettre, la norme californienne CARB (California Air Resources Board) spécifie une quantité allant de 0,05 à 0,13 ppm. Ces mesures d'émanation sont faites selon le test de la grande chambre (ASTM E1333). En Europe, la norme E1 exige des émissions inférieures à 0,1 ppm. Cela signifie qu'avec un renouvellement d'air à un taux raisonnable et une certaine quantité de ce type de panneau, l'air ne contiendra pas plus de 1 milligramme de formaldéhyde dilué dans 10 kg d'air (un volume de 8 150 litres) à 21 °C. C'est beaucoup moins que dans l'haleine d'un fumeur !



Presque tous les adhésifs pour le bois y adhèrent de façon mécanique (partie gauche de la figure) en pénétrant d'abord dans les pores du bois et en s'y solidifiant sous l'effet de la chaleur ; toute contrainte importante par la suite entraîne une rupture du bois, non pas du joint de colle. Il est possible que les adhésifs de type isocyanate forment, de plus, des liens chimiques avec le bois (partie droite de la figure).

François Chaurette, ing.
Conseiller technique
cecobois

OUTILS DE CALCUL

Logiciels pour la conception des structures en bois,

des outils indispensables au travail de l'ingénieur

Les logiciels de calcul des structures en bois sont des outils indispensables pour l'ingénieur. Non seulement les codes du bâtiment et les normes de calcul sont de plus en plus complexes, mais les structures doivent être conçues pour résister à de nombreuses conditions telles que les charges de neige, d'occupation, de vent et de séisme. De plus, le bois est un matériau anisotrope, c'est-à-dire qu'il a des propriétés différentes selon la direction du fil du bois. À cet effet, le nombre de logiciels et de calculatrices s'est accru de façon appréciable au cours des dernières années, permettant de faciliter le travail de l'ingénieur. Ce dernier dispose maintenant de plusieurs outils de conception efficaces et adaptés, que ce soit pour dimensionner une simple poutre ou colonne, ou encore, pour concevoir des projets complexes et de grande envergure. Survolons les principaux logiciels disponibles au Québec.

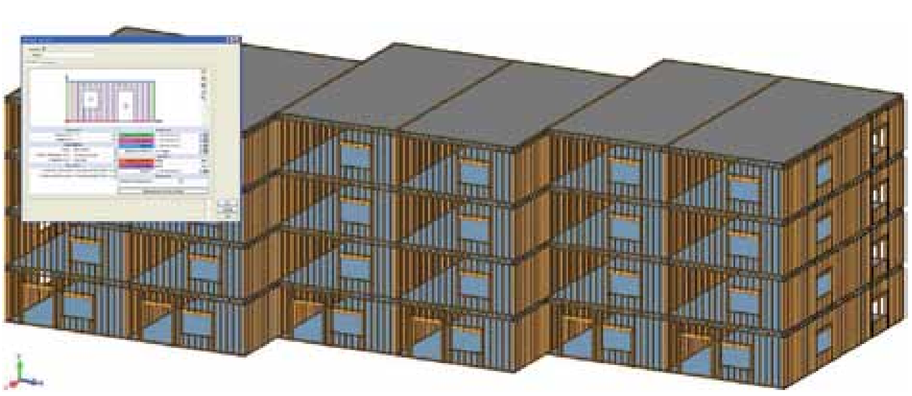
Logiciels de conception de bâtiments

Il existe au Québec deux logiciels de conception de structures de bâtiments ou d'autres structures telles que des ponts et des tours, offrant des modules de calcul pour des charpentes en bois. Il s'agit de ceux de la société informatique SAFI Inc. et de la compagnie Graitec.

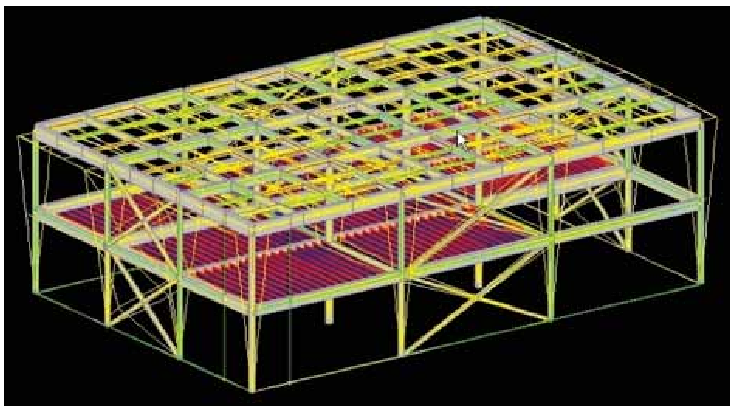
Ces deux logiciels sont très utilisés dans les bureaux d'ingénieurs-conseils. Ce sont des logiciels très puissants qui permettent de combiner différents matériaux (bois, acier et béton) et d'effectuer des analyses complexes de l'ensemble de la structure : analyse des charges gravitaires et latérales simultanément, cas de chargements multiples ou analyse sismique selon les exigences du Code national du bâtiment.

Ces deux logiciels permettent de concevoir aussi bien des structures complètes de bâtiments que des structures plus simples telles que des poutres et des colonnes, ainsi que des fermes, des arcs, des murs de refend et des diaphragmes.

Leur module contient une vaste base de données des matériaux en bois de sciage et en bois lamellé-collé, ainsi que des éléments en bois de charpente composite génériques et propriétaires, et des poutrelles de plancher. Grâce à eux, il est possible de concevoir des structures complexes à poutres et poteaux ainsi que des structures à ossature légère.



Extrait du logiciel SAFI Bois de SAFI Informatique Inc.



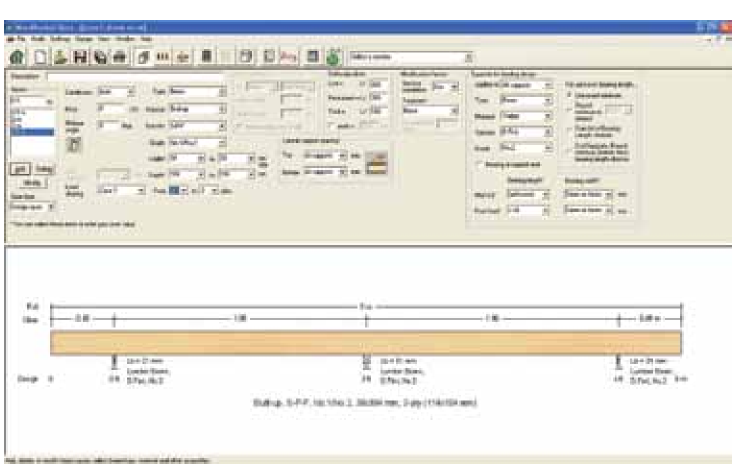
Extrait du logiciel ADA de Graitec

Logiciel de conception d'éléments structuraux

Le logiciel le plus répandu dans ce domaine est le logiciel WoodWorks du Conseil canadien du bois. Il est composé de 3 modules : Sizer, Shearwalls et Connections.

1 Module Sizer

Ce module est le plus populaire de tous. Il permet de calculer rapidement des éléments structuraux de façon individuelle tels que des poutres, des solives ainsi que des poteaux et des colombages de murs. Pour les poutres et solives, il permet de calculer des portées multiples et des porte-à-faux, et ce, pour différents types de charges (uniformes, concentrées ou trapézoïdales). On peut y calculer des éléments simples ou composés (3 – 2x10, par exemple) pour les poutres ou les colonnes. On peut également calculer des éléments en bois de sciage, en bois lamellé-collé ou en bois de charpente composite (par exemple, du LVL). En mode concept, il est possible de dessiner la structure d'un bâtiment de plusieurs étages et le transfert des charges gravitaires se fait automatiquement sur chacun des éléments de la structure.

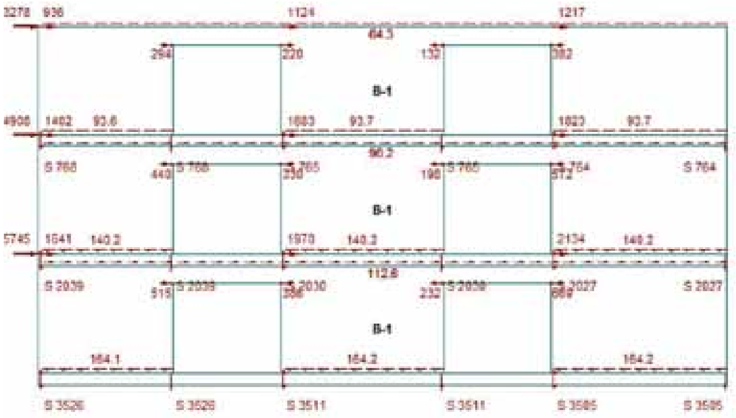


Extrait du module Sizer

2 Module Shearwalls

Ce module permet la vérification des murs de refend cloués pour des bâtiments à ossature légère multi-étagés. Les charges sismiques et de vent se génèrent automatiquement sur l'ensemble du bâtiment. L'usager peut définir la composition complète des murs avec les ouvertures, le revêtement et le clouage. Ce logiciel vérifie la résistance des murs en plus de fournir une analyse détaillée de chacun d'eux en indiquant les forces de cisaillement dans les segments de murs, dans les collecteurs au-dessus des ouvertures ainsi que les réactions d'ancrage.

Suite à la page 8



Extrait du module ShearWalls

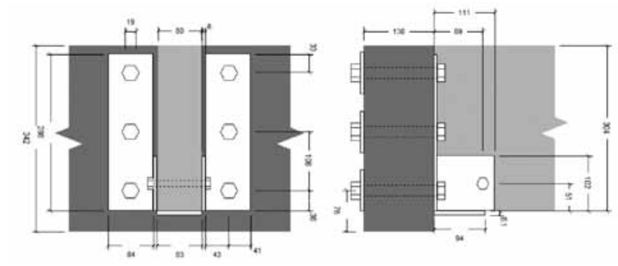
WoodWorks® SOFTWARE FOR WOOD DESIGN — www.cwc.ca

SAFI — www.safi.com

GRAITEC — www.graitec.ca

3 Module Connections

Le module Connections contient plusieurs assemblages types qui utilisent des clous, des boulons, des rivets ou des disques de cisaillement. Ce module permet de concevoir des assemblages simples tels que des étriers, des bases de colonnes et des entures. L'utilisateur peut définir une partie ou la totalité des paramètres de l'assemblage (diamètre et espacement des boulons, épaisseur des tôles d'acier, etc.), ensuite le logiciel complète et valide l'assemblage.



Extrait du module Connections

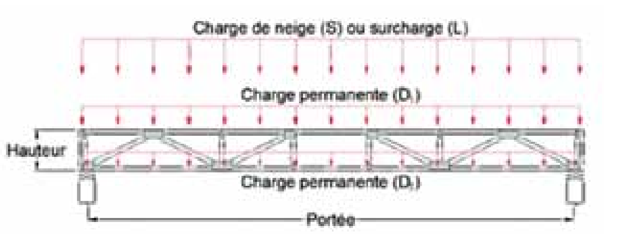
Les calculatrices cecobois

Cecobois a créé une série d'outils de calcul pour différents usages. Ces calculatrices sont des outils simples et disponibles via la section *Outils de calcul* du site Internet de cecobois (www.cecobois.com)

Ces calculatrices permettent de calculer :

- des poutrelles de bois en I ;
- des poutrelles de bois ajourées ;
- des poutres de bois ;
- des colonnes ;
- des murs à colombages ;
- la résistance au feu de poutres et poteaux en bois lamellé-collé ;
- la résistance au feu pour les ossatures légères et le bois massif ;
- des murs de refend cloués ;
- la conformité d'une structure de bois selon le CNB 2005 ;
- des panneaux lamellé-croisés CLT.

Ces calculatrices permettent à un concepteur de vérifier rapidement la faisabilité d'un élément de structure (la hauteur d'une poutrelle, par exemple) pour des charges uniformes et des portées simples. Elles utilisent les matériaux et les dimensions que l'on retrouve couramment sur le marché, dont le bois de sciage, le bois lamellé-collé, le bois de charpente composite ou les poutrelles de plancher.



Poutrelles ajourées en bois
Analyses selon CSA 086 - Calculs aux états limites

Série	Sollicitation	Résistance limitant la conception
2x4 - EPS	99 %	Efforts combinés - membrure inférieure
2x4 - 1650	72 %	Efforts combinés - membrure inférieure
2x4 - 2100	62 %	Vibration
2x4 - 2100	54 %	Vibration
2x4 - 2400	51 %	Vibration

Extrait de la calculatrice de poutrelles ajourées de cecobois

Éditorial

LE REGARD D'UN « ÉTRANGER »

Professeur Pascal Triboulot
Directeur honoraire de l'ENSTIB
Professeur associé à l'UQAC

Le colloque organisé par l'Institut des régions ressources (IRR) à Chicoutimi, les 9 et 10 mai derniers, a cherché à comparer le modèle social, économique et culturel du Vorarlberg en Autriche avec la réalité d'une région, celle du Saguenay–Lac-Saint-Jean, et plus globalement celle du Québec. Le Vorarlberg est devenu en deux décennies le Land le plus prospère d'Autriche. Cette prospérité est due à sa forêt, à l'architecture, à la construction bois, à une vraie complicité entre architectes et ingénieurs, à un savoir-faire traditionnel revisité par la modernité, à des élus volontaires, à une traduction concrète du développement durable, à une adhésion collective d'une population qui a pris son destin en main et qui est fière de ce qu'elle construit avec le bois. Chacun a compris là-bas que, dans un monde qui s'interroge sur son futur, la ressource renouvelable qu'est le bois, comme matériau de construction et source d'énergie, était une vraie réponse aux enjeux de la planète.

J'ai eu le privilège d'être un observateur neutre et attentif, durant une année entière, de ce secteur de la construction bois et de ses acteurs. Le premier des constats porte sur la présence réelle au Québec de tous les éléments nécessaires à un repositionnement du bois sur le marché de la construction non résidentielle :

- La forêt est là, certifiée à presque 100 %, elle est en capacité d'être exploitée durablement et la régénération de celle-ci est une réalité. Il reste à faire comprendre, à une population québécoise de plus en plus urbaine, que la dimension économique fait partie du triptyque du développement durable ;
- Sans évoquer l'industrie papetière, les entreprises de première transformation, longtemps concentrées sur le monoproduit destiné à l'ossature légère, cherchent et commencent à trouver un nouveau souffle dans l'innovation et les produits d'ingénierie ;
- Consciente des enjeux économiques pour les territoires, la commande publique est « frémissante ». Perçue comme une concurrente, alors qu'elle peut très bien être complémentaire, l'utilisation du bois dans la construction non résidentielle se heurte au Québec, bien plus qu'en Europe, à une opposition d'un autre âge ;
- La force de l'ingénierie au Québec n'est plus à démontrer. Elle est internationalement reconnue. Il reste que les cursus de formation des ingénieurs ont, en général, fait l'impasse totale sur les compétences minimales liées à la conception des structures en bois ;
- L'architecture au Québec gagnerait à retrouver la place qui doit être la sienne dans l'acte de construire. Elle ne doit pas se plier aux exigences de l'ingénierie, mais au contraire, s'inscrire dans une collaboration étroite, un partenariat fort avec celle-ci. Une architecture « avec le bois », qui donne de la fierté collective à tout un peuple, a été l'une des raisons du succès du Vorarlberg. Le Québec devrait s'en inspirer, au risque de détourner de cette activité liée au bois, et pour longtemps encore, toute sa jeunesse, jeunesse sans laquelle on ne peut écrire le futur.

Pour l'observateur que je suis, le « fonctionnement en silo » de tous ces acteurs est un frein indéniable à une dynamique québécoise sur ce secteur du bois-construction. À l'image du Vorarlberg, la réponse peut venir du principe du bottom up. C'est dans cet esprit que l'UQAC s'est employée à aller bien au-delà des préconisations du Rapport Beaulieu. Inscrire durablement les compétences bois, au même titre que celles liées au béton, à l'acier ou à l'aluminium, dans son cursus d'ingénieurs en génie civil, constitue une première marche. S'investir dans les actions de formation continue en constitue une deuxième. « Qui n'a pas de passion, il ne lui sert à rien d'avoir de la science », disait Miguel de Unamuno. Reconstruire le lien historique entre, bien entendu, la forêt, mais aussi le bois qui en est extrait, et les jeunes Québécois constitue un enjeu majeur. Sans passion, sans fierté collective, sans le bonheur d'inventer demain avec le bois, ce sera plus difficile.

CONSTRUIRE EN BOIS est une publication du Centre d'expertise sur la construction commerciale en bois (cecobois)

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RÉVISION
Interscript

IMPRESSION
LithoChic

CONCEPTION GRAPHIQUE ET PRODUCTION INFOGRAPHIQUE
jfLarouchepublicite.com

DÉPÔT LÉGAL
Bibliothèque nationale du Québec
Bibliothèque nationale du Canada

Imprimé sur papier Enviro

100%

BIOGAZ

PARTENAIRES

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cecobois en action

Cecobois y était !

Colloque de l'Ordre des ingénieurs du Québec (OIQ)

En mai dernier, cecobois a participé au colloque annuel de l'Ordre des ingénieurs du Québec à titre d'exposant. L'OIQ a pour rôle d'encadrer la pratique du génie afin de s'assurer de la qualité des services rendus par ses membres et de veiller à la protection du public. Plus de 460 ingénieurs ont participé à ce colloque en plus de 24 autres exposants.

Congrès annuel du Conseil de l'industrie forestière du Québec (CIFQ)

Cecobois a animé un kiosque lors du Congrès annuel du CIFQ, tenu les 23 et 24 mai derniers. Après 3 ans d'absence, le retour du Congrès de l'industrie forestière a été chaleureusement accueilli par les membres du CIFQ et ses partenaires.

Photo : © Philippe Ruel

Salon international de design de Montréal (SIDIM)

Cecobois a fait un premier pas dans le monde du design lors du Salon international du design de Montréal qui se déroulait les 25, 26 et 27 mai derniers à la Place Bonaventure. Le SIDIM est l'événement culturel en matière de design et de créativité où plus de 20 000 personnes, professionnels du design, gens d'affaires, journalistes et consommateurs convergent chaque année pour découvrir les nouveaux produits et tendances en matière de design. Plusieurs fournisseurs en bois d'apparence étaient également présents.

Visite de WoodWorks Canada et US à Québec

L'équipe de Cecobois a accueilli, du 18 au 22 juin, les conseillers techniques des autres provinces du Canada et des États-Unis ainsi que le personnel du Conseil canadien du bois. Cette rencontre avait pour but de créer une opportunité d'échange sur les différents enjeux concernant l'utilisation du bois en construction commerciale et de partager l'expertise de chacun. De plus, la journée du mercredi 20 juin a été consacrée à la visite de quelques constructions non résidentielles en bois de la ville de Québec. En compagnie des architectes, de l'équipe de Cecobois et de David Croteau (Nordic), le groupe a apprécié découvrir le talent québécois à travers ces bâtiments : Pavillon Kruger de l'Université Laval, Stade Telus, Fondaction, Quai des cageux, Promenade Champlain et Édifice Complan. Une visite réussie où Québec a ravi des cœurs !

Congrès annuel de l'Ordre des architectes du Québec (OAQ)

Du 31 mai au 2 juin, cecobois a participé, à titre d'exposant, au Congrès annuel des architectes. Il s'agit du plus important rassemblement d'architectes au Québec. L'Ordre des architectes du Québec (OAQ) contrôle l'accès à la profession d'architecte et en réglemente l'exercice dans la province. Son registre compte à ce jour 3 200 architectes et quelque 1 000 stagiaires.

Cecobois y sera !

15 septembre 2012 :
Tournoi de golf du CIFQ, Club de golf le Grand Portneuf

2, 3 et 4 octobre 2012 :
Technibois, Centre de foires de Québec

16 au 19 septembre :
Séminaire de l'Association des ingénieurs municipaux du Québec, Boucherville

8 novembre 2012 :
Contech Québec

29 novembre :
Contech Montréal

Systèmes préfabriqués à ossature légère en bois pour bâtiments commerciaux
Les cas d'Ultramar et Tim Hortons

cecobois

Centre d'expertise
sur la construction
commerciale en bois

Une division du
Bureau de promotion des produits
du bois du Québec

Bien des entrepreneurs, ingénieurs et architectes se montrent encore étonnés lorsqu'on leur parle d'éléments préfabriqués et d'ossature légère en bois pour des bâtiments commerciaux. Et pourtant...

Les systèmes structuraux préfabriqués à ossature légère en bois sont tout aussi indiqués pour de petits bâtiments commerciaux qu'ils peuvent l'être pour des constructions résidentielles. Et cela, au moins deux chaînes de commerce, au Québec, l'ont bien compris avant d'effectuer un virage complet vers ce type de construction.

En fait, ce n'est qu'une question de logique. Il y a très longtemps que la construction à ossature légère en bois fait consensus auprès des constructeurs d'habitations. L'expertise acquise au Québec en cette matière n'est plus à démontrer, non plus que la qualité et la durabilité de ces bâtiments résidentiels en bois. On en trouve de très beaux exemples tout à fait solides et fonctionnels qui ont plus de cent ans.

Au cours des dernières décennies, la préfabrication en usine de composants structuraux pouvant être livrés directement au chantier et assemblés rapidement est venue donner une valeur ajoutée à ces constructions à ossature légère en bois. Les composants préfabriqués incluent principalement les murs à ossature légère, les poutrelles de planchers et les fermes de toit. Non seulement le recours à ces systèmes préfabriqués procure-t-il une meilleure qualité au produit fini (voir l'encadré), mais il offre en plus d'importantes économies de temps et d'argent.

Or, en toute logique, ce qui vaut pour ces constructions résidentielles s'applique aussi pour des bâtiments commerciaux ou industriels dont la taille est comparable à celle des immeubles d'habitation. Pour des chaînes de commerces qui projettent plusieurs constructions, les économies d'échelle peuvent être énormes. Ultramar et Tim Hortons en savent quelque chose. Voilà quelques années, ces deux entreprises ont choisi l'ossature légère préfabriquée en bois pour la construction de leurs commerces de détail au Québec. Leurs premières réalisations avec ce système ont tout de suite été concluantes.

Les stations-service d'Ultramar

Ultramar exploite 258 stations-service couplées à des dépanneurs à heures prolongées, sous les bannières Dépanneur du coin et Corner Store, au Québec, en Ontario ainsi que dans les provinces atlantiques. En pleine phase d'expansion, l'entreprise érige chaque année plusieurs nouveaux établissements un peu partout sur le territoire. Sauf exception, tous les Dépanneurs du coin sont faits sur le même modèle. Il s'agit de bâtiments d'un étage, ayant une superficie de 200 ou 230 m2 selon les régions, comprenant une aire ouverte pour le service à la clientèle et quelques espaces clos pour les toilettes, un bureau, une chambre froide, un petit entrepôt et une cuisine dans les dépanneurs qui font leurs propres pâtisseries.

À titre de directeur de la construction chez Ultramar, Jacques Savoie est responsable de l'érection de ces petits bâtiments commerciaux. Une journée de l'hiver de 2008, alors qu'il prenait un repas dans un restaurant, il a observé une équipe de travailleurs monter une structure préfabriquée sur le terrain voisin. Étonné de la vitesse à laquelle se déroulait l'opération et se disant que ce serait intéressant d'ériger ses dépanneurs aussi vite, il est allé s'informer auprès du responsable de l'équipe. « Nous sommes capables de monter une structure comme celle-là en une journée, avait dit le représentant du fabricant. Et nous pouvons le faire aussi avec des bâtiments commerciaux. Ce n'est pas plus compliqué. »

Après avoir fait des évaluations et examiné la question de près avec un manufacturier de bâtiments préfabriqués, Ultramar a conclu à la possibilité d'ériger ses bâtiments à meilleurs coûts, de manière plus efficace et plus rapide avec cette méthode qu'avec les systèmes traditionnels en acier utilisés jusqu'à maintenant. Plusieurs autres avantages militaient également en faveur de cette solution. Dès 2009, un premier Dépanneur du coin avec ossature légère en bois préfabriquée a donc vu le jour à Mascouche, à titre de projet pilote, et fut aussitôt suivi de quelques autres. Si bien que, l'année suivante, l'entreprise optait officiellement pour un virage bois.

Ainsi, à la fin de 2011, une dizaine de nouveaux Dépanneurs du coin dotés d'une structure à ossature légère préfabriquée en bois avaient pignon sur rue aux quatre coins du Québec, et de cinq à sept autres projets étaient sur les tables à dessin pour 2012. L'entreprise envisageait en plus d'exporter sa nouvelle formule vers ses futurs établissements des provinces atlantiques et, éventuellement, de l'Ontario, avec des fournisseurs locaux.

Les composants structuraux

Lorsqu'il effectue la livraison des composants préfabriqués au chantier, le fournisseur arrive avec la coquille complète du bâtiment : murs extérieurs, fermes de toit et même divisions intérieures. Les plans ayant été faits selon les dimensions spécifiées par le promoteur, il suffit ensuite d'assembler ces éléments sur les fondations.

Les murs sont constitués de montants de bois de sciage classique de 38 x 140 mm (2 x 6 po), espacés aux 400 mm (16 po), en essence EPS (épinette-pin-sapin) du Québec ou du Canada et recouverts de panneaux de lamelles orientées (OSB) sur la face extérieure. Ils sont livrés en sections de 3,4 à 4,6 m de hauteur (11 à 15 pi), déjà munis de l'isolant (matelas de 15 cm de laine minérale) avec pare-vapeur et fourrures à l'intérieur, pare-air et lattage à l'extérieur. Leur résistance thermique est de R-25,5. Ne reste ensuite qu'à installer le gypse et les parements extérieurs : brique sur le tiers inférieur et revêtement de bois ou d'acrylique pour les deux tiers supérieurs. Au sortir de l'usine, les murs possèdent déjà toutes les ouvertures aux dimensions exactes pour recevoir les portes et fenêtres. Dans le cas des établissements d'Ultramar, l'une des façades est constituée d'un mur rideau avec vitres thermos à l'argon et film anti-UV.

Le toit est composé de fermes plates de 1 à 1,20 m de hauteur, franchissant des portées d'environ 12 m (bâtiments de 12 x 18 m). On les couvre de panneaux de contreplaqué à rainures et languettes, d'un isolant de polystyrène expansé ou de laine minérale

et d'une membrane d'étanchéité (Soprema) ou d'une couverture multicouche gravier-goudron, au choix de l'entrepreneur (résistance thermique de l'ensemble : R-20 pour les toitures plates et R-34,7 pour les toits en pente). Dans 20 % des cas environ, les toitures sont plutôt revêtues d'une membrane blanche réfléchissante de façon à réduire les îlots de chaleur dans les villes. Éventuellement, ce type de membrane pourrait devenir la norme chez Ultramar.

De plus, les fermes de toit sont laissées complètement apparentes à l'intérieur des bâtiments. Aucun matériau de finition n'est utilisé au plafond. Elles sont simplement enduites d'une couche de peinture de sorte qu'elles s'harmonisent très bien au décor intérieur. Les cloisons intérieures sont elles aussi en ossature de bois recouvertes de placoplâtre. Dans certains cas, une partie du parement extérieur est également fait de bois.

Gain de sept jours et 26 000 $ d'économie

Selon les indications fournies en 2011 par le directeur de la construction, il fallait autrefois, avec l'ancien système de construction, environ 10 jours pour fermer complètement un bâtiment, fondations et installation de la membrane de toit non comprises.

Avec la construction préfabriquée à ossature de bois, trois jours suffisent. Un gain de temps de 70 % pour cette partie du projet ! Quant à l'économie d'argent, on l'estime à près de 26 000 $ pour un projet qui aurait coûté 91 000 $ avec une structure d'acier (voir le tableau). Un gain de 28 % !

Parmi les autres avantages de la préfabrication en bois, l'entreprise signale les ventes supplémentaires réalisées grâce à l'ouverture du commerce une semaine plus tôt, ce qui n'est pas négligeable lorsque multipliées par le nombre de nouveaux dépanneurs. Elle mentionne également la fabrication en usine dans des conditions idéales, ce qui donne une structure de bâtiment mieux isolée, avec moins de ponts thermiques et des mesures plus précises, au millimètre près.

Il y a aussi moins de risques de vol sur le chantier : le bâtiment étant fermé rapidement, moins de feuilles de contreplaqué et moins de madriers disparaissent durant la nuit, témoigne le directeur de la construction. Le chantier engendre en outre beaucoup moins de débris de construction (retailles de pare-air et de pare-vapeur, bouts de montants métalliques…), d'où la réduction considérable des frais de conteneur à déchets, sans compter le bénéfice pour l'environnement.

Environnement et emploi

En plus de ces avantages directs pour Ultramar, le directeur de la construction parle des bénéfices indirects qui profitent à l'ensemble de la société et s'inscrivent dans la philosophie de gestion responsable de l'entreprise. En choisissant le bois, Ultramar voulait se donner des bâtiments écoénergétiques, se rapprochant le plus possible des constructions vertes (éventuellement LEED) et se montrait sensible à la réduction des émissions de gaz à effet de serre que procure l'utilisation du bois par rapport aux autres matériaux. Entraient également en considération les retombées économiques régionales : emploi de main-d'œuvre forestière et transformation locale de la matière plutôt qu'importation d'acier des États-Unis.

Concernant la sécurité des occupants et la protection contre les incendies, les nouvelles constructions d'Ultramar répondent aux exigences de la partie 9 de la division B du Code national du bâtiment pour ce type de petits bâtiments. Dans certains cas où l'immeuble se trouve trop près des distances limitatives prescrites par le Code, des mesures particulières peuvent être exigées afin de répondre aux exigences d'incombustibilité ou de degré de résistance au feu de la façade de rayonnement concernée comme l'utilisation d'autres matériaux structuraux et de revêtement extérieur ou, encore, par l'emploi d'une double épaisseur de gypse à l'intérieur.

Dans l'ensemble, Ultramar est très satisfaite de son choix en faveur du système préfabriqué à ossature légère en bois. La seule difficulté s'est présentée au début lorsque les entrepreneurs et autres professionnels amenés à travailler sur les projets se montraient réticents à cause de l'idée qu'ils se faisaient du bâtiment préfabriqué en bois, alors rarissime en construction commerciale. Mais en constatant l'économie substantielle de temps et d'argent, ainsi que la qualité des bâtiments, ils changeaient vite d'attitude.

Les restaurants Tim Hortons

Elle aussi en pleine période d'effervescence, la chaîne de restaurants Tim Hortons érige, en moyenne, une vingtaine de nouvelles constructions par année, un rythme qui n'est pas près de ralentir.

Dans les années 1990, l'entreprise utilisait l'ossature légère en bois pour ses restaurants, mais en construction traditionnelle entièrement réalisée sur le chantier. Lorsque l'acier est devenu temporairement moins cher que le bois, vers 1998, elle a opté pour les structures métalliques. Puis, en 2008, elle est revenue au bois, mais cette fois en mode préfabriqué en raison des nombreux avantages que cela apporte. La préfabrication offrait dorénavant beaucoup plus de possibilités, avec davantage de produits sur le marché et une rapidité qui n'existait pas au début, avant que la technique soit bien implantée.

Cinq modèles

Tim Hortons construit cinq modèles de bâtiments en fonction de la configuration du terrain et des exigences municipales. Ce sont tous des immeubles d'un étage, à toit plat dans 75 % des cas, et d'une superficie de 280 m^2 en moyenne. Ils peuvent accueillir de 35 à 50 clients assis.

Les murs et les fermes de toit sont livrés au chantier en même temps, prêts à être installés. Les murs préfabriqués arrivent au chantier en sections d'environ 3,5 m (11 pi 6 po) de hauteur. Ils sont constitués de montants en bois de sciage de 38 x 140 mm (2 x 6 po) espacés tous les 400 mm (16 po), en essence EPS, et la face extérieure est revêtue de panneaux de lamelles orientées OSB. La plupart du temps, ils sont livrés déjà isolés (laine minérale ou polystyrène expansé, pour une résistance thermique de R-20) et munis du pare-air, du pare-vapeur et des fourrures extérieures et intérieures. Toutes les ouvertures sont déjà présentes pour recevoir une généreuse fenestration dans la partie publique. Les poutres, linteaux et colonnes peuvent être en bois d'ingénierie. Les parements sont le gypse à l'intérieur et le bois ou la brique à l'extérieur.

Les fermes de toit, d'une hauteur d'environ 1 à 1,5 m, franchissent des portées allant de 10 à 15 m. Elles sont recouvertes de contreplaqué, d'un isolant rigide polyisocianurate (pour une résistance thermique de R-32) et d'une membrane TPO blanche, réfléchissante et recyclable.

Tout le bois utilisé par Tim Hortons provient du Québec ou de compagnies canadiennes qui certifient leurs produits selon les normes en vigueur au pays. Alors qu'elle a toujours recours aux mêmes architectes et ingénieurs, l'entreprise fait appel à des fournisseurs locaux pour les entrepreneurs et les fabricants, maintenant présents dans la plupart des régions.

Les économies

Comme Ultramar, c'est principalement pour des raisons d'économie de temps et d'argent que Tim Hortons a choisi le système préfabriqué à ossature légère en bois. Selon l'architecte Robert Poirier, depuis 25 ans concepteur principal des bâtiments de la chaîne de restaurants au Québec, l'entreprise réalise généralement des gains de l'ordre de 10 % sur les coûts de construction d'un projet, et de 15 à 20 % sur les délais de livraison du produit.

Un projet de 450 000 $ (bâtiment seulement) coûte en moyenne de 50 000 $ à 75 000 $ moins cher avec le préfabriqué en bois. Quant au gain de temps, on l'estime à une semaine au minimum sur les huit que peut prendre l'ensemble d'un projet. L'assemblage des composants se fait en deux jours par l'équipe du fabricant, après quoi le toit est fermé. Par la suite, on travaille au chaud à l'intérieur, sans avoir à déblayer la neige sur la dalle ou à se soucier de la détérioration des matériaux et des équipements par les intempéries.

Bâtiments plus performants

La fabrication des composants en usine assure que le bois soit toujours livré au bon degré d'humidité, avec moins de défauts et une plus grande précision d'assemblage. Il en résulte moins de perte de bois, moins de risque de variations dimensionnelles des éléments d'ossature pouvant entraîner de la fissuration dans le gypse, et donc des bâtiments de meilleure qualité et plus performants. Le manufacturier offre d'ailleurs toujours une garantie sur la qualité de son travail (pose de l'isolant, du pare-air, du pare-vapeur…).

Outre l'absence de débris sur le lieu de construction et la réduction du risque de vol ou de vandalisme des matériaux et équipements, l'architecte des projets de Tim Hortons mentionne un aspect fondamental : une livraison presque instantanée des composants préfabriqués, même en période de pointe de construction (grâce au nombre de fournisseurs et à l'abondance du bois sur le marché), comparativement aux délais qui pouvaient souvent atteindre de quatre à six semaines avec le système classique en acier utilisé auparavant.

Pour Tim Hortons, il ne saurait être question d'abandonner l'ossature légère préfabriquée. Certes, le bois a ses limites, relativement à l'humidité entre autres. Mais lorsque la membrane de toit est bien installée et que les parties sensibles sont bien protégées, la charpente de bois s'avère tout aussi durable qu'une structure d'acier… comme l'entreprise le constate régulièrement d'ailleurs lorsqu'il lui faut rénover ses premiers restaurants en bois.

Coûts d'un projet d'Ultramar – Tableau comparatif entre une ossature préfabriquée en bois et une structure métallique

Travaux	Bois ($)	Acier ($)
1 semaine profit/administration	-	4 750
1 semaine conditions générales	-	3 500
Système intérieur	16 500	30 000
Parapets	- *	15 000
Murs préfabriqués	33 007	
Installation des murs préfabriqués	15 615	
Structure d'acier	-	36 000
Conteneur à déchets	-	550
Fond de clouage autour des vitrines	-	800
Coulis sans retrait	-	350
Total	**65 122**	**90 950**
Réduction de coût	**25 828**	

Source : Ultramar

Un produit fini de meilleure qualité

Plusieurs raisons expliquent pourquoi les systèmes structuraux préfabriqués en bois donnent un produit fini de meilleure qualité.

- La conception des systèmes structuraux est effectuée avec des logiciels sophistiqués, directement liés à l'équipement de fabrication des usines. Cela assure à la fois une très grande précision des éléments, l'uniformité des dimensions et des formes demandées par le promoteur et une grande efficacité structurale, chaque composant étant prévu pour résister aux charges auxquelles il sera soumis. Sans compter que la conception par ordinateur rend possible la fabrication de fermes de toit de toutes les formes offrant de nombreuses possibilités pour les profils de toiture, avec des éléments de longue portée et la résistance mécanique nécessaire.
- Les composants étant fabriqués dans un environnement contrôlé en usine, le temps qu'il fait à l'extérieur n'a aucune influence sur l'échéancier des travaux de même que sur le comportement futur des composants. Les risques de retrait, de gonflement ou de gauchissement sont réduits au minimum.
- La pose en usine des matériaux qui forment l'enveloppe (pare-air, ainsi qu'isolant et pare-vapeur lorsque demandés) assure une meilleure étanchéité à l'air et une réduction des fuites, d'où une grande efficacité énergétique du bâtiment.
- Tous les dessins d'atelier ayant servi à la fabrication des composants peuvent être fournis par les fabricants, assurant que chaque élément a été fabriqué selon les directives du concepteur, ce qui offre une meilleure garantie de conformité.

Pourquoi ce système coûte moins cher ?

Le système préfabriqué à ossature légère en bois est le plus économique qui soit, tous matériaux confondus. Voici pourquoi.

- Le bois de sciage utilisé pour l'ossature légère est un matériau de construction abondant et très économique en comparaison de l'acier et du béton. En outre, l'existence d'une centaine de fabricants et fournisseurs de composants préfabriqués en bois dans toutes les régions du Québec est un gage de saine concurrence qui favorise des prix avantageux.
- Comme les murs préfabriqués constituent à la fois l'enveloppe du bâtiment et les éléments porteurs, les coûts associés au système structural s'en trouvent réduits.
- La préfabrication des composants permet d'optimiser la conception des systèmes selon les différentes résistances du bois utilisé, et donc de diminuer les dimensions des différents éléments ou d'augmenter leurs espacements afin de minimiser la quantité de matériaux requis pour obtenir les performances désirées.
- La précision des calculs et des assemblages en usine minimise les pertes en résidus de matériaux.
- L'assemblage des composants du système sur le chantier s'effectue rapidement, avec précision, par des équipes expérimentées qui en maîtrisent la technique, minimisant ainsi les pertes de temps.
- Les composants étant fabriqués en usine, il n'y a aucun délai attribuable à des arrêts de travail à cause du mauvais temps.
- Les besoins en équipement et en main-d'œuvre spécialisée sur le chantier sont moins grands.
- La grande disponibilité des produits sur le marché ainsi que le grand nombre de fabricants assurent une fluidité de l'approvisionnement et préviennent toute perte de temps et d'argent à cause d'un engorgement du marché.
- Puisque le bâtiment est monté et donc fermé plus rapidement, il y a moins de risques de pertes dues au vol et au vandalisme sur le chantier.
- Les projets étant livrés plus rapidement, les propriétaires sont en mesure de tirer des revenus plus tôt de l'exploitation de leur commerce.

Le bâtiment

Ultramar

- Classe des bâtiments : F2
- Aire des bâtiments : 200 à 230 m^2
- Nombre d'étage : 1
- Principaux produits de bois utilisés
  - Murs préfabriqués : montants de 38 x 140 mm (2 x 6 po) en essence EPS, espacés aux 400 mm (16 po) et revêtus de panneaux OSB
  - Fermes de toit : fermes légères à connecteurs métalliques de 1,2 m de hauteur en moyenne, franchissant des portées de 12 m et recouvertes de panneaux de contreplaqué à rainures et languettes
  - Une partie du parement extérieur pour certains projets
- Coût de l'ossature pour un projet, incluant l'enveloppe et l'installation : 65 122 $ (comparativement à 90 950 $ pour une charpente en acier).

Le bâtiment

Tim Horton

- Classe des bâtiments : A2
- Aire des bâtiments : 280 m^2 en moyenne
- Nombre d'étage : 1
- Principaux produits de bois utilisés
  - Murs préfabriqués : montants de 38 x 140 mm (2 x 6 po) en essence EPS, espacés aux 400 mm (16 po) et revêtus de panneaux OSB
  - Fermes de toit : fermes légères à connecteurs métalliques de 1 à 1,50 m de hauteur, ayant des portées de 10 à 15 m et recouvertes de contreplaqué
  - Bois d'ingénierie pour les poutres, linteaux et colonnes, dans certains projets
  - Parement extérieur pour certains projets
- Coût de construction d'un projet (bâtiment seulement) : 450 000 $ (économie de 50 000 $ à 75 000 $ par rapport à une charpente en acier).

Équipe de réalisation Ultramar

Architecture : principalement Michel Bastien Architecte (Michel Bastien)

Génie : Exp. (Luc Malo, ing.)

Entrepreneurs : LC 2000 (Guy Brodeur),
N. Sani (André Dupont)

Fabricants : Structure Alternative (Michel Pietracupa)

Équipe de réalisation Tim Horton

Architecture : Sauvé Poirier Architectes (Robert Poirier) ; Luc M. Allard Architecte (Luc M. Allard)

Génie : Équation Groupe-conseil (Yves Fallu, ing.)

Entrepreneurs : selon le projet

Fabricants : selon le projet

Cecobois remercie Ressources naturelles Canada et le ministère des Ressources naturelles et de la Faune du Québec pour leur contribution financière à la réalisation de cette étude de cas.

Ressources naturelles et Faune Québec

Ressources naturelles Canada
Natural Resources Canada

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Mars 2012

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Une division du
Bureau de promotion des produits
du bois du Québec

North American Wood*WORKS!* Technical Advisors Meeting- Round Table Discussions

Notes from June 22, 2012 - Quebec City Meeting

Recommendations, Suggestions , Actions Items	Priority Ranking (Use X to indicate your ranking)				Possible US/Canada Joint venture		Comments
	High	Low	Medium	N.A.	YES	NO	
DESIGN TOOLS (Calculators, guides, technical bulletins…)							
Develop software / tool(s) to design connectors							
Publish information / literature on connectors (e.g. guide) with visual information (photos, renderings) on various types of connectors, options, applications, solutions							
Produce a list of connector suppliers							
Host design connector workshops - with actual laboratory tests on-site to showcase strength							
Identify best / most common design options for trusses and publish solutions							
Identify and reference existing cost estimation resources							
Generate inventory of firms /individuals that can provide information on engineered wood products and costing							
Pull together inventory of constructed projects to build costing database							
Encourage / convince specialized firms to develop costing database - quantity surveyors, estimating firms, contractors							
Produce cost case studies and fact sheets - project cost, time of erection, relevant examples with cost per square foot							
Develop cost case studies focused on specific types of buildings (e.g. schools)							
Gather information on the cost of new system / applications and products (CLT, etc.)							
Produce tool kit for designers such as BC Rethink Wood Kit - wood samples (LVL, I-joists), case studies (paper, cd, usb), fact sheets							
Produce case studies on durability with focus on solutions							
Produce video or literature on maintenance issues - coating products, proper detailing, information on treatment							
Post online literature that deals with construction details - with examples							
Publish design manual for mid-rise construction - step by step reference guide (US version of APEG-BC)							
Promote wood benefits as it relates to the building code, calculation examples, details...							
Produce a 'How to' guide to design specific types of structures (e.g. schools, recreational facilities)							
Develop a US and Canadian (could be regional) wood use matrix (similar to BC)							
Provide wood product specifications for tender documents (sample)							
Improve websites to have similar navigation structure and/or content access							
Link WW web sites to calculators developed by suppliers and other industry partners							
Develop a comprehensive Tall wall online calculator that includes all engineered wood products							
Expand/promote use of carbon calculator - capitalize on opportunity to provide a plaque or certificate to recognize building owners							
Develop simple fire and acoustic calculator for different material and assembly options							
Develop an online code check tool							
Produce a simple structural sizing tool - for online application							
Ensure wood options are well defined/included in Revit software							
CONVERSIONS - Influencing Projects to Wood							
Produce 1 page project sheets for every project - this helps everyone know what is happening on a project							
Explore new ideas to distribute follow-up material (mailing = time consuming)							
Need to intervene early-on before design stage -success is best if we get in early							
Develop procedures to formalized follow-up and filter leads							
Develop approach to minimize paperwork (reporting)							
Keep track of projects that don't turn-out (compile information lessons learned)							
Technical directors should spend less time on administrative issues more on pursuing projects							
Need to quickly adapt as "field" is always changing							
Review the best practices and tactics to get leads -such as knock on door, events, speaking/presentations, ongoing networking							
It is important to follow-up (design office and job site, what do they need?)							
Post completion follow-up is important...what was their experience: good or bad? Will they use wood in the future?							

Participate to construction industry association events							
Focus on Influencing (early on) rather than converting							
Look at new strategies to increase conversions - with same $/# resources							
Need to develop new wood champions							
Third party should verify program results (multiplier - same # of projects, but multiplier shows more)							
It is short-sighted to think conversion/influence is just projects, it is also about people/professionals							
We need to develop new approaches to incite designers to give us information on project lead							
Need to ask industry what information, data they would like to get from us.							
Need to get better system to evaluate value of wood in projects							
Needs to have common standards across North America							
Important to provide prompt responses to technical assistance questions							
To influence project need to influence the entire construction team - need a refined tactic to deal with the entire Team							
Engineers remain very important and should be a focus							
Focus on contractors - important							
Need to review the terms conversion/influence as they may be misleading							
Increase training around how to do tradeshows - raffle for awards book (drop business cards), good spot at show (sign-up in time)							
Design simple booth for trade show - ensure clarity in messaging							
Expand and maintain contact databases							
RESEARCH needed to Support the Wood *WORKS* teams							
Need more data, research and solutions on shrinkage							
Do real time monitoring (5 & 6 storey) on settling/shrinkage							
Identify best practices to build shear walls							
Execute comparative LCA of different buildings - by time, by occupancy							
Assess impact of fire retardant treatments on engineered wood product design values							
Determine how to build straighter walls with sawn lumber							
Evaluate operating energy comparison of different building envelopes							
R & D on how to improve fire resistance of wood products and systems							
Research on how to make wood structures as safe (or closer) as concrete buildings (better combustibility story)							
Determine if polymers can help with durability							
Research wood moment frames							
Investigate how to span farther with wood							
Need cost comparison - CLT versus stick building							
Identify tactics to better share/swap ideas between regions/countries							
Need to be better informed about on-going research as it seems everybody is doing research...							
Reinforce ties with FPI/NRC/FPL as we are a great delivery vehicle for research to 'hit the street'							
Research into how general contractors make their money ex: B12 model so that we can show them how to make more $							
Research impact of insurance risk management/pricing							
Research the long-term maintenance costs of wood products/systems versus non-wood							
Research better ways to design shear walls [simplified] and take into account top & bottom openings.							
Bring building science information into one place							
Compile best practices in one place							
Research new assemblies (& hybrids) and inter-relationships [ex: shrinkage]							
Research wall systems: e.g. elevator shafts, walls with tighter stud spacing, sound & vibration, ensuring assemblies / materials meet market need							
Research means to increase building areas (re: fire)							
Research biophilia [wood & human health]							
Research specific building types ex: hospitals with code analysis							
Develop new two hour wall/one hour floor details [no UL approved / test assembly]							
Research factors that affect decisions into materials							
Research solutions that will help wood products meet new code provisions ex: energy, passive house							
Research fire resistance of appearance grade product							
Investigate flame spread rating of eastern cedar [appearance]							

Research incremental contribution of individual components for fire resistance							
Research acoustic products used in light-frame construction							
Examine acoustic performance of wood (products) in performance of art buildings.							
Study infectious disease control of wood products in hospital type projects							
Research peoples perceptions (unclear) and how to modify for wood products in general, mid-rise & tall buildings							
Research thermal mass performance of all massive wood products							
Research how insurance industry treats wood buildings…and why							
Examine what happens to construction waste and debris - what to do with it? Educate into how to minimize (ex: sorting)							
TRAINING & EDUCATION							
Existing practitioners:							
Wood Solutions Fairs- (all agreed our best hit for reaching new practitioners - important to keep it free!)							
Seminars, Lunch & Learns (office presentations - also keep it free)							
Workshops (Engineers) can change/in-depth specific: - Charge fee for participation - duration 1 to 1.5 days Successful Topics: connectors, lateral loads, CLT symposium, fire code, alternate solutions (e.g.. Schools)…							
Attend professional associations AGMs (architects/engineers/building officials) chapter meetings							
Technical webinars (free & live/recorded).							
Produced short videos - You tube 10 to 15 minutes in duration							
Wood Design & Building - tie closer together WW, insert ad for L&L/seminars, contact information of WW Team							
Produce quarterly newsletter (best practices) from regional TA							
Develop contractors' educational presentation: topics of interest - breakfast seminar 1-1.5 hours, small groups							
One on one education							
Research questions raised during training sessions and share answer with all N.A. TA's via common database							
Future Practitioners: (Colleges & Universities)							
Host Professor's conference (1.5 days + kit)							
Develop new tools/resources for educators							
Lecture series (use international speaker from other event)							
Presentation by TA's + industry guest speaker							
Create a course that include practical + theory + lab							
Student/Professor Tours - visit sites that showcase: appearance, structure, envelope, environmental							
Develop education module (9 -10 done). 6 week course by wood education institute. Course(s) owned by Woodworks							
Develop wood construction management program (new areas for curriculum)							
Create awards program for student - use as event to inspire							
Increase profile on YouTube							
Partner local chapter architects - joint event architects + students (evening)							
OTHER SUGGESTIONS							
1-							
2-							
3-							
4-							
5-							
6-							
7-							
8-							
9-							
10-							
11-							