Wood

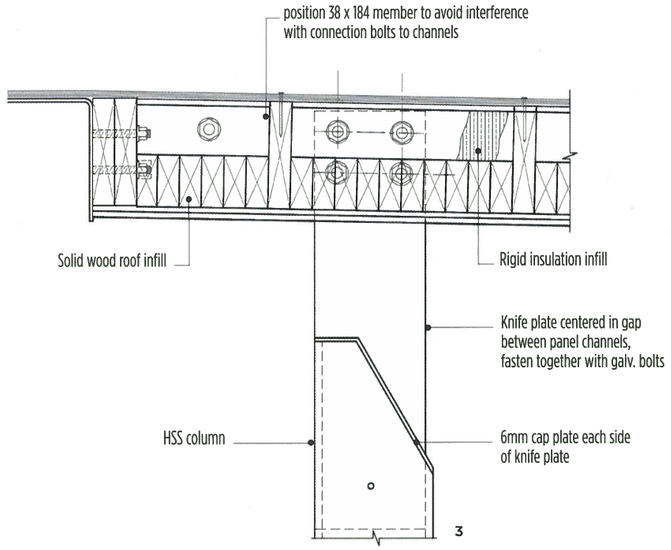
Sustainable ***with or without*** *LEED*

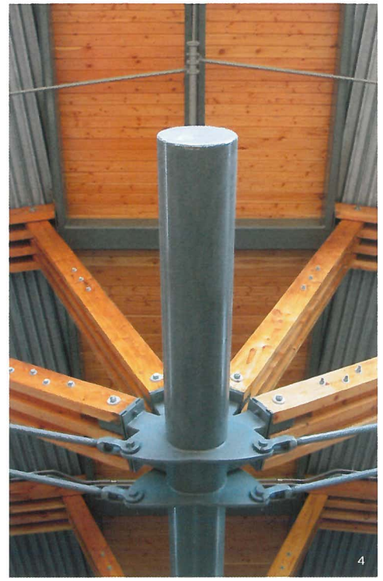
Duane Palibroda

As structural engineers, Fast + Epp have been involved in many leading edge sustainable design projects, working with architects such as Busby Perkins+Will, Hughes Condon Marler and KMBR. Some projects have scored high on the LEED rating system, while others have chosen not to pursue certification.

CANOPIES FOR THE CANADA LINE STATIONS WERE CONSTRUCTED USING MODULAR PREFABRICATED PANELS THAT INCORPORATE SOLID WOOD ELEMENTS WITHIN A STEEL CHANNEL FRAME. PHOTO: MARTIN TESSLER, COURTESY BUSBY PERKINS + WILL ARCHITECTS CO. [1].

THE STRUCTURE FOR THE MATERIALS TESTING FACILITY INCLUDES MORE THAN 95% RECLAIMED WOOD. PHOTO: MARTIN TESSLER, COURTESY BUSBY PERKINS + WILL ARCHITECTS CO. [2].





DETAIL OF THE ROOF PANELS OF THE CANADA LINE TRANSIT STATIONS MADE OF 2X4 AND 2X8 FRAMING WITHIN A SIMPLE STEEL FRAME. THE PREFABRICATED WOOD AND STEEL ROOF PANELS WERE TRUCKED TO THE SITE ALLOWING SEVERAL STATION ROOFS TO BE COMPLETED IN LESS THAN A WEEK [3]. DETAIL OF THE WOOD AND STEEL HYBRID TRUSS AT THE NORTH CARIBOO COMMUNITY CAMPUS. PHOTO: MCFARLAND MARCEAU ARCHITECTS LTD. [4].

At the time of writing [September 2010], we have three buildings under construction that have reasonable expectations of meeting the Living Building Challenge. With all this accumulated experience, we have come to the conclusion that it is most important to do the right thing – whether or not this gets you credit under LEED.

It is possible that we have a degree of bias, but we do believe that the structural design of buildings is badly underrepresented in the LEED rating system. While the building structure typically represents 20% of the construction value of the project, it usually contributes to only 3 - 4 out of 70 credits in LEED NC in Canada. Limited to the Materials and Resources section, structure can contribute to a local materials credit, a recycled materials credit, or the certified wood credit should the structure happen to be of Forest Stewardship Council [FSC] certified wood. There is also the possibility of a Design Innovation credit, but in this case any structural innovation will be competing with all the other design innovations there might be in the project.

Certified Wood

Even pursuing these few credits has presented us with a dilemma on several projects. The relative scarcity of FSC certified construction lumber in British Columbia can mean that using local lumber [even if certified under another reputable system] can brand the project as less sustainable. Even though local certified lumber is the logical choice, the pursuit of the LEED credit may require the contractor to do some cross border shopping.

In the face of international recognition of other common North American certification systems such as CSA and SFI, the USGBC initiated a review of this issue in 2005. The decision was made to create a LEED Benchmark and offer other certification systems the opportunity to demonstrate compliance and so become eligible for the LEED credit.

In 2008, the USGBC published the first draft of its Forest Certification Benchmark and invited comment from all interested parties. More than two years later, the process is in the fourth draft stage. The Benchmark contains 81 criteria that must be met to achieve compliance, making it unlikely that this will be a straightforward or streamlined process. Again, given the acceptance by other international green building certification systems of non-FSC certified material, this seems an enormous and unwarranted effort for the clarification of a single credit, particularly when other structural materials such as steel and concrete do not appear to be subject to the same scrutiny.

Environmental considerations related to extraction and production of materials do, however, figure in the Living Building Challenge. Whereas a LEED rating is based on the accumulation of individual credits, the Living Building Challenge is based solely on prerequisites. Again FSC certified material is the only wood officially recognized. The status of engineered wood products such as Parallam and Timberstrand is also currently under review due to their glue content, although temporary exemptions have been granted upon request until a final ruling has been made. When one considers that large solid wood sections probably utilize no more than 40-50% of the wood fibre in a given tree, and products such as Parallam and Timberstrand utilize close to 100% - this potential exclusion makes little sense. Add to this the fact that engineered wood is stronger than sawn lumber, is available in much longer lengths [thereby requiring fewer supports and connections] and the anomaly is further compounded.

Notwithstanding these concerns about LEED, one could perhaps even argue that the under-representation of building structure within the rating system gives structural engineers a degree of freedom as so few points are at stake. Whether or not this is generally true, at Fast + Epp we have always argued for what we believe is the best and most sustainable solution, whether it gets us the LEED credit or not. Our own conviction is to first select the appropriate structural material for the project, whether it be wood, steel or concrete.

Our increasing use of wood as a viable sustainable building material is consistent with the "Wood First" policies enacted in France, New Zealand and more recently in British Columbia where governments are seeking to reduce both their environmental impact and carbon footprint. As wood contains about 1 tonne of carbon for every cubic metre of material, it is easy to understand why it appears so prominently in carbon neutral buildings the world over, including those being constructed here for the Living Building Challenge.

Hybrid Construction

Our own attitude to wood, and how it can work efficiently with steel and concrete, has also evolved over time and perhaps points the way to how wood will continue to develop in the future. In our experience, mixing these core materials in a variety of creative ways has often led to highly efficient hybrid structures that, in addition to minimizing overall material use, make a significant contribution to the architecture of the building.

An early example of this mixing of materials was the roof for the exhibition space at the Whitehorse Business Tourism Centre [designed in 1993 with architect Florian Maurer]. There we developed bowstring trusses using a steel pipe tension member, a pair of solid wood compression members and struts made from saplings salvaged from a local forest fire. Variations on this composite truss or king-post theme followed in projects such as the Armstrong Spallumcheen Arena [designed with CEI Architecture / Graham Edmonds Cartier] and the North Cariboo Community Campus [designed with Larry McFarland Architects].

A trip to Germany in the late 1990s prompted another line of investigation. There, the traditional technique of nailing solid sawn lumber side by side on edge to form roof and floor elements was enjoying a revival – no doubt because European designers recognized the fact that solid sawn lumber has the lowest embodied energy of any major building material, and is a long term carbon storage system.

We first experimented with this technique on the Brentwood Town Centre Skytrain Station [designed with Busby + Associates in 2002]. Here the precision of factory prefabricated glulams is complemented by the site-built roof diaphragm which exploits the inherent flexibility of standard 2x4 lumber to follow the 3-dimensional curvature of the roof. Interestingly, the incorporation of heavy timber on many of Vanvouver's Millennium Line stations [championed by Alan Hart of VIA Architecture and LMDG Code Consultants]

Ideas for LEED and wood certfication

As it currently stands, there is a serious disconnect between the LEED rating system and the use of BC wood, which is unfortunate given that locally-grown wood is already recognized as a sustainable structural material by the local design community and the provincial government. Rather than accept the exclusivity of the FSC certification, we would submit that the current inequities in the LEED rating system could be addressed with the incorporation of a few simple ideas:

1. Recognize softwood lumber as a renewable resource:

The current criteria include a 10 year material lifecycle, which effectively promotes materials such as bamboo, hemp and grass, none of which could be considered a locally viable building material. Given that to be sustainable we should be designing buildings for a minimum 50-year lifespan, it seems logical that a building material which had a compatible lifecycle should be considered renewable.

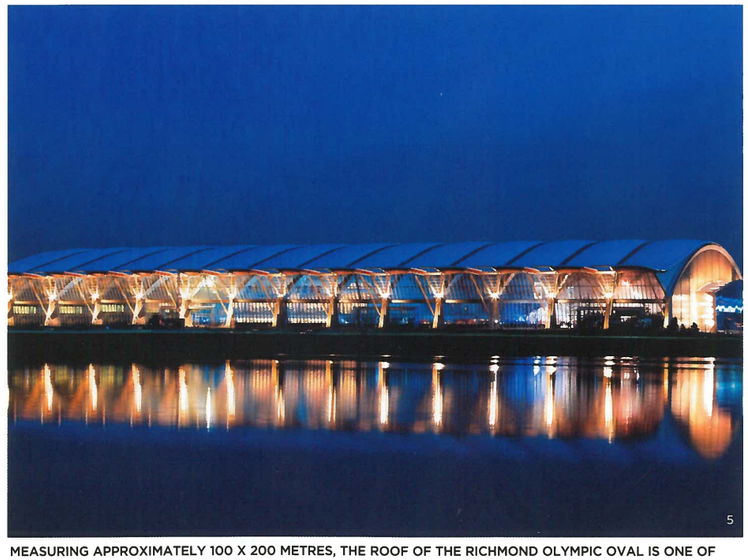
2. Develop rational criteria to include other nationally/internationally recognized certification systems:

As the debate over the "FSC only" policy rages on, other reputable wood certification systems such as CSA and SFI are being recognized both nationally and internationally. If either of these certifications were recognized by LEED it would instantly increase the availability of BC wood and make it much more viable as a sustainable material.

3. Provide a sliding scale point system related to the wood content in a building:

The Energy & Atmosphere section of the LEED score sheet currently gives a point for 5% Renewable Energy, another point for 10%, another point for 20%, and a possible further innovation point for significantly higher percentages - four possible points for a single strategy. In fairness to wood, we would propose a similar sliding scale based on the percentage of wood used in the building. For example, you could give 1 point for 30% structural content, a further point for 50% content and a bonus point if the wood is FSC certified (thereby respecting the original LEED criteria).

It is interesting that probably the most sustainable building our office has been involved in to date was the Materials Testing Facility in Vancouver with Busby + Associates Architects back in 1999, well before LEED was even a twinkle in anyone's eye. This building achieved an unprecedented 95% recycled content for structural material by creatively reusing heavy timber and glulam from a recently demolished warehouse. If one were to compare this building to the current LEED Canada scorecard it would probably only achieve 3, maybe 4 points.

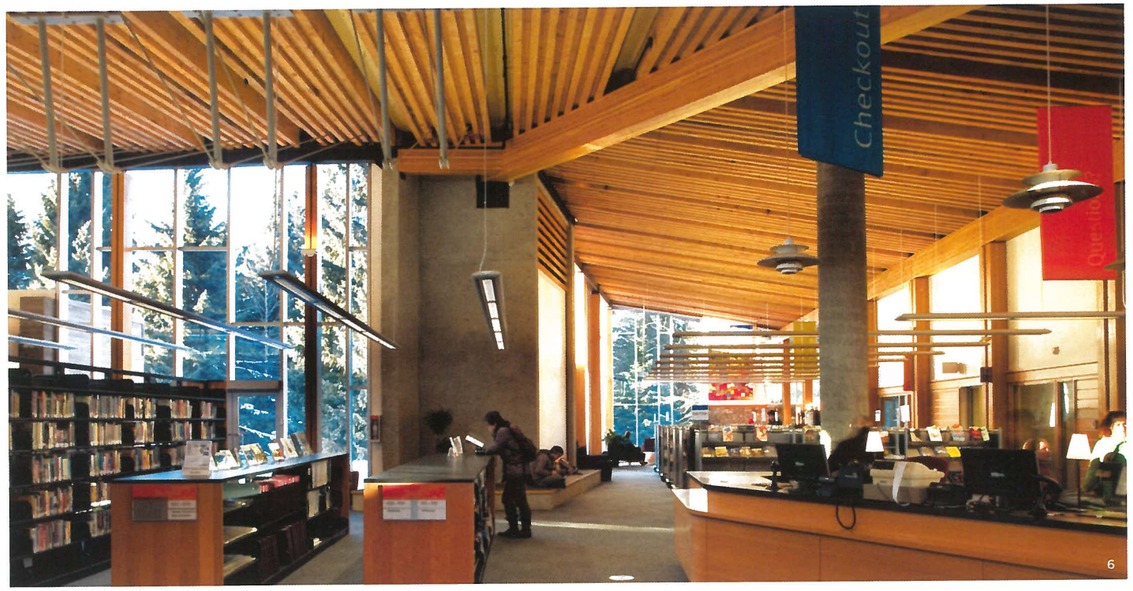


MEASURING APPROXIMATELY 100 X 200 METRES, THE ROOF OF THE RICHMOND OLYMPIC OVAL IS ONE OF THE LARGEST WOOD ROOFS IN THE WORLD. PHOTO: STEPHANIE TRACEY [5].

has led to an increased acceptance of wood in subsequent transit projects.

With each successive project we have found that solid wood laminated elements are easy and economical to construct and have a simple yet compelling aesthetic, and we have continued to use them in a variety of applications including the recently completed Canada Line Stations [designed with Busby Perkins + Will and VIA Architecture] and the Richmond Christian School [designed with KMBR Architects/Allen Maurer Architects].

The Canada Line stations in particular also serve to illustrate another area of interest – the use of prefabrication to improve quality, lower costs and shorten construction schedules. The roof panels, which comprise solid 2x4 and 2x8 framing within a simple steel frame, were trucked to site and lifted into place by crane. Fabricated concurrently in the shop of Solid Rock Steel in Surrey while the concrete platform structures were being poured, the prefabricated panel system enabled us to cover many stations in less than a week.



LOCALLY SOURCED AND FABRICATED HEMLOCK WAS USED FOR THE ROOF OF THE WHISTLER PUBLIC LIBRARY. PHOTO: NIC LEHOUX [6].

Our ability to create wood/steel composite systems is thanks in part to George Third and Sons, the Burnaby-based steel fabricator who created the glulam and steel ribs for Brentwood Station as well as the glulam-steel arches for the Richmond Olympic Oval roof. The success of these projects and the exposure they received both throughout the industry and in the press, made other steel fabricators more willing to bring wood into their shops.

At a basic level, the Canada Line roof panels also represent the benefits of integrated design. The 2x8 members that project at intervals above the 2x4s, are bridged by a plywood diaphragm to create a void within which services can be run. The result is a clean appearance, a reduction of site work and enhanced performance because of the physical protection afforded by the panels. The most celebrated example of this approach is the roof of the Richmond Oval [designed with Cannon Design Architects]. There, mechanical and electrical services and acoustic insulation are concealed within the arches and the WoodWave roof panels, which were design-built by StructureCraft Builders [See SABMag 17, May/June 2009].

As a further footnote on the Oval, when measured by the ATHENA Impact Estimator Program, which compared the environmental impact of an all-wood roof with an all-steel roof, the all-wood roof clearly proved to be the most sustainable solution.

Returning finally to the issue of wood and LEED, our most misunderstood building is probably the Whistler Public Library, designed with Hughes Condon Marler Architects and completed in 2008 [see SABMag 20, Nov/Dec 2009]. The solid wood roof uses locally sourced 4x12 hemlock members lag screw laminated together into prefabricated panels about 4 feet in width and up to 40 feet in length. By offsetting the members both horizontally and vertically, and reinforcing the longer spans with a steel king post/cable system, we were able to keep the overall structural depth of the roof to only 16 inches - this in spite of the fact that it supported very high snow loads and a green roof. Using this system, we achieved the 40 foot spans using pieces that ranged in length from only 20 – 26 feet. While at first glance a solid wood roof might not appear to be an optimal use of material, a broader comparison with a more conventional alternative such as glulam purlin and wood deck construction, identified several environmental advantages. As a low-tech, locally sourced and fabricated solution, the solid hemlock system had lower embodied energy than the alternatives and with a shallower structural depth, reduced the overall volume of the building – and hence construction costs and life cycle energy consumption.

Innovative solutions always emerge in direct response to local opportunities and design constraints. The use of locally harvested solid sawn wood and efficient/economical engineered wood seems to me to epitomize the intuitive and practical response we should be making to the challenge of sustainability. With respect to structure, and even more so to wood, it is time LEED reward structural designers for doing the right thing. Just to keep things in perspective, this highly charged debate in the design and construction community over FSC-certified lumber effectively amounts to a single point, the same amount of points one would get by positioning a building near a bus stop. ◀

DUANE PALIBRODA, P.ENG., STRUCT.ENG., M.I.STRUCT.E. (UK) IS A SENIOR ASSOCIATE WITH FAST + EPP STRUCTURAL ENGINEERS IN VANCOUVER BC. A NEW BOOK, SYMPHONY OF STRUCTURE, ON THE CREATIVE STRUCTURAL ENGINEERING OF FAST + EPP CAN BE FOUND AT WWW.SABMAGAZINE.COM.