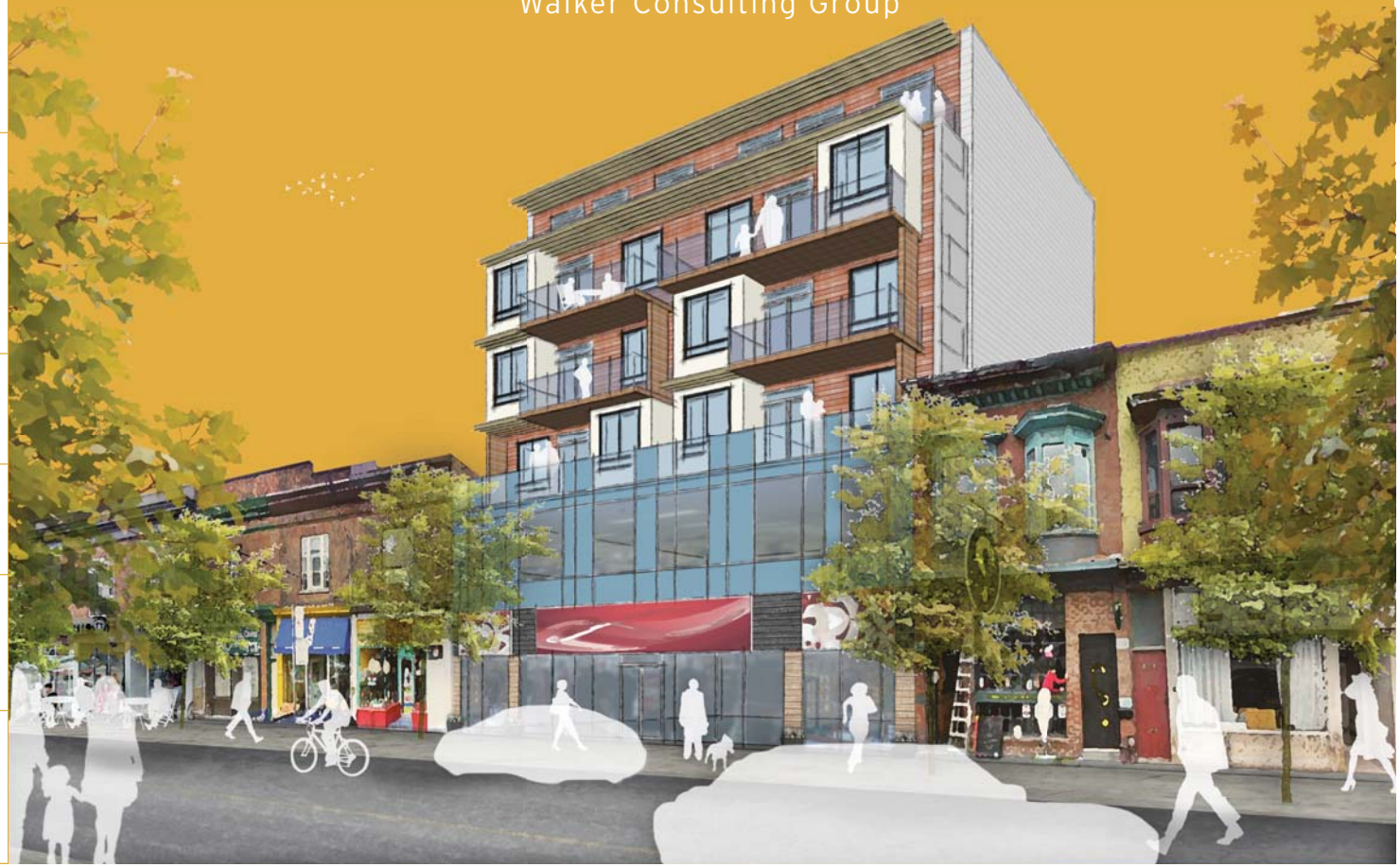
WOOD WORKS!
Project of the Canadian Wood Council

wood solutions
in mid-rise construction

Report by | Jeff Walker
Walker Consulting Group



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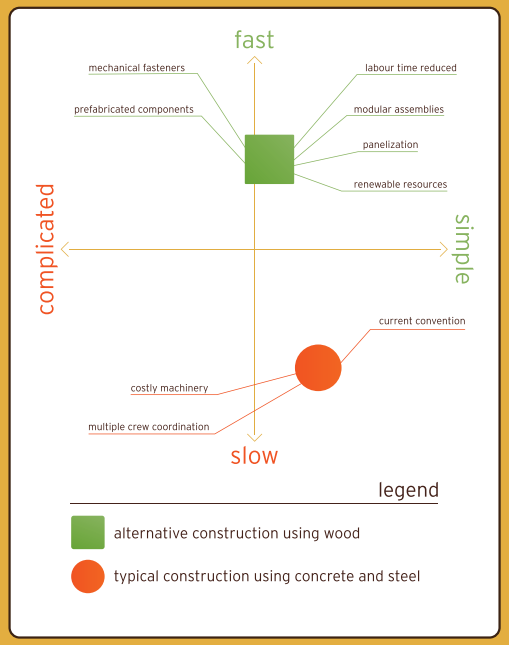
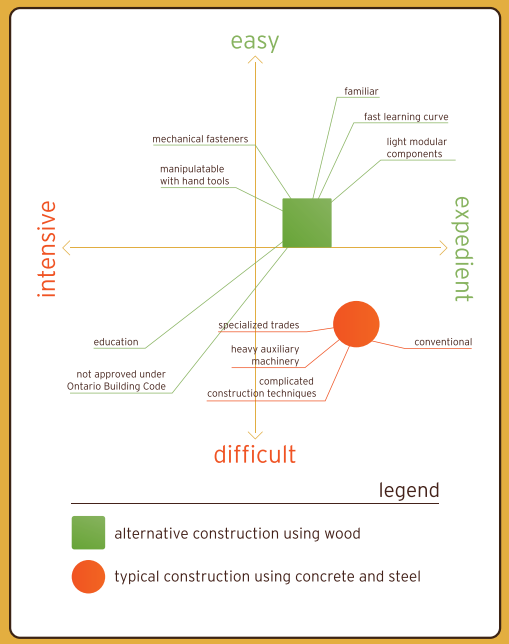
conceptual sketches, graphics and cover design by Quadrangle Architects Limited

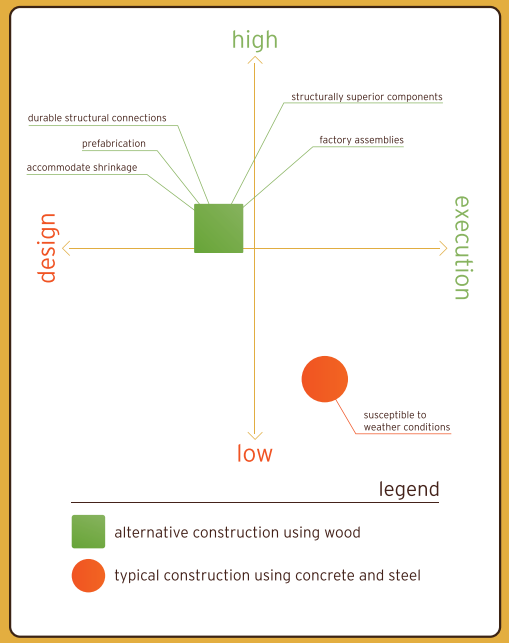
think...speed



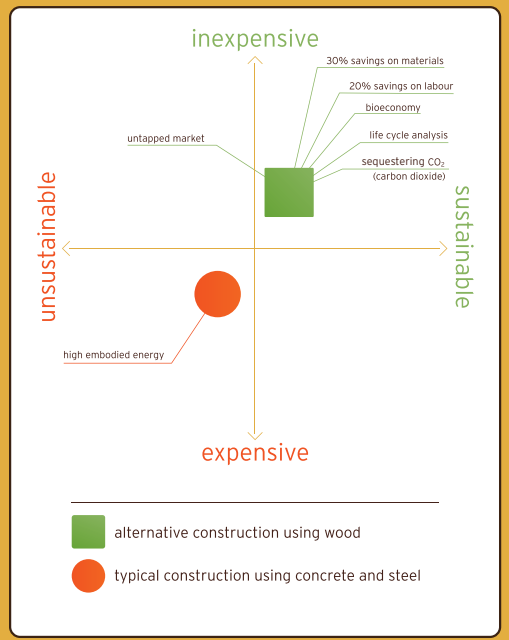
think...ease

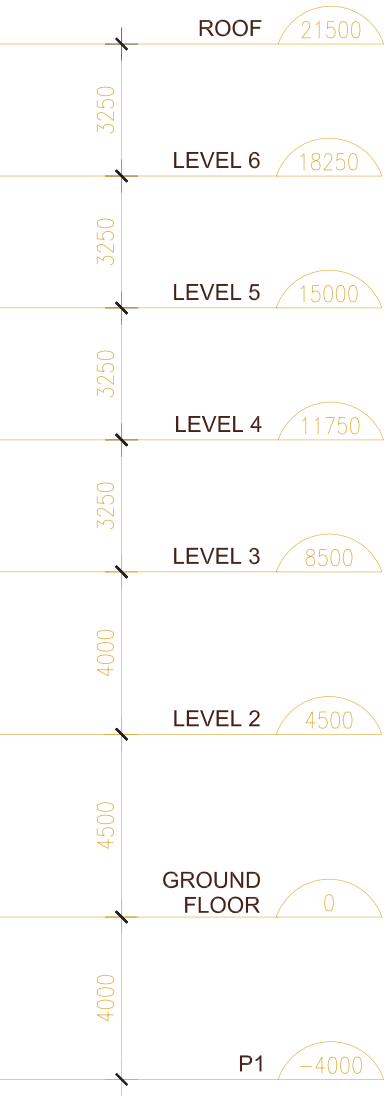


think...quality



think...cost

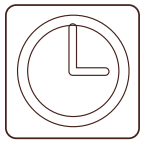




Summary

This report contains some of the research findings from the *Wood Solutions in mid-rise construction* study. It highlights some of the opportunities, challenges, considerations and implications that would be associated with expanded wood use in the mid-rise market sector in Ontario. The work, included analysis of current markets, and the technical and practical aspects of introducing a Light Wood Frame (LWF) structural option to mid-rise buildings. Findings were compiled from in-depth interviews with over 40 experts and stakeholders.

The Walker Consulting Group compiled the report and carried out the research for this project on behalf of Wood WORKS! Special thanks must be given to RHC Design-Build and Brookfield Homes, both involved in Ontario's design-build sector. BTY cost consultants in B.C. provided additional invaluable cost comparison information.
Graphic design, cover and conceptual sketches were produced by Quadrangle Architects Limited.



speed

Savings in construction time using wood can be invaluable, particularly when considering the growing potential for building in Ontario and the reality of a winter climate that restricts the length of the building season in some parts of the province.

Background

Some reasons to think differently about wood-framed buildings:

Full Scale Testing

• In 2000 in the United Kingdom, a major research project, headed by British Research Establishment (BRE)“TF 2000” began. Its necessity had come about because of developments in multi-storey wood-frame use by the building industry. It was a collaborative project, bringing government, industry and the research sector together. The project involved the construction and full-scale testing of a 6-storey prototype light wood-framed building .
A primary function of the research was to develop confidence in wood-frame by demonstrating the safety, benefits and performance of light wood-frame and compare performance to expectations of the Building Code.

Research testing and objectives focussed on the following areas:

• engineering design and specification
• differential movement
• structural stability (racking stiffness)
• disproportionate collapse
• fire (compartmentation and stairs)
• acoustics (floors and walls)

Findings from the project have led to the following:

• Harmonization of the U.K. Building Code, adopting objective based standards.

• A best practice guide for mid-rise light wood-frame construction.

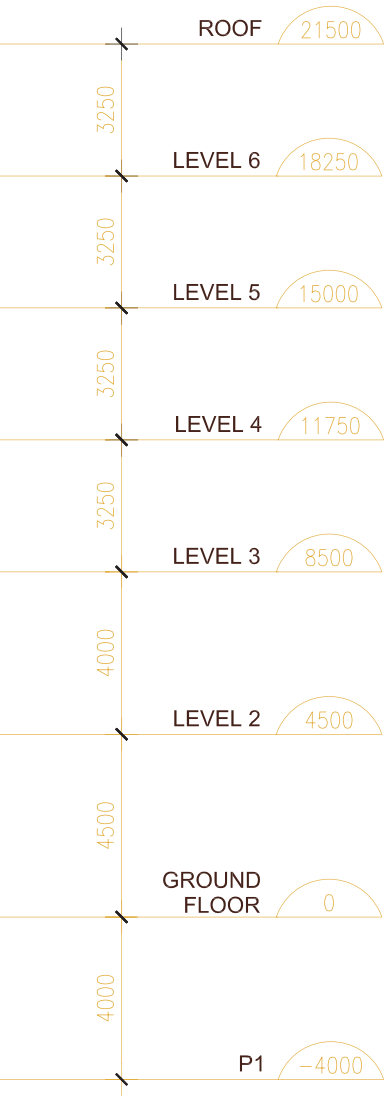
• Invaluable research data on how a 6 storey wood-frame structure behaves.

Seismic Performance

• Earthquake events in Japan, China and Italy have caused massive loss of life and damaged hundreds of thousands of buildings. Wood structures have displayed a high level of seismic performance and safety that comes from a material with greater ductility and a lighter building mass than other building materials. Many jurisdictions have started to investigate further how they view and use wood systems to improve safety in their codes and standards.

• In 2009, experts collaborated to conduct the world's largest shake-table test in Japan.

A 7-storey light wood-frame building, comprising 23 units, was constructed using light wood-frame wall systems, engineered wood products, wood components and connection systems that are typically manufactured and used in North American construction.
From the research conclusions made following successful completion of the 7.5 magnitude earthquake testing, the building had performed beyond expectations. The case for allowing more performance-based design for light wood-frame systems to utilize their potential continues to be made.



The Ontario Context

What is the market opportunity for higher wood structures in mid-rise construction in Ontario?

• By 2036, the population of Ontario is projected to rise by more than 36%. [36] The Greater Golden Horseshoe region, encompassing the Greater Toronto area, projects an increase from 3.1 million to 11.5 million people. [37]

• Ontario's construction industry represents between 38% and 42% of all non-residential building permits value in Canada.[38] In 2008, Statistics Canada reported that total value in Canada to be $28.7 Billion. With almost 39% of the national total, Ontario issued over $11 Billion.

• More higher-density, multi-family residential buildings are being built each year in Ontario; projections suggest demand will continue to increase significantly over the next 20 years.

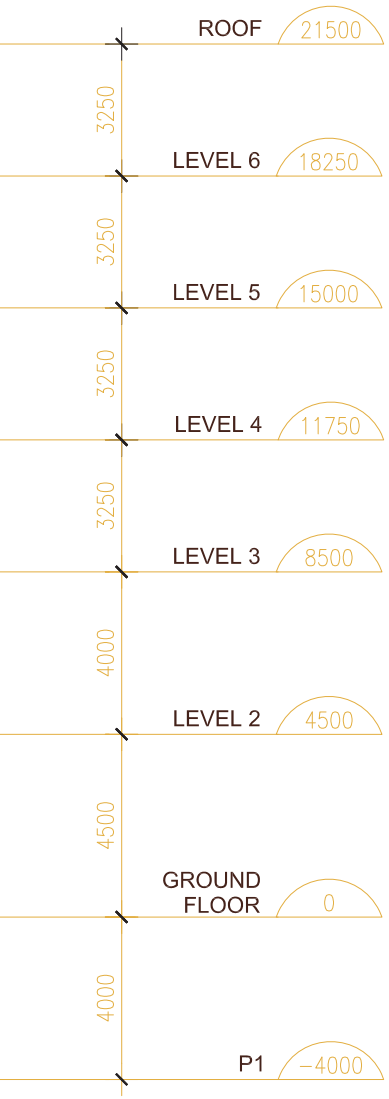
• In 2007-2008multi-storey residential unit starts rose from 21.5% to 39.1% of the total market.[39] Housing experts in Ontario see this as a shift in the typology of housing requirements in large urban centres across Ontario. Adoption of higher densification policy by municipalities will dictate what types of buildings developers must build. Higher density, multi-family mid-rise buildings will satisfy a need for density.

36 Ontario Department of Finance, Ontario Population Projections Update, 2009.
37 Government of Ontario, Growth Plan for the Greater Golden Horseshoe, 2006.
38 Reed Construction Data, CanData Annual Construction Forecast 2010-2012
39 Reed Construction Data, CanData Annual Construction Forecast 2010-2012.

• A legislative and policy mandate in Ontario aims to reduce urban sprawl. The Greater Golden Horseshoe growth plan and the accompanying legislation, the Places to Grow Act, set severe limitations on continued suburban expansion into lands currently utilized as agricultural or greenbelt in Southern Ontario. By 2015, at least 40% of all residential development in the greater Golden Horseshoe region must be built on land already utilized for residential or commercial use.

• Densification is mandated into almost all municipal growth plans in the Province.[40]

• In Toronto, led by the mayor and the city's urban planning department, "Urbanizing the Avenues" has been a major component of Toronto's plan to manage growth while maintaining the community orientation of greater Toronto's main residential avenues.[42] The concept behind this process is to retain a sense of



community in urban spaces while accommodating greater density – specifically, fewer 1-storey structures and strip malls, as well as a minimum of high-rise structures in these designated areas.

Key components of structures to be built under this plan include:

- Mixed-use, with transparent, animated ground floor uses
- Common Setback/Build-to Line
- 1:1 Street to Height Ratio
- Buildings that Frame the Street (access to sunlight)
- Generous Tree-lined Sidewalks
- Great Public Transit

• In large urban centres across the Province municipalities haveadopted growth plans that pursue revitalization of downtown core areas. Central to these efforts is a need for mixed-use buildings, close to accessible local transit systems that can accommodate for retail, commercial and residential needs.
In many cases, a further requirement is for affordable senior and social housing.

• Green growth is at the centre of Northern Ontario's plans for the future.
The growth plan for the Northern Ontario region places a premium on ensuring sustainable growth.[41] Contained in the plan are specific goals for the forest sector, placing emphasis on growth through development of value-added products, new markets for wood in construction, promoting the bio-economy and advancing research and related science.

40 Town of Markham Growth Management Strategy, Town of Whitby Intensification Strategy, Kitchener Growth Management Plan, Town of Pickering Growth Plan.
41 See Backgrounder: Northern Ontario Green Growth Plan, October 2009
42 Presentation by Robert Freedman, Director of Urban Design, City of Toronto, to the Canadian Urban Institute, 2005

Market Size

The current size of the mid-rise market in Ontario (5-6 storey structures) represents about 3% of total multi-storey structures currently built in Ontario (see table). This represents approximately $100 million dollars per year.

Market experts estimate that this sector could represent 10% or more of the Ontario market over the next 10 years, and would be significantly higher if Light Wood Frame (LWF) was introduced and given an opportunity to compete.

A report compiled for the Ontario Government, projected growth in the mid-rise sector to reach 8-10% of the total market over the next 20 years.[44]
Amongst reasons cited, growth may occur because

Non-Residential and Residential Mid-Rise Starts - Ontario

Ontario	2008	2009	2010
Non-Residential:	Total Starts:1955	Total Starts: 1814	Total Starts: 1521
Storey 1-4	603/1955 = 30.84 %	636/1814 = 35.06 %	533/1521 = 35.04 %
Storey 5-6	21/1955 = 1.07 %	27/1814 = 1.49 %	23/1521 = 1.51 %
Residential:	Total Starts: 378	Total Starts: 402	Total Starts: 459
Storey 1-4	104/378 = 27.51 %	158/402 = 39.30 %	245/459 = 53.38 %
Storey 5-6	16/378 = 4.23 %	22/402 = 5.47 %	16/459 = 3.49 %

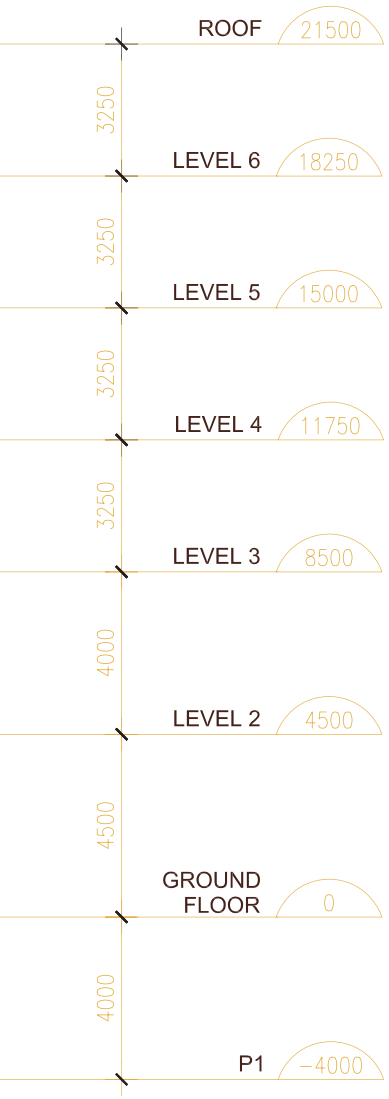
many projects that might have previously been designated to be low- or high-rise will now be deemed more appropriate for a mid-rise solution.
Many interviews with developers and urban planning experts stressed that 6-storey mid-rise will essentially become a new market opportunity.

Reasons cited include:

- Intensification of projects – municipal planning considerations
- Land availability and cost
- Development fees
- Green building and sustainable development requirements
- Costs considerations and project feasiblity. Currently costs for building with concrete or steel are less economically viable in a 5-6 storey context, thereby creating a new opportunity for the use of light wood framing. [45]

44 Peter Gabor Architects, Wood Use Impact Study, 2010.

45 Interview with John Giancola, Brookfield Homes



Market Projections

Projections of the potential size of the mid-rise market in Ontario are difficult.

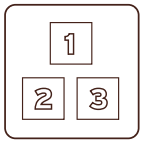
Should an opportunity arise for LWF and wood hybrid construction to be permitted to be considered for buildings higher than the current 4 storeys that the OBC allows, the economics of building in this market segment will change.

One market that may provide insight is British Columbia. The building code in BC was amended in April 2009 allowing Group C, up to 6 storeys, sprinklered buildings to be constructed out of LWF.

The data available from B.C. suggests a significant increase in the number of mid-rise (5 or 6) storey residential projects currently under construction, projected to be 19 in total for 2010, up from 7 in 2009.[46] Of those 19 projects, two-thirds or more are utilizing a LWF or wood hybrid solution.

Introducing an LWF option has made building mid-rise structures considerably more cost-effective.

46 Reed Construction Data, 2010.



ease

The capability, speed and quality of building crews is critical to the success (and profitability) of building projects. With wood systems (particularly panel systems and CLT), the learning curve for crews is much shorter than it is with steel and concrete systems and, once experienced with wood, crews can erect these structures very quickly with a high degree of precision.

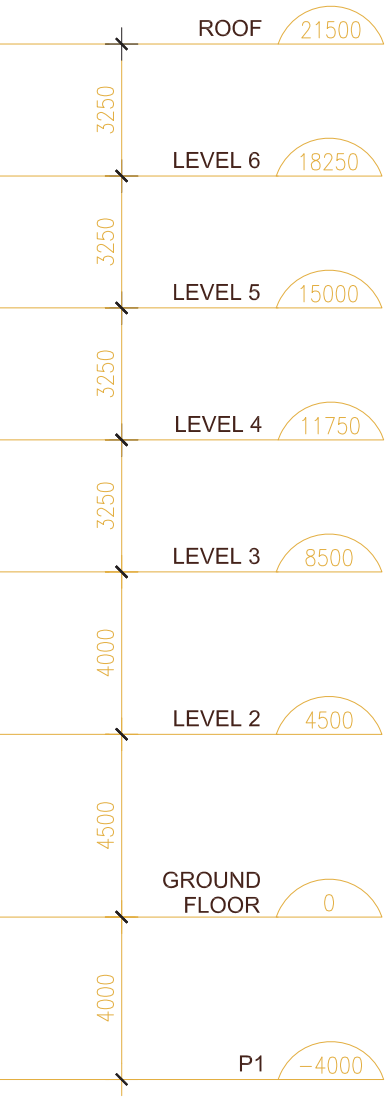
Do Ontario's designers, builders and developers want this opportunity created for wood in mid-rise?

More than 20 Ontario-based architects, engineers and developers were interviewed as part of this study and, with a handful of caveats, there was a clear consensus that light wood-frame structures in mid-rise construction are strongly advocated.
Support for the concept is predicated on a number of factors:

- The economics of building with structural wood systems. Evidence from within the building sector has long suggested that using LWF systems would, in most cases, cost developers less to construct mid-rise buildings up to 6-storeys in height, than constructing an equivalent building with concrete or steel, each achieving the same or higher level of structural integrity.[47]

47 Experts suggest that there will always be differences in cost depending on the location, the site characteristics and the parameters of the structure, but estimates consistently suggest that the cost difference is between 5-15% for LWF versus cast-in-place concrete or cold formed steel.

think...commercial



Economics in Focus: Cost Comparison

- RHC Design/Build ran costing analysis using 2 recent projects of similar character (one steel and one LWF) as reference points.
- The results showed a significant differential in terms of cost for the two structures, in both 4-storey and 6-storey contexts.
- The cost gap, assuming all considerations for increased structural enhancements as well as sprinkler systems and fire separation, was between 12-15%
  - The cost gap for a concrete structure vs. LWF was estimated to be similar.
- In addition, the wood structure would be erected about 70% of the time, so carrying costs on the project (about $5 million) are more beneficial in a LWF scenario.

	Cost per square foot: Light WoodFrame	Cost per square foot: Cold Formed Steel
4-Storey	$79/sq. foot	$99/sq. foot
6-Storey	$82-85/ sq. foot	$95-97/sq. foot

Estimates of cost efficiencies for the LWF option were between $20-$30 per square foot, assuming a $175-$200 per square foot cost of a mid-rise structure constructed from other materials.

According to developers, architects and engineers, the top aspects of mid-rise light wood-frame structures that reduce construction costs:

- Lower labour and material cost
- Reduced construction time
- Improved quality through off-site prefabrication
- Improved productivity levels
- Lighter construction (eliminates preloading requirements in some cases)
- Ease of running services
- Wider range of labour available
- Locally available resources

Few design and development teams have thoroughly costed mid-rise projects for multiple structural systems as current OBC Code provisions discount the use of LWF in structures higher than 4 storeys. [48]

48 Developers and architects/engineers typically agree on a building design and a construction type/material before costing occurs. Design specifications are then passed to the cost consultant who prices the development.

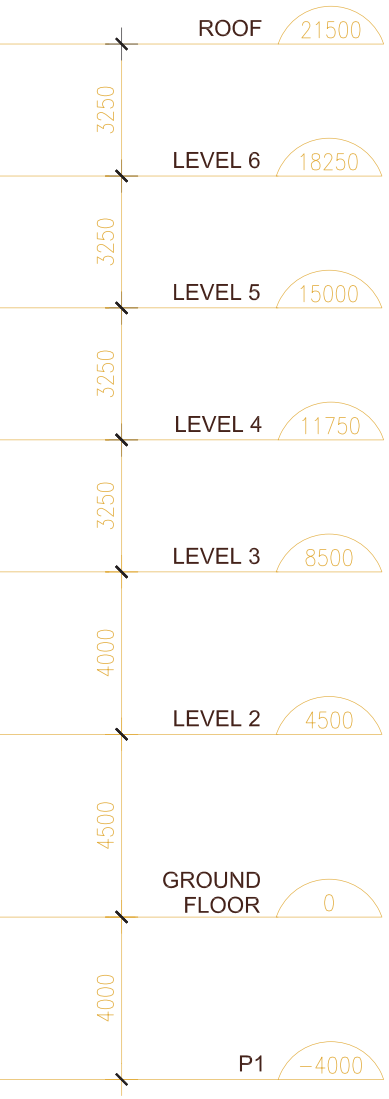
• **Opportunities for innovative design.**
Designers suggest wood presents opportunities for architectural and design creativity. A more cost effective designed LWF solution allows for many more architectural/design elements to be added.

• **More opportunities to build green.**
From interviews conducted, wood was universally recognized by stakeholders as being a green product. The definition of “green” was typically not confined to the definitions outlined by LEED or other building rating systems, where wood often is not recognised as a green product.[50] For most, the definition of “green” encompassed concepts like embodied energy, life-cycle assessment, energy efficiency in the home[51], and by reducing on-site waste.

• **More opportunities to build mixed-use buildings - retail, commercial and residential.**
In the U.S., many mid-rise developments feature wood-framed, mixed-use, mid-rise buildings that are built using hybrid solutions, a concrete podium or pedestal with LWF above.
This method of construction is seen to be very efficient from a land use and cost perspective. Ontario has a significant demand for this type of building, utilizing land more effectively and satisfying planning demands.

• **More opportunities to build affordable publicly funded housing projects.**
Experts in other jurisdictions, pointed to the fact that one of the categories where light wood-frame systems have become a preferred building approach is in publicly funded social housing. City and municipal governments are faced with pressure of increased demand and shrinking budgets. Wood systems are seen as a method to satisfy demand more quickly and for a lower cost per square foot.

• **More opportunities to shorten build time, extending the building season.**
The use of LWF often enables builders to shorten build time, maximizing potential profits from a faster turnaround of their initial investment. These savings can be significant to a developer, as carrying costs for investments for any additional build time can be difficult to manage. In addition, because LWF structures can often be built during winter months using faster, more efficient, panelized methods, this minimizes downtime due to inclement weather.



• Opportunities to learn from other jurisdictions

The level of experience and knowledge that can be transferred for designing 6-storey wood-frame buildings, utilizing the most modern approaches dealing with seismic and fire issues, acoustical and material performance, gives a high degree of confidence that a best practise guide could be quickly developed.

Concerns that were raised were with LWF structures that were on-site stick frame, not a factory built system, and the ability of inexperienced crews to work with LWF, thereby not being able to ensure thath precision, safety and structural integrity is maintained. Value was attached to educational programs and demonstration projects.

50 Lighthouse Consulting, Building Rating Systems and Wood: Responding to Climate Change, 2010.

51 Wood-framed houses have a low-energy usage when compared to concrete-built structures. Wood is easy to insulate to high standards, whereas concrete and steel construction must overcome challenges related to thermal bridging and moisture

quality

There are no significant engineering/ structural reasons that make wood systems less viable than those of other materials. Indeed, many engineers and architects say that modern wood systems are more structurally sound than systems made from concrete or steel.

condensation on cold surfaces. Light metal framing reduces thermal resistance by nearly 50%, which results in increased energy use. Because wood-framed construction is easily adaptable to any energy code, wood-framed buildings help lower energy bills. (Canadian Wood Council, 2002)

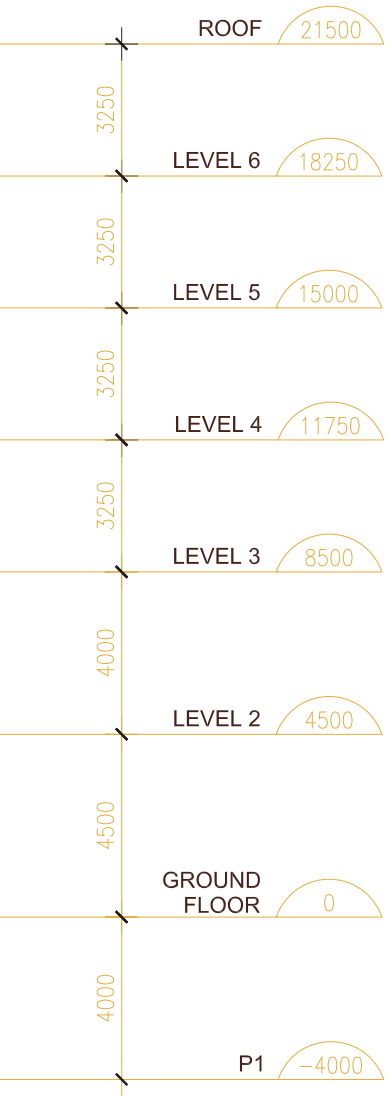
Considerations for Ontario

Experts interviewed from the United States, Europe, British Columbia and Ontario, involved with various mid-rise initiatives, offered a number of suggestions that should be considered if an opportunity for expanded light frame wood use is created:

1. A best practices guide for structural engineers involved in designing wood systems.

6-storey wood structures are fundamentally different from a structural perspective than 3- or 4-storey wood structures. The Association of Professional Engineers and Geoscientists of BC – APEGBC developed a technical and best practice bulletin, released subsequent to the code changes in BC 2009. It has been an invaluable resource used by those involved in the entire building process.[53]

think...residential



53 See Structural, Fire Protection and Building Envelope Professional Engineering Services for 5 and 6 Storey Wood Frame Residential Building Projects (Mid-Rise Buildings),APEGBC, April 2009

A preference is shown for factory produced structural wood systems, ensuring that the moisture content in materials can be carefully controlled, and greater consistency in assembled wood components through quality control methods can be achieved.

2. Fire Prevention Systems and Modeling for 6-storey wood structures.

Sprinkler systems should be mandated for all structures and rules be introduced for fire separation within mid-rise structures, following British Columbia's lead.

Better utilization and use of NRC's FIRECAM (Fire Risk Evaluation and Cost Assessment Model) 54 was also seen as an important future consideration for Ontario.

In British Columbia, collaboration between developers, fire officials and Wood Works has allowed for the transfer of knowledge and information.

3. Construction Fire Prevention provisions.

A series of provisions should be developed to mitigate the risk of fire in pre-completed wood structures. LWF structures are generally more vulnerable during the construction phase, as wall and floor fire assembly ratings are based on a completed assembly.

Some suggested provisions:

- Developing and maintaining a fire safety plan
- On-site security guard during construction phase
- Activating sprinkler systems sooner in the construction progress
- Requiring builders to install shear walls or other stabilizing systems to help ensure that main structural components are not compromised in the event of an accident
- Requiring builders to temporarily compartmentalize buildings during construction to reduce open, fire-prone spaces
- Requiring builders to meet frequently with fire officials to ensure compliance with preventive rules and procedures.

4. Sound transmission considerations.

Acoustical performance and sound transmission is an important non-structural design consideration that must be considered in multi-storey wall and floor construction. A systems approach when designing with wood components is required to better understand STC ratings of assemblies.

Lightweight gypsum concrete and other types of floor toppings can be an effective way of reducing sound transmission in multi-storey struc-

tures. Use of resilient channels and insulation reduce sound travel even more. Objective-based standards would help establish a level of performance standards in sound transmission.[55]

5. Measures to mitigate moisture risks.

Two key discussion papers [56] that were prepared for the BC Building & Safety Policy Branch when it was considering code amendment found that constructing taller wood buildings will extend the exposure of the structural wood components to moisture and its effects during the construction phase.

Designers will have to consider these effects when designing and specifying components and systems. A good understanding of material behaviour will significantly minimize the effects of moisture on the building when constructed.

6. Pre-fabricated or panelized systems.

Throughout the interview process, engineers and fire code experts seemed to prefer to design and work with an off-site, factory manufactured panelized system. LWF wall and floor panels, and new innovative Cross Laminated Timber (CLT)[57] systems have been shown to substantially reduce construction time while maintaining a high level of precision and quality. Although comfortable with on-site framed wood systems, experts felt that the margin for error can be greatly reduced with a pre-manufactured option.

An introduction of a 6-storey opportunity could provide an incentive to invest further in this growing value-added sector in Ontario.

7. Demonstration Projects.

There was seen to be value placed on 6-storey demonstration projects.

There was particular interest in such buildings being erected to help educate stakeholders about some of the key differences in designing and erecting a higher wood building.

Ideally, involvement at municipal, provincial and federal government levels would ensure knowledge transfer.

8. The future. New products and design techniques.

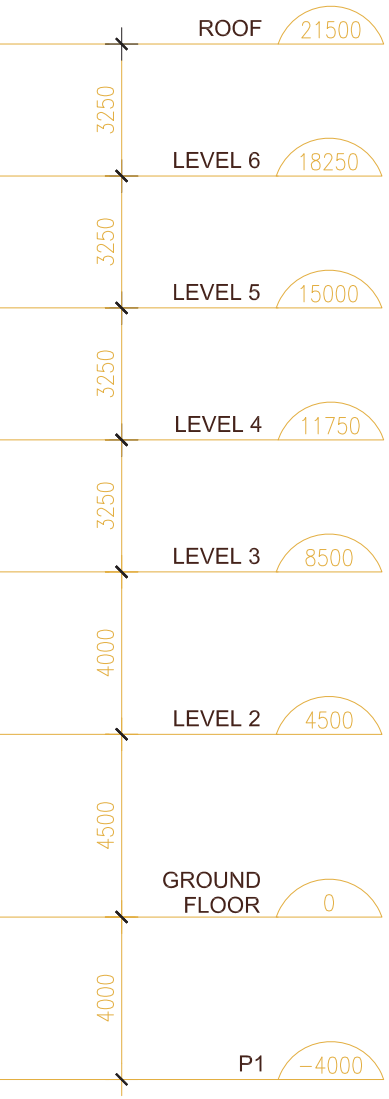
New wood technologys and materials have been developed outside of Canada and their performance has led to innovation in the way we could build in the future.

Current design parameters will be exceeded causing us to rethink how we think about wood.

CLT has become widely accepted in Europe for wood buildings up to 9-storeys in height.

An approach to designing with new materials and innovative systems may be to establish objective, performance-based standards for buildings and by empowering design teams to meet code objectives.

56 Senez Calder Reed, Engineering Review of B.C. Code Change, 2009



57 CLT is a wood product that creates large engineered wood panels manufactured by cross-laminating lumber with adhesive under pressure. Developed in Europe and recently entering UK and Japanese markets, CLT is gaining market share.

Ontario's Wood Industry & Scope

Ontario's forestry sector is a key component of Ontario's economy and is the second largest industrial sector in the Province. The forest products industry currently supports almost 200,000 direct and indirect jobs in over 260 Ontario communities. Of these communities, 40 are categorized as highly dependent on forestry to survive. An additional 63 are identified as being moderately dependent.[58]

Wood is the preferred material for low- and medium-density residential housing construction throughout Canada. The Canadian Wood Council estimates that 95% of low-density housing and 85% of medium-density housing, including townhouse and multi-storey development in North America, are of wood-frame construction.

For non-residential buildings, an estimated 19% of industrial, commercial and institutional buildings are constructed of wood.[59]

58 ONWW, Strategic Plan 2012

59 ONWW, Strategic Plan 2012

Wood use in Residential Construction

As the table below shows, the number of residential building permits issued in Ontario in recent years has averaged roughly 75,000 units a year, with low-density, singles and semi-detached units comprising almost 60% of units; medium-density, row/townhomes comprising 16%; and high-density apartments 25%.

The percentage share of low-density housing

Residential Building Permits in Ontario 2003-2009

Residential Building Permits - Ontario								
	2003	2004	2005	2006	2007	2008	2009	Average 2003-09
Total Residential (not inc. conversions)	**86,664**	**87,862**	**82,736**	**70,955**	**72,020**	**68,878**	**56,020**	**75,019**
Singles/Semis (inc. mobile homes)	57,124	56,807	46,626	42,396	43,466	34,450	28,372	**44,177**
Row/Townhomes	12,491	13,340	13,573	11,356	11,525	11,727	8,202	**11,745**
Apartment	17,049	17,715	22,537	17,203	17,029	22,701	19,446	**19,097**
Percentage Split of Residential Building Permits - Ontario								
Total Residential (not inc. conversions)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Singles/Semis (inc. mobile homes)	66%	65%	56%	60%	60%	50%	51%	**59%**
Row/Townhomes	14%	15%	16%	16%	16%	17%	15%	**16%**
Apartment	20%	20%	27%	24%	24%	33%	35%	**25%**

Source: Statistics Canada

has been decreasing, dropping from 66% of all building permits in 2003 to 51% in 2009, with the percentage of apartments increasing from 20% to 35% over the same period.

There could be a variety of causes for this market shift in Ontario, including;

- a declining supply of low-density development land
- affordability of larger unit types
- economic constraints
- aging population
- acceptance of higher density living
- changes in work habits

This is particularly true in the Greater Toronto Area (GTA), which accounts for 50% of all building permits in Ontario and the majority of apartment construction.

Wood use in Non-Residential Construction

The use of wood for non-residential construction in Canada and the United States is not widely accepted. With a greater product selection, structural performance, quality assurance and availability, wood is gaining acceptance as a suitable material for non-residential construction requirements.

Non-residential buildings are generally classified into three categories:

- Industrial
- Commercial
- Government-Institutional

In the table (page 19), about 45% of annual non-residential building activity in Ontario is commercial, 31% is government-institutional and 23% industrial. While industrial development has decreased in recent years, commercial and government-institutional building activity has remained relatively constant.

Value of Non-Residential Building Permits in Ontario 2003-2009

Value of Non-Residential Building Permits - Ontario ($ 000's)								
	2003	2004	2005	2006	2007	2008	2009	Average 2000-09
Total Non-Residential	**$ 8,807,600**	**$ 8,548,862**	**$ 9,058,713**	**$ 8,854,213**	**$ 10,933,213**	**$ 10,764,925**	**$ 9,347,720**	**$ 9,473,607**
Industrial	$ 2,148,147	$ 2,103,487	$ 2,094,510	$ 2,210,968	$ 2,807,874	$ 2,285,699	$ 1,678,025	**$ 2,189,816**
Factories and Plants	*$ 1,147,341*	*$ 1,011,160*	*$ 847,085*	*$ 1,149,018*	*$ 1,413,583*	*$ 823,116*	*$ 785,658*	*$ 1,025,280*
Commercial Warehouses	*$ 348,005*	*$ 510,991*	*$ 691,069*	*$ 511,045*	*$ 544,452*	*$ 657,954*	*$ 362,259*	*$ 517,968*
Commercial	$ 3,498,237	$ 3,804,742	$ 3,965,617	$ 4,303,933	$ 4,988,213	$ 5,102,520	$ 4,541,951	**$ 4,315,030**
Trade & Services	*$ 1,284,259*	*$ 1,193,453*	*$ 1,169,696*	*$ 1,486,100*	*$ 1,438,149*	*$ 1,638,813*	*$ 1,031,038*	*$ 1,320,215*
Office	*$ 899,650*	*$ 1,031,376*	*$ 1,177,193*	*$ 1,283,244*	*$ 1,851,699*	*$ 1,785,975*	*$ 1,683,735*	*$ 1,387,553*
Hotels & Restaurants	*$ 377,890*	*$ 333,741*	*$ 463,817*	*$ 368,845*	*$ 475,742*	*$ 609,689*	*$ 535,883*	*$ 452,230*
Government-Institutional	$ 3,161,216	$ 2,640,633	$ 2,998,586	$ 2,339,312	$ 3,137,126	$ 3,376,706	$ 3,127,744	**$ 2,968,760**
Schools-Education	*$ 1,409,639*	*$ 1,323,488*	*$ 1,508,009*	*$ 1,052,096*	*$ 1,294,583*	*$ 1,459,349*	*$ 1,621,102*	*$ 1,381,181*
Hospitals-Medical	*$ 614,899*	*$ 516,476*	*$ 764,869*	*$ 382,782*	*$ 1,072,220*	*$ 1,149,187*	*$ 763,652*	*$ 752,012*
Welfare -Home	*$ 623,795*	*$ 433,695*	*$ 189,420*	*$ 252,941*	*$ 261,606*	*$ 297,339*	*$ 193,055*	*$ 321,693*
Government Buildings	*$ 290,734*	*$ 149,974*	*$ 194,862*	*$ 367,634*	*$ 216,406*	*$ 231,737*	*$ 269,130*	*$ 245,782*
Percentage Split of Residential and Non-Residential Building Permit Values - Ontario								
Total Non-Residential	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Industrial	24%	25%	23%	25%	26%	21%	18%	**23%**
Commercial	40%	45%	44%	49%	46%	47%	49%	**46%**
Government-Institutional	36%	31%	33%	26%	29%	31%	33%	**32%**

Source: Statistics Canada

Note: Commercial Warehouses are classified by Statistics Canada as "Commercial", however for purposes of this study, they are considered industrial. Furthmore, minor industrial repair value has been removed from industrial category

cost

Concrete and steel, currently the only structural materials that are approved and allowed for mid-rise construction in Ontario, are more expensive than wood systems for mid-rise structures. Using wood might make some 5- and 6-storey projects, that were not previously viable, economically feasible.

APPENDIX A: Case Studies: LWF in Mid-Rise Construction

Remy Apartments, Vancouver, B.C.

The Remy, located in Richmond, B.C., provides 188 apartments and a daycare in 3 buildings. These buildings were the first 6-storey wood-frame residential developments permitted under new code provisions in B.C. They feature energy-efficient geothermal heating and cooling, co-op cars and green roofing as a part of the development's eco-friendly design.

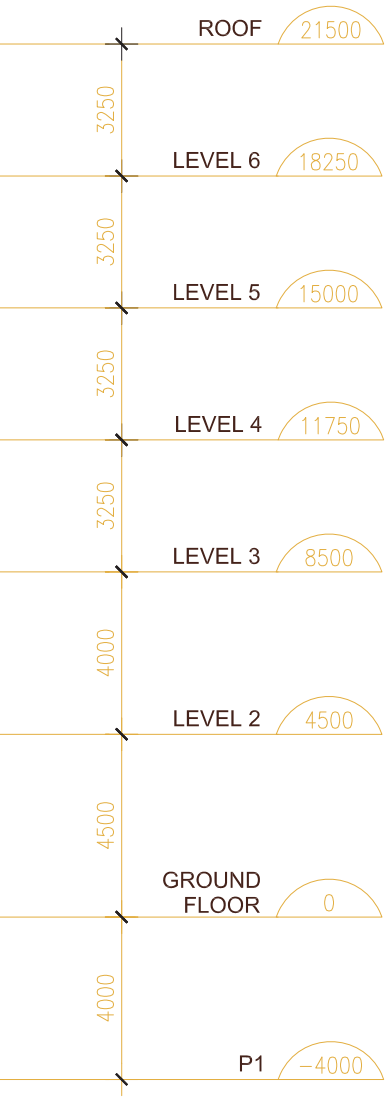
The project occupies 2.2 acres, with two levels of parking (one below grade and one above) built of concrete.
The Remy site includes:

- 33 Seniors' Rental Housing (SRH) apartments for low-income seniors and people with disabilities
- 48 affordable apartments for low- to moderate-income families and singles
- 37 affordable homeownership units for sale to qualified buyers
- 70 private market apartments
- 50-60 space children's daycare

The light wood-frame building rises over the second level of the parkade at the back end. The project includes 6 storeys of LWF in the front and 5 at the rear of the building. To mitigate fire risks, the wall assembly utilized 2 layers of gyproc Type C drywall (a fire retardant board), the second layer overlapping seams on the first.

According to the project's developer, the building was able to be built at a lower cost than a comparable steel or concrete structure. "We had originally designed a 6-storey concrete and steel structure," said the developer, adding that the 2008 economic downturn shelved it. "But when we built it with wood, we saved 12 per cent (on construction costs)…that's not pocket change," he said, adding that he saved about $4.8 million.

Conceptual Sketch: Remy Apartments | Courtesy Patrick Cotter Architects



Denny Park Apartments, Seattle, Washington

Denny Park Apartments is a 55,000 square foot, 6-storey, mixed-use building in Seattle's South Lake Union neighborhood, built in 1999. The goal of Denny Park is to meet a growing need for affordable housing in downtown Seattle and promote economic sustainability and livable neighbourhoods.

50 dwelling units situated above street-level commercial space serve households at 30%, 50% and 60% of the median income, including 8 transitional housing units for homeless families with children. There is a mix of studios, 1, 2 and 3 bedroom units, and a common room with kitchenette adjacent to a courtyard.

The main goal that this project sought to achieve was to maximize residential density and minimize building area provided for parking. Pedestrian-friendliness was prioritized, with glass canopies and sidewalk planters enhancing outdoor areas. The planters also contain structural soil allowing groundwater to recharge. Bicycle racks encourage bicycle use. Parking was minimized to encourage alternative transportation, made feasible by the proximity to mass transit.

Denny Park Apartments is an example of affordable and sustainably designed housing. Denny Park Apartments participated in the Seattle Built Green program (3-star) and Built Smart, administered by the City of Seattle's electric utility, Seattle City Light. The project satisfies 159 items on the Seattle BuiltGreen Certification Checklist for sustainable design. The building uses interesting forms and colours to redefine the image of low-income housing. The design recalls the industrial history of the neighbourhood.

Photo: Denny Park Apartments, (Runberg Architecture Group)

Why Build with Wood?

1 | **Wood has an excellent strength-to-weight ratio.** It is strong, lightweight and flexible, and there are many examples of using wood to achieve long spans (2010 Richmond Olympic Oval) and tall structures (AGO).

2 | **Wood offers one of the safest building systems in an earthquake.** Wood structures are lighter than other building systems – less mass is an advantage because it means lower forces are exerted on the building; wood shear walls are ductile due to the nailing, therefore withstanding the motion generated by seismic events.

3 | **Availability of skilled tradespeople.** Wood-frame construction is well-known to designers, trades and builders – there is a long tradition of creating strong and durable wood buildings.

4 | **Wood is durable.** There are many buildings that have been built with wood that are hundreds of years old. Proper drainage detailing to prevent moisture accumulation along with appropriate finishes to prevent decay or increase pest resistance will help ensure a building that will stand the test of time. When considering fire performance, wood's charring characteristics slow the spread of fire in larger members.

5 | **Wood is cost-effective.** Wood is widely accepted as the most economical option for building single-family homes using light frame wood construction, but it has also been shown to be more economical for larger non-residential buildings (example: Timmins Library).

6 | **Wood is easily sourced locally.** One of wood's great strengths as a building material in Canada is its abundance and ability to be sourced locally almost everywhere in North America.

7 | **Wood products are versatile.** There is a wide range of products and uses. Wood products can be strictly functional (eg. rough framing) or they can be scaled up in design and be exposed for their aesthetic value in institutional and commercial buildings (eg. exposed glulam structure in the AGO's Galleria Italia expansion).

8 | **Wood buildings are adaptable.** Wood buildings are more easily renovated, added on to, and adapted to changing uses over the lifespan of the building.

9 | **Wood is sustainable.**

- Wood is the only renewable major construction material
- Wood buildings are easier to insulate because wood is less conductive than steel and concrete
- Wood can be recycled and re-used
- Wood outperforms other major building materials with regards to Life-cycle assessment (LCA) – an approach for assessing impact materials have on the environment based on material extraction or harvesting, through manufacturing and processing, transportation, use on-site, maintenance, disposal and re-use.

Wood outperforms steel and concrete because it: requires less energy in production; produces fewer green house gas emissions; releases fewer pollutants into the air and water; and generates less solid waste.

10 | **Building with wood supports regional economies**. The forest industry is the second largest contributor to Ontario's economy. In many regions, forestry is the most important primary industry. Currently, the industry is facing tough challenges and must develop more value-added mills in Ontario. By choosing to build with wood, we are helping to increase demand that will create jobs in Ontario and contribute to innovation and investment in an industry that is important to the provincial economy.

WOODWORKS! Project of the Canadian Wood Council

Ontario Northern Ontario Heritage Fund / Fonds du patrimoine du Nord de l'Ontario

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Natural Resources Canada / Ressources naturelles Canada