Mid-rise Construction in British Columbia

A CASE STUDY BASED ON THE REMY PROJECT IN RICHMOND, BC

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TABLE OF CONTENTS

1. Introduction 3

2. Reviving an Old Idea / Historical Context 3

3. Advancing Light-frame Wood Construction in BC 4

4. Mid-rise Design and Construction in Detail 5
    a. Structural 6
        i. Shrinkage 6
        ii. Managing Increased Vertical Loads 7
        iii. Resisting Increased Lateral Loads 8
        iv. Seismic Performance Sidebar - Link to Shake Table Test 9
        v. Other Loading Issues 9
        vi. Architectural - Implications of Structural Issues 10
            1. Differential Movement 10
    b. Acoustic, Thermal and Fire Performance 11
        i. Acoustic Performance 11
        ii. Thermal Performance 14
        iii. Fire Performance 15
    c. Construction Site Methodology and Other Building Issues and Solutions 17

5. Sustainability and Affordability 19
    a. Sustainability 19
    b. Affordability 20

6. Future Options and Further Enhancements 21

7. Conclusion 23

THE REMY PROJECT

1. INTRODUCTION

Modern six-storey light-frame wood construction in British Columbia (BC) incorporates highly-detailed, researched and safe solutions. The engineering technology being adapted in the province is positioning BC at the forefront of the North American wood-frame construction industry. Mid-rise building solutions currently being developed and refined in BC will lead to more sustainable communities and affordable housing solutions that will positively change the face of North American cities.

The Remy project is the first development in BC to receive a building permit under the revised BC Building Code, allowing full six storey light-frame wood construction. The 2.2 acre site comprises mid- and low-rise residential structures and a community centre. (site plan on page 12)

REMY PROJECT - NORTHEAST ELEVATION

2. REVIVING AN OLD IDEA / HISTORICAL CONTEXT

With concrete and steel structures predominating in our urban centres for most of the 20th century, it is easy to forget that wood was once the material of choice for mid-rise construction. In the historic core of many Canadian and US cities, heavy timber post-and-beam office and warehouse buildings, some more than 100 years old, still stand in testimony to the durability and strength of wood.

These structures have proven relatively straight-forward to upgrade to meet the numerous changes to the fire and seismic provisions of the National Building Code of Canada (NBCC).

As the 21st century gathers momentum for environmental awareness and concerns about climate change escalate, wood is re-emerging as the material of choice for mid-rise construction for both residential and commercial buildings. The environmental benefits of wood as a construction material are well-documented and include the long-term storage of carbon dioxide sequestered by growing trees, the low embodied energy required to process wood, and the life cycle benefits that result from these properties. The scientific evidence was sufficiently conclusive by 2007 for the Nobel-Prize-winning Intergovernmental Panel on Climate Change to conclude that: “a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber fibre or energy from the forest, will generate the largest sustained mitigation benefit.”

In this new generation of wood buildings, diversity is the key, with different technologies proving successful according to the scale, type and location of specific building projects. Around the world, several methods of construction have been successfully employed - a modified post-and-beam technique based largely on engineered wood products for a six-storey commercial building in Québec City; a cross-laminated timber (CLT) construction for eight-storeys of a nine-storey apartment tower in London, England; and a modified light-frame system used for multi-family residential construction in the Pacific Northwest, including several under construction and almost 100 projects in the design/ development stage in BC.

Of these diverse buildings, perhaps the most surprising are those that have been realized in light-frame wood construction. Collectively these buildings have transformed our understanding of what is possible using only standard dimension lumber and the engineered wood products readily available from local retail lumber yards.

LIGHT-FRAME WOOD CONSTRUCTION

3. ADVANCING LIGHT-FRAME WOOD CONSTRUCTION IN BC

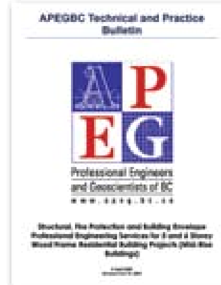
Light-frame wood construction has long been a mainstay of the North American forestry, construction and design industries for small commercial and residential buildings. Perhaps because of familiarity, many architects and engineers have tended to take the technology for granted, and may have overlooked its potential for larger-scale buildings.

This situation has been perpetuated in part by the National Building Code of Canada (NBCC), which has historically applied strict limitations on the size and height of combustible (light-frame wood) construction. However, ongoing research into the structural and life-safety performance of buildings of light-frame wood construction, together with advances in fire detection and suppression systems, have resulted in incremental changes to the NBCC over time. In 1990, the maximum allowable height for residential (Group C) buildings of wood-frame construction was increased from three to four storeys, and in 1995 this increase to a four-storey height limitation was extended to Group D and E occupancies, which include most office, retail and commercial services buildings.

More recently, in 2009, the Province of British Columbia amended its own provincial building code and further increased the permissible height of light-frame wood construction for residential buildings to six storeys – a change that is expected to be considered for adoption in some form nationally in the near future. This recent change brings the BC Building Code more closely in line with those of other international jurisdictions including the states of California, Washington and Oregon, which have permitted similar opportunities for developers for more than a decade.

Light-frame wood construction has always been known for its economy, versatility, and speed of erection, but not necessarily for its strength, accuracy and precision. While that perception may have been quite legitimate several decades ago, new materials, innovative engineering solutions and off-site prefabrication have substantially increased the quality and sophistication of light-frame wood construction. For the most part these changes have been unobtrusive, hidden neatly away within wall, floor and roof assemblies, but collectively their impact has been profound. (APEGBC Technical and Practice Bulletin)

As a result of these changes, light-frame wood construction is now considered a viable, affordable and environmentally-preferable alternative to concrete and steel.


APEGBC Technical and Practice Bulletin

Professional Engineers and Geoscientists of BC

ASSOCIATION OF PROFESSIONAL ENGINEERS AND GEOSCIENTISTS OF BRITISH COLUMBIA (APEGBC)

APEGBC TECHNICAL AND PRACTICE BULLETIN

Structural, Fire Protection and Building Envelope Professional Engineering Services for 5 and 6 Storey Wood-Frame Residential Building Projects (Mid-Rise Buildings) April 2009; Revised June 10, 2009

4. MID-RISE DESIGN AND CONSTRUCTION IN DETAIL

While the outward appearance of light-frame wood residential buildings may not have changed significantly over the years, the quality and precision of design and construction has certainly increased.

Several key aspects of design that become more critical in this new generation of mid-rise buildings include:

- Increased potential for cumulative **shrinkage and differential movement** between different types of materials, as a result of the increased building height
- **Increased, dead, live, wind and seismic loads** that are a consequence of building to a greater height
- **Increased fire-resistance ratings for fire separations** as required for buildings of greater height and area
- **Ratings for sound transmission** as required for buildings of multi-family residential occupancy, as well as other uses

The responses to these imperatives within more complex mid-rise buildings involves the adaptation of structural and architectural design details that address key building-related issues including the areas associated with acoustic, thermal and fire performance that have been commonly tackled by the industry for a number of years.

Additionally, construction site methodology needs to evolve and other building issues require effective solutions for light-frame, mid-rise buildings to be broadly accepted as a viable alternative to concrete and steel.


ORIENTED-STRAND-BOARD (OSB) SHEATHED SHEARWALL

a. Structural

i. Shrinkage

Multi-storey light-frame wood buildings are typically constructed using the platform-frame method, in which each floor is constructed as a platform on top of the single storey walls of the floor below.

This means that the physical height of the building results from the use of a combination of different wood elements, some of which have vertical wood grain (the wall studs), and others that have horizontal wood grain (the sill plates, top plates and floor joists). Solid-sawn lumber has more than 10 times as much shrinkage perpendicular to grain as parallel to it, so the overall amount of potential shrinkage in a platform-frame building increases significantly with each additional storey.

There are several approaches to minimize overall vertical shrinkage of a mid-rise building's structure:

- The use of engineered wood products (EWPs), such as wood I-joists or open-web floor trusses in place of dimension lumber joists
- The use of dimension lumber plates and floor joists which have been dried to 12 percent moisture content
- Using one-inch-thick plywood as single or double base or top plates

Vertical shrinkage, in some way, affects all building systems and effective mid-rise design and construction requires special attention to each of the following:

- internal or external balcony details
- elevator, stair or service shafts
- electrical, plumbing and heating systems
- fire stop/fire block details for enclosed cavities
- fire-resistance-rated assemblies
- composite material connection details
- cladding and building envelope specifications and details

ROBUST CONNECTION DETAILS AT KEY AREAS OF THE STRUCTURE

a. Structural

ii. Managing Increased Vertical Loads

In low-rise, light-frame wood buildings, the dead (self-weight) loads imposed by the weight of the construction materials are relatively small, and the evenly-spaced wall studs offer multiple paths for the roof, floor and wall vertical (dead, live and snow) loads to be carried down to the ground. Header beams and double or multiple studs are generally sufficient to transfer these loads around window and door openings and enough structural redundancy in the system exists to compensate for the occasional imprecision of stick-built construction.

The higher a building rises, the greater the vertical loads become and the greater attention that must be paid to load paths and to the efficiency of load transfers. Load transfer is more efficient when there is full contact between force transfer members.

One approach to assure that loads are handled more effectively in light-frame, mid-rise construction is to use Engineered Wood Products (EWPs) at key column and beam locations and at critical blocking details.

Another approach is assuring greater precision of all assemblies and location of key components within assemblies by utilizing integrated design and prefabrication technologies.

An extremely high degree of precision and quality control for all wall assemblies that is only possible through factory prefabrication is paramount for mid-rise construction to be successful in the long term. Prefabrication for typical floor assemblies can add additional accuracy to a mid-rise structure as well.

Factory prefabrication offers the advantage of:

- Computer Numerically Controlled (CNC) measuring and cutting that reduces the variability found in non-Precision End Trimmed (PET) building members
- A dry environment where moisture content variability of individual wood elements is reduced
- Tighter-fitting wall and floor sections – clamping and squaring on a framing jig before nailing assures greater accuracy and minimizes the effects of potential consolidation in top and bottom plate gaps which can occur when simply hand-framed
- Greater precision of nailing patterns
- A higher degree of supervision and quality control

STRUCTURAL COMPOSITE LUMBER (SCL) HEADERS AND BEAMS

iii. Resisting Increased Lateral Loads

Higher buildings are subject to increased lateral loads from both wind and seismic events; wind because of the increased surface area, and seismic because of the increased height. In low seismic regions of BC, it is the increased wind loads that will govern lateral design, whereas in coastal areas of the province, where seismic activity is more prevalent, it will be the seismic loads that dictate lateral design criteria. Similar to gravity loads, lateral loads cumulate from the top of building to the foundation. Therefore, shearwalls in lower storeys of mid-rise buildings must be stronger than shearwalls in structures four storeys or less.

In taller wood-frame buildings, lateral stability is enhanced by the use of continuous self-adjusting steel tie-rod systems that are coupled vertically at approximately 10-foot intervals and are typically located at each end of a shearwall.

The exact location of these systems is normally dictated by specific site conditions and determined by the consulting engineer and specific system supplier.

These tie-down systems are designed and calibrated to resist the uplift forces imposed by wind or seismic forces, ensuring that the building's components and assemblies are held tightly together. These systems can react to shrinkage as well.

A number of proprietary systems that are similar in principle but vary in detail are available in the market.

Overall horizontal and vertical shear load resistance is provided through the composite interaction of an effectively positioned tie-rod system, strategically located shearwalls and sheathed floor and roof assemblies acting as horizontal diaphragms.

In taller buildings, shearwalls and diaphragms are critical and must be carefully detailed and constructed to resist the larger lateral and uplift forces potentially impacting the structure.

Appropriately situated shearwalls, effectively positioned EWPs, the use of specialty connectors and tighter nailing patterns generally create the solutions required to offset the higher forces acting on a mid-rise building.

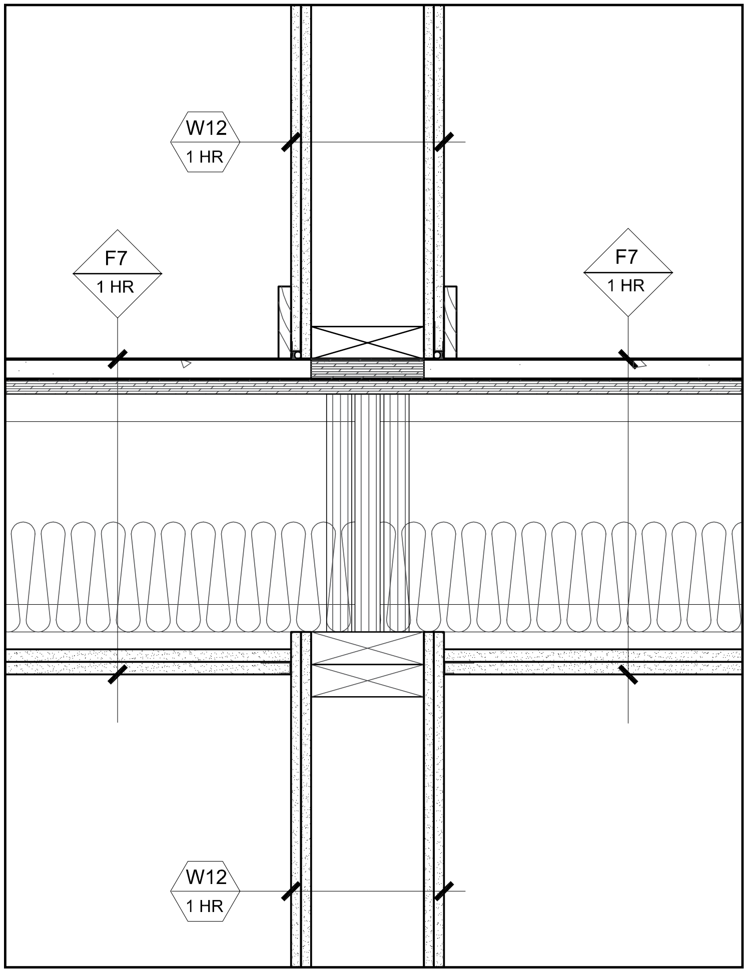
SELF-ADJUSTING TIE-ROD SYSTEM - SIMPSON STRONG-TIE® ANCHOR TIEDOWN SYSTEM (ATS)

SELF-ADJUSTING TIE-ROD SYSTEM; TYPICAL BRIDGE DETAIL – SLACKJACK® SHRINKAGE COMPENSATION DEVICE, EARTHBOUND CORP.

a. Structural

iv. Seismic Performance Sidebar

As part of the BC Building Code review process that considered the new six-storey provisions, earthquake engineering researchers examined the seismic performance of a full-size, six-storey wood building on the world's largest shake table at a facility in Miki City, Japan. The structure was built from BC forest products, with construction techniques commonly used in Canada.



PARTITION AT L5 FLOOR - LOAD-BEARING

The research project's simulated ground shaking was modelled on the Northridge earthquake, which caused major damage in the Los Angeles area in 1994. The strongest test simulated an earthquake expected to occur once every 2,500 years. The building was subjected to seismic forces for about 40 seconds, with the virtual energy exerted on the structure stronger than both the 1995 Kobe and 2001 Seattle earthquakes.

Before more than 400 international observers, the building performed extremely well, with no structural damage observed.

The test confirmed that seismic risk can be kept at a more than acceptable level for six-storey, light-frame wood buildings when they are detailed and constructed well.

Shake Table Test Link: **www.shaketabletest.ca**

v. Other Loading Issues

Another consequence of constructing larger buildings in wood is that building systems, such as air handling equipment, will also increase in size. When rooftop units are used, it is preferable to use a larger number of small units dispersed across the roof to distribute loads rather than to use a single large unit. This is likely to improve the overall energy performance of the system, as the building can then be zoned according to solar orientation and units sized for efficiency. This approach is also likely to minimize issues of noise and vibration associated with large mechanical units.

vi. Architectural - Implications of Structural Issues

1. Differential Movement

Prior to 2005, the NBCC required all firewalls to be constructed of masonry or concrete. Designers then often used the same concrete construction to create the fire separations surrounding stairwells and elevator shafts, even in low-rise buildings permitted to be of light-frame wood construction. However, concrete is a material that has very different thermal and moisture movement characteristics from those of wood.

Using wood-based systems in whole or in part in these applications has the benefit of minimizing the differential movement between the various elements of the building that might otherwise be evident at door thresholds or pose problems in the calibration of elevator stopping intervals.

At a cosmetic level, surface cracking of interior finishes can also be minimized through the use of dimensionally-stable Engineered Wood Products (EWPs).

(See the Fire Performance section on page 15 for additional discussion of firewalls.)

EXTENSIVE USE OF ENGINEERED WOOD PRODUCTS (EWPs)

ELEVATOR SHAFT SOLID WALL FRAMING

ELEVATOR SHAFT

SQUASH BLOCK FRAMING DETAILS

b. Acoustic, Thermal and Fire Performance

i. Acoustic Performance

Airborne and structure-borne noise transmissions have been identified as performance issues in light-frame wood construction in the past. Additional mass, greater stiffness, use of sound-absorbing insulation or resilient metal channels, and structural discontinuity between the source of the noise and the listener can all be employed as strategies to improve the quality of acoustic separation.

Horizontal noise transmission between adjacent units has traditionally been dealt with by increasing the thickness of gypsum board on either side of the partition, which may be constructed using either staggered studs (in which two sets of 2x4 studs are attached in a staggered pattern on a single 2x6 plate); or independent double stud walls that are built parallel to one another with a void between them. Recent testing has confirmed that the transmission of noise and vibration (flanking) can be further reduced by breaking the continuity of the subfloor and ceiling system at the acoustic separation. Additionally, blocking members can be added in the floor cavity to reduce joist vibration, and concrete topping is now universally used on all floors to minimize vertical transmission of airborne noise. Research has shown that the addition of an extra layer of floor sheathing is also an effective method for reducing the transfer of noise and vibration.

In the Remy project, one of the first mid-rise, six-storey projects in BC, the developer's preference was to use a one-inch-thick gypsum-concrete topping for the floors (rather than the more conventional 1-½-inch-thick concrete), coupled with two layers of gypsum board on acoustic (resilient) metal channels for the ceiling below. The architects capitalized on the opportunity this provided to replace one of the 2x4 or 2x6 sill plates in the double sill plate that is typically used for the walls with a one-inch-thick plywood sill plate, thus reducing the potential for overall vertical shrinkage in the structure.

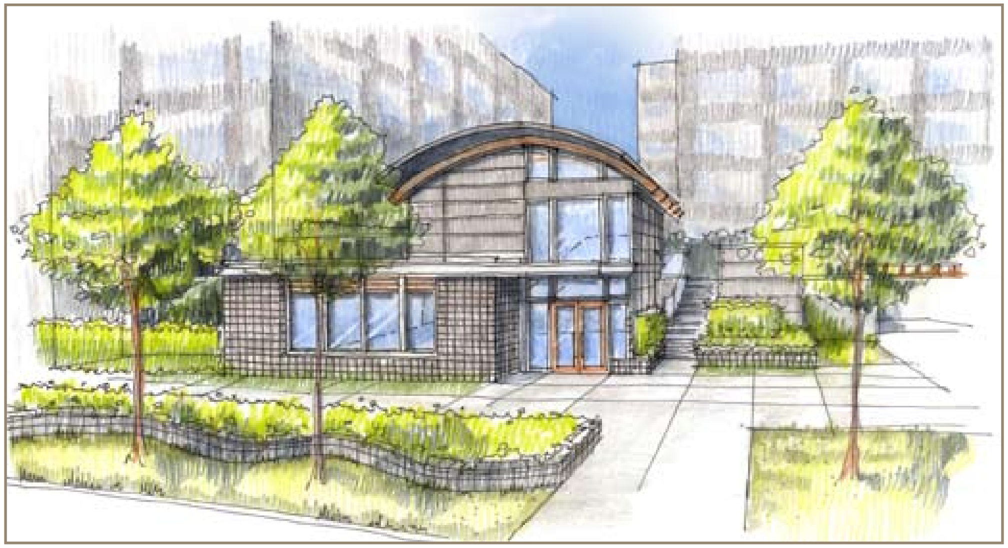
RESILIENT CHANNEL

ONE-INCH-THICK GYPSUM-CONCRETE TOPPING / ONE-INCH PLYWOOD BOTTOM PLATE

THE REMY SITE PLAN

COMMUNITY CENTRE / DAYCARE ARCH DETAIL

COMMUNITY CENTRE / DAYCARE



COMMUNITY CENTRE / DAYCARE RENDERING

b. Acoustic, Thermal and Fire Performance

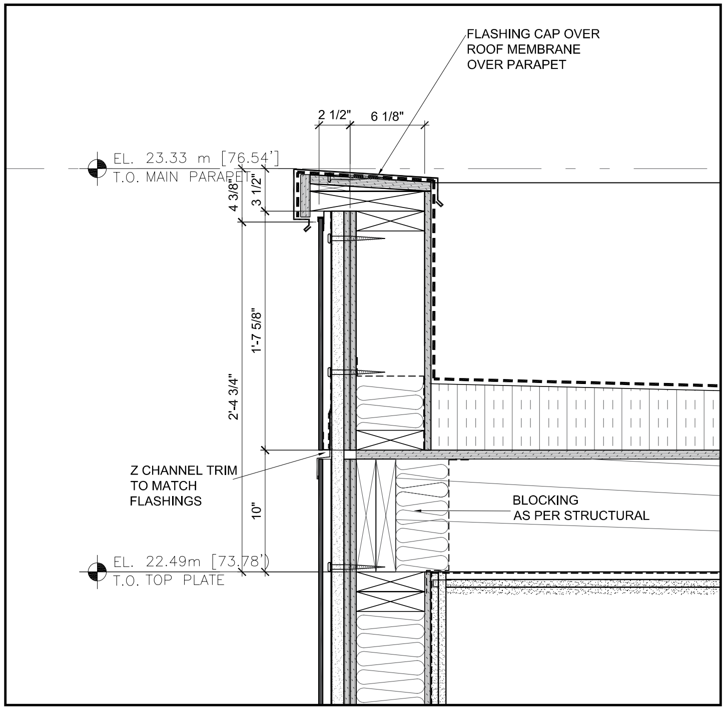
ii. Thermal Performance

Energy conservation has become an important concern for all building types, not simply those constructed in light-frame wood. Increased levels of insulation and reduced ventilation rates both require more stringent performance modeling to maximize benefits and eliminate any potential problems of condensation or impaired indoor environmental quality.

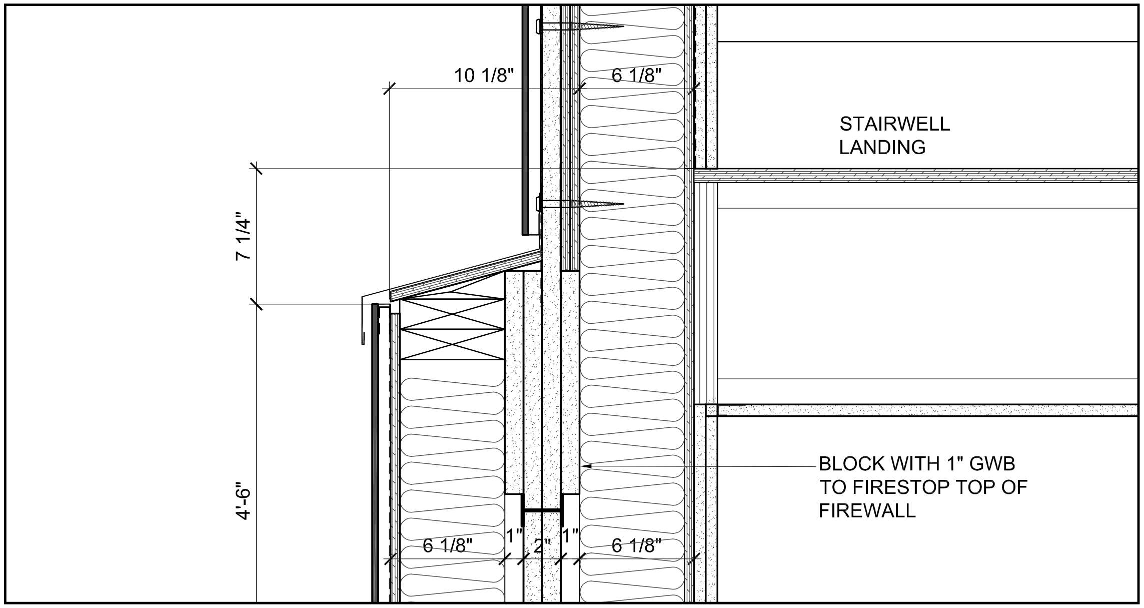
The relatively good thermal properties of wood have always minimized the problem of thermal bridging through the building envelope. However, as higher standards of thermal performance become the norm, even this issue will need to be addressed. In addition to the familiar cavity insulation (now often spray-applied material, such as cellulose or foam), there is a tendency to provide further insulation on the exterior of the building behind the rain screen cladding. It is possible to build such systems without the vapor barrier if the permeability of the different insulation materials is controlled in a way that permits vapor diffusion through the wall.

Such systems are almost entirely airtight, and therefore high performance buildings, including six-storey structures, must be fitted with heat recovery ventilators or other air intake systems that run continually and ensure that the minimum required air changes per hour are achieved.

It should be noted that fire safety requirements related to possible spread of fire to adjacent properties, as well as the need to limit fire propagation up the exterior of the building, need to be considered in the choice of exterior cladding systems that include combustible insulation materials.



ROOF PARAPET AT STAIRWELL



FIREWALL AT RATED EXTERIOR WALL

iii. Fire Performance

NONCOMBUSTIBLE EXTERIOR CLADDING PRODUCTS

In 2005, firewalls with a two-hour fire-resistance rating were permitted to be constructed with noncombustible materials other than masonry or concrete, as long as they were protected in such a way that the day-to-day wear did not impair their effectiveness. As a result, 'gypsum firewall systems' have been developed. These systems often utilize a typical wood-frame wall on either side of the gypsum firewall as the means of protecting the firewall as required by the building code.

In the Richmond, BC - based Remy project, such a gypsum firewall system was used to divide the project into separate buildings. Two separate load-bearing wood-frame walls were placed on either side of a double layer of one-inch-thick fire-rated gypsum sheathing. The potential for differential lateral movement and vertical shrinkage between the wood-frame walls and the gypsum firewall was dealt with by mounting the gypsum sheathing in a specially-designed metal channel frame.


TWO-HOUR GYPSUM FIRE-RESISTANCE-RATED FIREWALL SYSTEM

b. Acoustic, Thermal and Fire Performance

iii. Fire Performance (con't)

The gypsum firewall system was designed to allow for collapse of the wood-frame wall on one side during a fire event without causing the collapse of the firewall. To do this, L-shaped 'break-away' clips were used to attach the gypsum sheathing to the adjacent wood wall framing. When one side is exposed to fire, the clips are designed to soften and break away, allowing the wood-frame structure on the fire side to collapse, while the clips on the unexposed side of the separation wall continue to support the firewall.

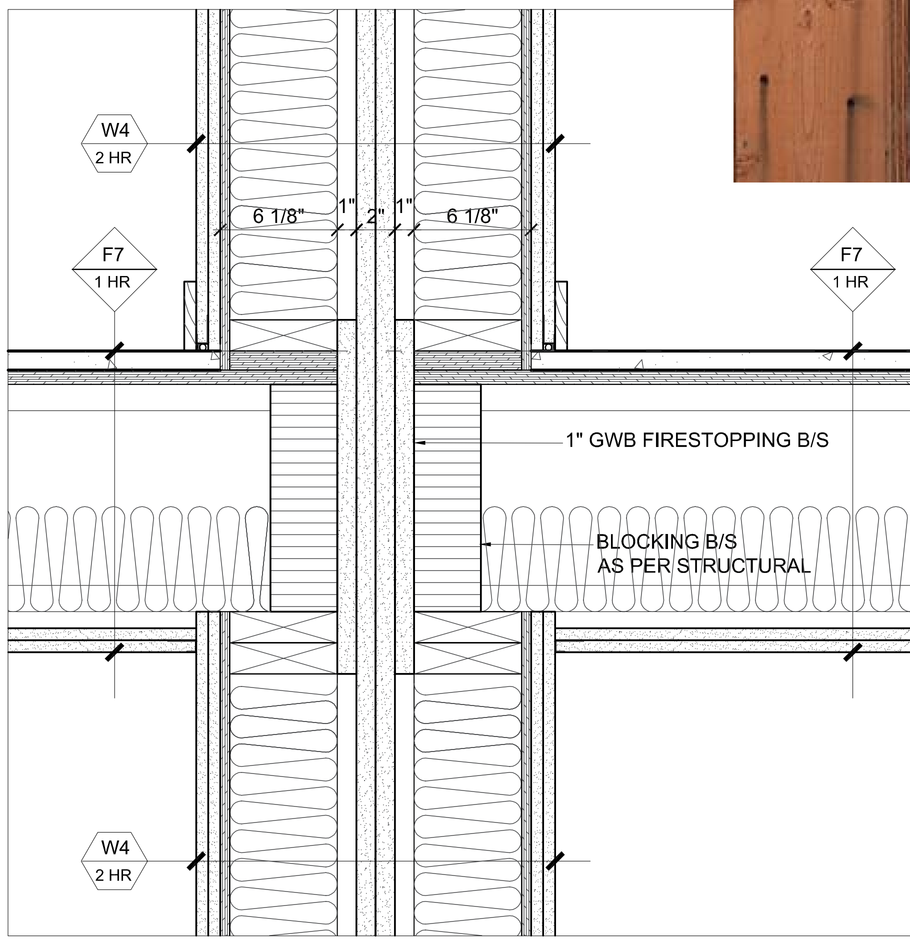
For up to six-storey construction, typical fire separations, other than firewalls, are required to have a fire-resistance rating of one hour. The BC Building Code does not prescribe any particular solution for such situations, thus designers and code consultants have some flexibility in determining the option best suited for their project.

For example, the Remy project used solid nail-laminated 2x6 dimension lumber construction to achieve the required one-hour fire-resistance rating for the project's elevator wall shafts.

The increasing use of light-frame wood construction has prompted the design, testing and analysis of various fire-resistance-rated wood-based floor and wall assemblies. It is probable that as more wood buildings are designed and constructed, the number of solutions available to designers for wood assemblies requiring a one-hour fire-resistance rating will grow.

Another code change associated with mid-rise construction is that the exterior cladding must now be either noncombustible or constructed of materials that are expected to limit vertical fire spread. This is intended to minimize the risk of fire spreading to upper dwelling units should the windows of a unit below break because of the heat from a fire.

GYPSUM FIREWALL SYSTEM - A TWO-HOUR FIRE RESISTANCE RATING



FIREWALL AT L5 FLOOR

b. Acoustic, Thermal and Fire Performance

iii. Fire Performance (con't)

Initially for the Remy project, a layer of exterior-grade gypsum sheathing behind the exterior cladding was considered. However, the architect and code consultants successfully demonstrated that the use of mineral wool rather than fibreglass insulation in the exterior walls, combined with heavy-timber-compliant members as window headers and jambs, would offer an equivalent level of protection.

Mineral wool insulation was used throughout this project, such as in the common walls between different dwelling units. As with the exterior walls, this application of mineral wool insulation provides enhanced fire stopping/fire blocking attributes to these areas.

MINERAL WOOL INSULATION

c. Construction Site Methodology and Other Building Issues and Solutions

In addition to the many technical improvements to light-frame wood construction, other market-related forces are beginning to influence the delivery process.

The evolution and refinement of prefabrication for walls and potentially other elements of the building envelope have changed the traditional material ordering and delivery systems for these buildings. Instead of trucks arriving with loads of dimension lumber that need to be stored on-site and incorporated piece by piece into the building, trucks now deliver carefully-labeled prefabricated components sufficient for one or two days of work.

In the Remy project, greater attention to structural and integrated design details resulted in more precise wall and floor panel prefabrication and greatly reduced the on-site framing complexity of the job.

OFF-SITE WALL PANEL PREFABRICATION

Prefabrication also has an additional environmental benefit that is often overlooked. Computer-assisted sorting and selection of materials ensures that use is optimized and waste is minimized. As well, because a single prefabrication shop may well be supplying a number of different projects at one time, any waste collection and recycling that is needed is centralized and hence more energy and material- efficient.

Overall, if detailed and constructed accurately, prefabrication speeds construction and minimizes inefficiencies as well as the potential for errors on-site.

Framing Details to Accommodate Window-Cleaning Equipment

Another less obvious consequence of building taller wood buildings is that conventional ground-based window cleaning equipment is no longer able to reach the full height of the structure. Hence accommodation must be made both structurally and architecturally to enable window cleaning cradles or other similar equipment to be suspended from the top of the building. At Remy, pairs of parallel-strand lumber (PSL) beams in the roof structural system run parallel to the perimeter of the building to enable a window-cleaning track to be securely mounted to the roof.

Solutions or options for window-cleaning on mid-rise buildings with pitched roofs will need to be considered and developed over time as well.

ON-SITE FLOOR PANEL PREFABRICATION

THE REMY SITE

FRAMING AND CONNECTION DETAIL

EXTERIOR DETAIL AT ROOF

FRAMING AND CONNECTION DETAIL

5. SUSTAINABILITY AND AFFORDABILITY

a. Sustainability

Sustainable Forest Management (SFM) has made Canadian wood a sound environmental choice for numerous traditional and new building applications. The environmental advantages of wood are considerable when compared to other major construction materials. At a time when 'carbon neutrality' is emerging as a key design goal in high-performance buildings, these advantages are becoming increasingly important.

Wood has lower embodied energy than either steel or concrete, as the extraction and processing of wood products is less energy intensive and often uses carbon neutral wood waste as an energy source. Hence, substituting wood for other materials in the construction of any building contributes to a lower overall carbon footprint for the building.

Also, growing trees sequester carbon dioxide by converting it into cellulose, which is the main component of wood fibre. A tonne of wood has sequestered 1.83 tonnes of CO_2 from the atmosphere while growing. The conversion of wood into durable building products prolongs the benefit of carbon storage, and through reforestation, the cycle of sequestration in the forest continues.

Increased urban density, which is the outcome of mid-rise construction, can help reduce the environmental impact of development in the built environment. The densification of existing neighbourhoods is known to reduce the carbon footprint per capita. Multi-family housing can save energy because of the reduced external envelope area for each dwelling. Denser neighbourhoods typically have more personal services within walking distance, thereby reducing the energy used for motorized transportation.

Increasing the permissible height for wood-frame residential buildings will encourage densification by providing an affordable alternative for urban neighbourhoods where existing zoning permits buildings of greater height. Such buildings will also realize the environmental advantages of substituting wood for other materials.

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5. SUSTAINABILITY AND AFFORDABILITY

b. Affordability

Housing affordability is affected by many factors, the most significant of which may be the variation in land acquisition and holding costs per square foot of buildable area. With mid-rise wood-frame construction as a new technology in BC, it is not yet possible to make a general statement about overall cost savings relative to other forms of construction.

However, based on projects under construction in 2011, it appears that the above-grade cost of mid-rise construction in wood will prove to be more than 10 percent less expensive than steel or concrete construction.

In areas with poor soil conditions, such as the location of the Remy project in Richmond, BC, the lighter weight of wood construction will deliver greater savings because less-intensive sub-grade structure and ground preparation is required.

Once the new technology has been streamlined, and particularly if the benefits of prefabrication are fully exploited, there will also be greater savings realized due to the reduced construction times relative to other construction methods. These factors, both speed of construction and more effective use of materials, will undoubtedly improve the affordability of housing as advanced wood-frame, mid-rise building technologies become mainstream.

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REMY SITE SIGNAGE (APRIL 9TH, 2011)

6. FUTURE OPTIONS AND FURTHER ENHANCEMENTS

Mid-rise structures in light-frame wood are just one of the many options that are being actively investigated by the Canadian wood industry. Other innovations include the following:

Cross-laminated Timber (CLT) Hybrid Buildings

CLT technology has been used in Europe in buildings up to nine storeys in height. CLT panels are fabricated in a manufacturing press from light-frame-dimension pieces of wood laid up like plywood in layers of alternating orientation. The major difference compared to plywood, however, is that CLT panels can be from five inches to 15 inches thick, up to 15 feet wide and 60 feet long, with overall dimensions limited only by the size of the CLT press and the economies and practicalities of transportation. Doors, windows and other openings are precut in the factory using computer numerically controlled (CNC) technology.

Panels for floors, walls and roofs can be delivered to the building site by truck, and lifted into place quickly and easily using a standard crane. This makes CLT construction fast and efficient. Several CLT buildings using imported panels have already been constructed in Canada and the United States, and a number of CLT manufacturers began operations in Canada during 2011.

One of the potential advantages of CLT in multi-storey construction will be if fire performance is classified or shown as being similar to that of heavy timber construction, a special type of wood construction recognized in the code as an alternative to some noncombustible construction. Yet another advantage of using CLT building solutions is a reduction in combustible concealed space resulting in less fire stopping/fire blocking details or the need for additional sprinkler heads.

CROSS-LAMINATED TIMBER (CLT) PANEL EDGE DETAIL

CLT PANEL SURFACE DETAIL

6. FUTURE OPTIONS AND FURTHER ENHANCEMENTS

Hybrid Construction Alternatives

Another approach to building higher in wood, and one that has evolved more directly from historic precedents, is a hybrid method based on post-and-beam technology with various concrete or structural steel options for elevator or stair shafts.

A system developed in Québec uses posts with end-grain-to-end-grain bearing for a six-storey commercial building. End-grain-to-end-grain bearing eliminates cross-grain shrinkage, and thus eliminates some of the detailing issues related to shrinkage outlined above.

Zone Framing

Zone framing is based on the principle that different areas of a building require different levels of accuracy and construction tolerances. In areas such as kitchens and bathrooms where precision-built millwork, equipment or appliances are to be installed, framing of walls must be built with a higher level of precision. In a zone-framing approach, these areas would be built using dimensionally-stable, accurate and more predictable EWPs.

Modular Construction Components

Modular construction is an extension of zone framing, where entire three-dimensional components, including complete kitchens and bathrooms would be factory-prefabricated and installed as complete units.

HYBRID CONSTRUCTION: QUÉBEC - FONDACTION PROJECT (PHOTO COURTESY OF CECOBOIS)

ZONE FRAMING - TALL WALL FRAMED WITH STRUCTURAL COMPOSITE LUMBER (SCL)

7. CONCLUSION

Outwardly it may seem little has changed. However, inwardly light-frame wood construction for mid-rise buildings has advanced significantly and presents a new level of affordability. Light- frame wood construction can now legitimately take its place alongside other technically-sophisticated construction systems, and indeed offers many environmental and other benefits if substituted for them.

While six-storey buildings may still seem like a new horizon for this technology, Canadian building researchers believe it may be possible to safely extend light-frame wood construction to eight storeys as well.

Additionally, with the evolution of a fully integrated design approach to mid-rise buildings combined with the introduction of new building materials like cross-laminated timber (CLT) and the further improvement of existing on-site practices, building experts believe the construction of even taller, better performing and lower unit cost wood structures is possible.

THE REMY SITE

CREDITS

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