R-Town Vertical 6 | Mass Timber Midrise

TORONTO, ON

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Photos courtesy of R-Hauz
unless otherwise marked

Introduction

The R-Town V6 pilot project is the first 6-storey, mixed-use, multi-unit residential building developed in Ontario that fully employs mass timber as the main structural system. The energy-efficient wood building was designed to Passive House standards and built with lower embodied carbon materials.

The decision to use Cross Laminated Timber (CLT) for the elevator cores and exit stair enclosures helped simplify the build by eliminating the challenge of integrating a noncombustible core into a wood building. It required the team to obtain approval for an alternative solution because this approach to construction currently falls outside the prescriptive requirements for 6-storey combustible construction in Ontario's building code.

It was the development team's vision to bring the benefits of offsite manufacturing to the midrise market in Toronto and the panelized, all-wood design developed for R-Town V6 streamlined the assembly process and successfully demonstrated proof of concept for challenging infill developments.

This modern approach to construction accelerates and improves project delivery and the versatile, repeatable design contributes to a sustainable and much-needed increase in density along urban arterial roads, creating more attractive, desirable housing in established, walkable neighbourhoods.

DEVELOPER:	R-Hauz
YEAR COMPLETED:	2021
GROSS FLOOR AREA:	26,173 ft^2 (2,431 m^2)

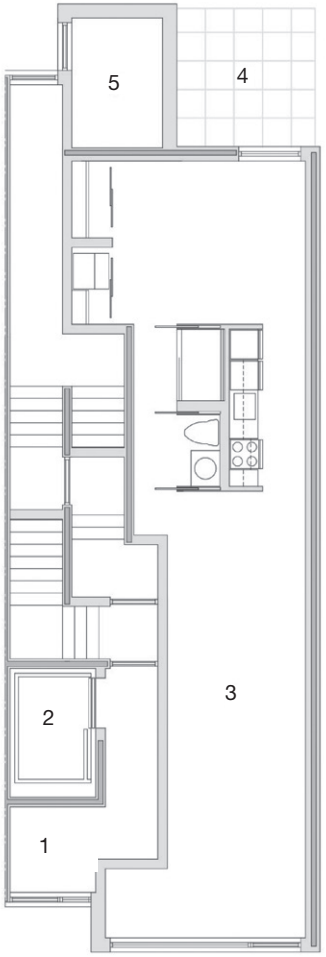
"The R-Town Vertical 6 prototype is a viable new model for midrise housing – a repeatable product that speeds up design, development, and construction."

– Leith Moore, Co-Founder and Principal, R-Hauz

Building Description

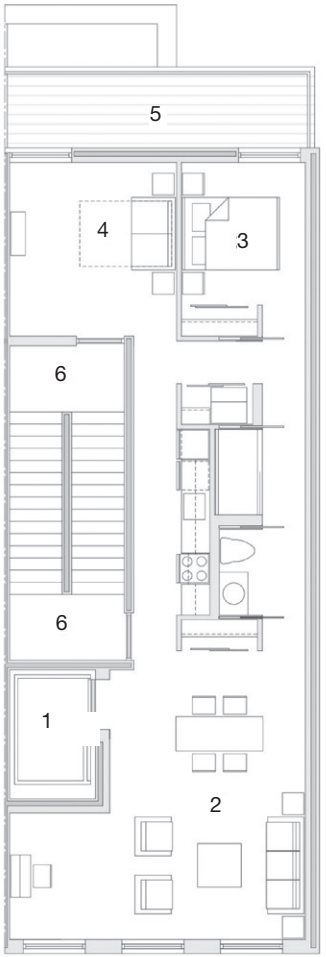
This 6-storey, mixed-use, infill development was constructed in two phases. There are 4 units of commercial space at street level and a total of 18 residential units in the 5 storeys above, all of which have direct elevator access. The entire building is exclusively powered by electricity, with no natural gas hook up, and there is no basement or underground parking.

The building has a green roof and each residential unit has a balcony or patio and is flooded with natural light, a result of the through unit access to front and rear views. The main plumbing chase for the building is located in a central 'wet core' so that future developments have the flexibility to adjust to a variety of site configurations. Room layouts can be reconfigured without changing the plumbing run locations through the building.



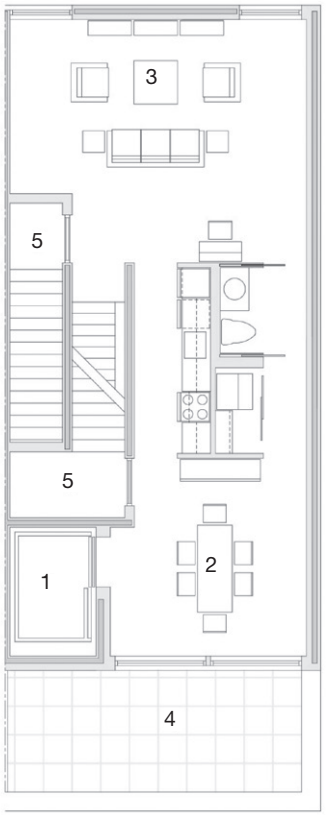
Ground Floor Plan

1 Main Entry
2 Elevator
3 Live/Work Suite
4 Patio
5 Mechanical



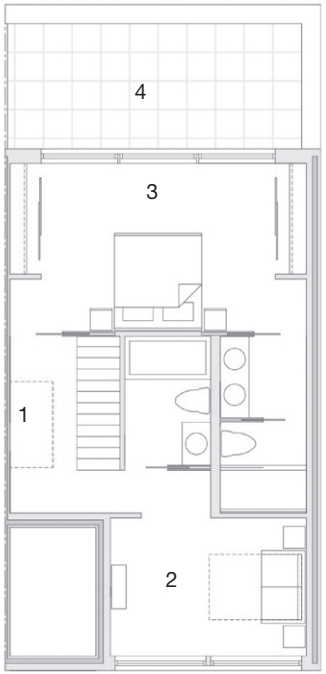
Second-Fourth Floor Plans

1 Elevator
2 Living/Dining
3 Bedroom
4 Study
5 Balcony
6 Exit Stair



Fifth Floor Plan

1 Elevator
2 Dining
3 Living
4 Terrace
5 Exit Stair



Sixth Floor Plan

1 Hall
2 Study/Guest Room
3 Main Bedroom
4 Terrace

Floorplans courtesy of CMV Group Architects

Design Approach and Planning

There are many advantages associated with prefabricated mass timber developments, not the least of which are reduced construction timelines and enhanced building performance. Designing with wood, however, requires a different approach to planning, coordination, and construction.

To pursue a midrise wood building, many key decisions must occur early in the planning phase to ensure an optimized design and successful project delivery. These early decisions are crucial when using prefabricated components and industrialized processes, so success relies heavily on engagement and collaboration with the entire team, including the mass timber manufacturer and MEP consultants, from the outset of a project. This enables early clash detection so potential issues can be eliminated during the design phase.

In areas where mass timber construction is emerging, bringing the Authority Having Jurisdiction (AHJ) into the project discussions early can help streamline the approvals process, particularly in a case where an alternative solution is required. When Ontario's Building Code was updated in 2015, permitting combustible construction up to 6-storey's in height, it included a requirement for noncombustible exit stair enclosures. Since that time, many midrise wood buildings have been built in Ontario using the 6-storey code provisions. Ongoing testing and research continues to build knowledge and demonstrate the fire performance and occupant safety of all-wood buildings, including elevator cores and exit stair enclosures that are constructed with wood assemblies.

The developer engaged the AHJ early on and drew from the extensive fire performance tests and other scientific evidence available to support the all-wood design. The team's fire code consultant prepared the alternative solution proposals that were reviewed and accepted by the City of Toronto's building department. Based on the success of this pilot project, the developer already has several similar projects planned for other locations.

Design Objectives

Wood has the ability to have a wide range of positive impacts, touching on social, economic, environmental, and cultural benefits. It can be a valuable tool in the creation of sustainable, affordable housing and the increased adoption of wood construction will result in new jobs and technological advancement all along the timber value chain. Using wood also helps reduce the carbon footprint of the built environment and improves our overall efforts for climate responsible development.

In addition to the high-performance prefabricated CLT structure which offers a higher degree of quality assurance than comparable site built processes, the R-Town V6 had the following design objectives:

- Front and back facing windows in each unit to maximize natural light and provide superior air circulation and passive heating and cooling
- Balconies and terraces in each unit with direct access to outdoor space
- Direct access to each unit via elevator and staircase
- Exposed wood ceilings
- Radiant heating and cooling
- Smart thermostats that adjust to current climate conditions
- Sound insulation

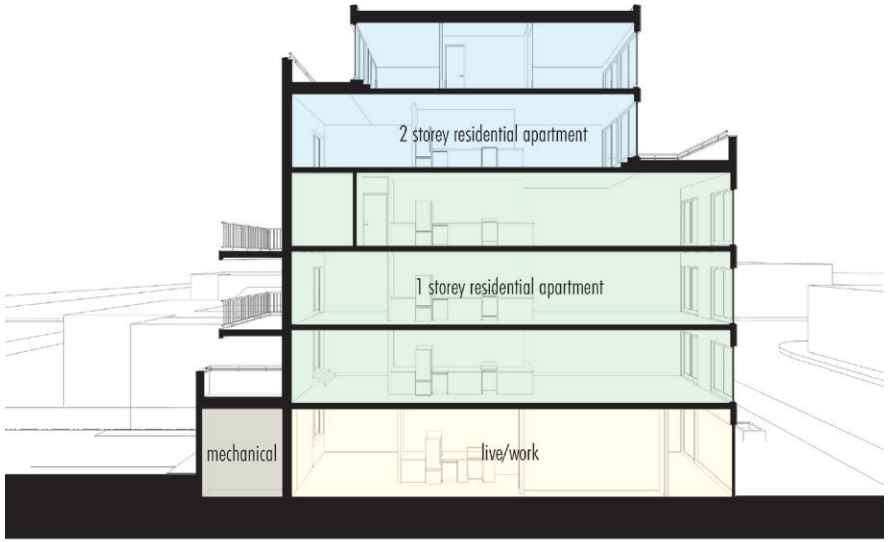
Flexibility in the aesthetic is provided by a front façade that is designed to allow adaptability and customization to the neighbourhood's character, including varying window panels, balconies, and other architectural features. Lateral stability was a key consideration in accommodating the narrow building footprint and height. Cross laminated timber was an ideal material because of its inherent rigidity.

Material Choice

From the outset of the project wood was the intended construction material. Mass timber offered important advantages in terms of expedited construction schedule and construction method. Off-site manufacturing enabled production to begin while demolition, site work and foundations were being completed.

Prefabricated assemblies delivered just-in-time by the material supplier used the public laneway to the rear of the building. This small area acted as the main staging area for the mobile crane to lift the CLT panel systems into place.

The construction approach eliminated many of the site and neighbourhood disruptions (such as traffic lane closures) that traditional methods and other materials would have required.



Drawing courtesy of CMV Group Architects.

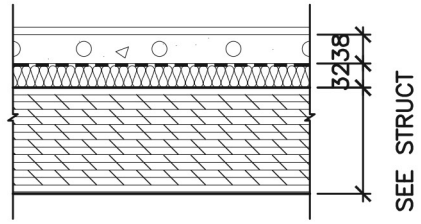
Building Code Considerations

The 6-storey V6 project has several building classifications: Group C, Residential Occupancy (OBC 3.2.2.43A); Group D, Business and Personal Service; Group E and A2, Mixed Major Occupancy at the ground floor street level.

The OBC 3.2.2.43A code requirements for 6-storey wood buildings specify fire-resistance ratings (FRR) for floor and roof assemblies of 1 hour. Load-bearing walls, columns and beams are required to have the same fire-resistance rating as the supported assembly.

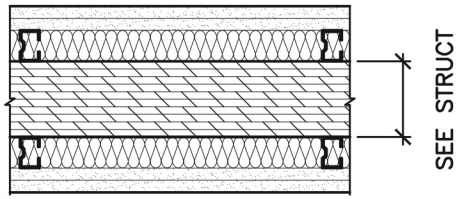
The building is fully sprinklered in accordance with NFPA 13: Standard for the Installation of Sprinkler Systems.

Floor assembly detail for the Cross Laminated Timber (CLT) floors 1 hour FRR

1 HOUR –	STC = 50 min.		TYPICAL DEMISING FLOOR: – FLOOR FINISH – 38mm CONCRETE TOPPING – IN SLAB HEATING TUBES (19mm DIAM.) – SEPARATION MEMBRANE – 32mm ROXUL UNDERLAYMENT (REFER TO ACOUSTIC RECOMMENDATIONS) ON – 140 CLT SLAB (SEE STRUCTURAL DWGS) NOTE: REFER TO ALTERNATIVE SOLUTION REPORT BY VORTEX FIRE

Details courtesy of CMV Group Architects

Wall assembly detail for the CLT exit stair enclosure. See Alternative Solution table on page 8 for exit stair required FRR performance.

FRR = 2HR PER ULC DESIGN NO. W453	STC = 50 min.		TYPICAL INTERIOR PARTITION (STAIRS AND ELEVATOR): – 2 LAYERS 13mm TYPE 'C' GYPSUM BOARD – 41mm METAL STUDS @ 400mm O.C. W/ ACOUSTIC BATT INSULATION INFILL BETWEEN STUDS – 100–140mm CLT PANEL (SEE STRUCTURAL DRAWINGS) – 41mm METAL STUDS @ 400mm O.C. W/ ACOUSTIC BATT INSULATION INFILL BETWEEN STUDS – 2 LAYERS 13mm TYPE 'C' GYPSUM BOARD

Alternative Solutions

The V6 is an all-wood residential building on Queen Street East in Toronto, Ontario. The 6-storey building is fabricated using panelized mass timber construction (CLT). The aim of this project was to create a repeatable building type that could be developed in small sized and infill lots, and help the city pursue growth at sustainable densities by creating more housing in the “missing middle.” Although constructing a mass timber building as an infill project can present some challenges, the alternative solution approach allows these challenges to be addressed. The project included the following alternative solutions:

Missing Middle housing is a range of buildings with multiple units that are compatible in scale and form with detached single-family homes and located in walkable neighborhoods.

CONDITION	REQUIREMENT	ALTERNATIVE SOLUTION
Exit Stair	The OBC requires the exit stair enclosure to be of noncombustible construction (typically steel framed or concrete) with a 1.5 hour fire resistance rating.	The mass timber (CLT) exit stair enclosure was approved through an alternative solution application. In lieu of required noncombustible construction, the CLT was encapsulated on both sides and was able to achieve a 2 hour fire rating which exceeded the level of performance required by the OBC.
Exterior Walls Within 1.2m of Property Line	The OBC requires exterior wall assemblies within 1.2m of the property line to be of noncombustible construction.	An alternative solution application was approved for the CLT exterior wall assembly based on provided encapsulation on both sides of the exterior walls to limit fire spread to other buildings or from other buildings.
Use of CLT	A method for calculating the fire-resistance of CLT is not currently in the OBC.	CLT is not currently specified in the code. An alternative solution application was prepared to demonstrate the performance of CLT and its ability to achieve the functional statements and objectives of Ontario’s Building Code.
Green Roof	The OBC requires a Class A roof on a combustible building.	An alternative solution was prepared to address the green roof on the building. The alternative solution included a set back of the green roof from adjacent buildings and means to fight a fire on the roof.

Structural Design

Image courtesy of Moses Structural Engineers

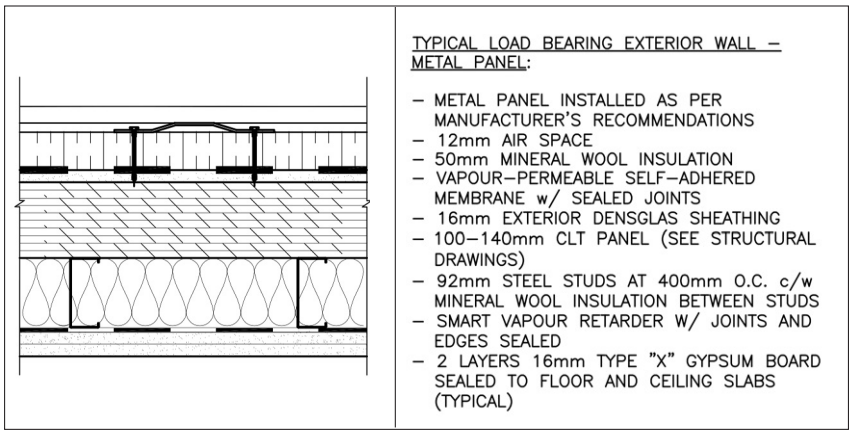
The building was designed without a basement space but, because the neighbouring buildings have them, caution was needed in the foundation design. Poor capacity soil conditions were identified as an issue with this site after a multi-stage analysis was performed. Helical piles with grade beams were deemed the best solution to carry the loads generated by the building.

In addition to foundation considerations, the adjacent buildings required the team to closely manage project tolerances. Prefabricated mass timber is very precise, with large elements fabricated to millimetre accuracy. Integrating that level of precision with existing buildings built many years ago was tricky because the existing structures had moved and settled over time which posed a concern because of the zero-lot line conditions of the project.

Ordering the CLT material needed to happen early in the process and, on the project site, demolition and site clearance happened before any fine dimensioning could take place. This presented a challenge, but the strategy and approach put in place worked well. Tolerances were set that allowed adjustment for site conditions. This was definitely needed due to the use of pre-clad wall assemblies (see detail W2 below). Precision fit was of critical importance for the exterior wall performance expectations and envelope performance.

Mechanical, electrical and plumbing openings were drilled once the structural system was in place because locates were not available to the mass timber fabricator at the time of the production run. The structural engineer developed typical details for penetrations of various sizes for openings in the wood structural systems to accommodate duct work, pipes and mechanical systems that followed for the MEP installation and fit out.

Exterior Wall Assembly



Detail W2 illustrates the exterior wall assembly detailing that was used to prefabricate the pre-clad panels off-site. Exterior walls in this zero-lot line application are required by Ontario's Building Code to be of noncombustible construction. W2 was designed to achieve a 2-hour FRR.

Connection Details

Flat strap drag struts were used as part of the lateral design of the building. These offer a great solution for managing lateral forces in an all-wood building.

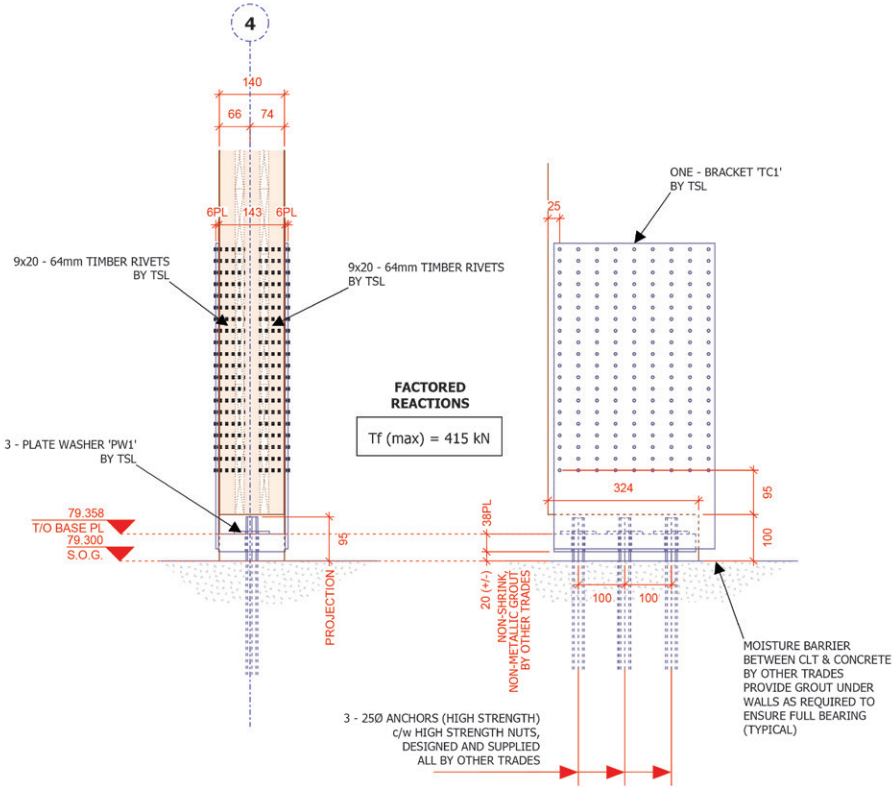
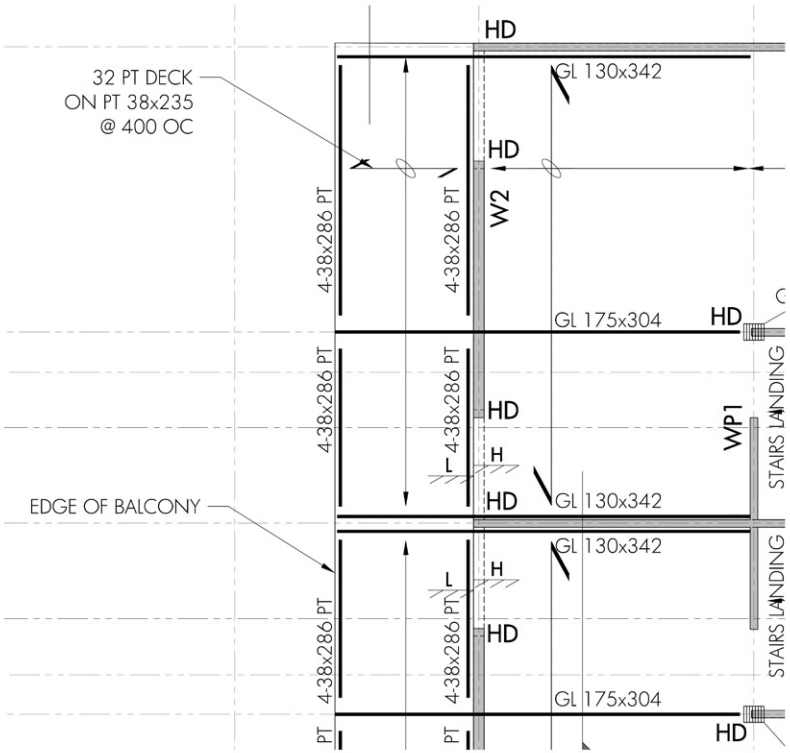


Diagram courtesy of Timber Systems Limited

Flat strap drag strut and joint sealant tape.
Images courtesy of Moses Structural Engineers

A challenge for the engineering team was designing a lateral system for the narrow buildings. Uplift becomes an issue, so adding mass to the floor assemblies, concrete topping in this case, assisted in managing the uplift forces. This had added benefits for the acoustical performance and fire-resistance ratings of the floor assembly.



Cantilevered balcony support with AYC Glulam
Diagram courtesy of Moses Structural Engineers

Each of the residential units at V6 has access to a balcony or patio. The exterior balconies at the rear of the building are supported by cantilevered Glulam beams that are fabricated from Alaskan Yellow Cedar (AYC). Alaskan Yellow Cedar is very durable wood species with natural extractives that make it decay-resistant and perfect for exterior structural applications.

The pressure treated (PT) lumber frames for the decks run parallel to the cantilevered Glulam beams. Balconies were installed after the exterior envelope was complete. The balconies are supported exclusively by the cantilevered AYC beams, with no additional fasteners required, maintaining the integrity of the building envelope.

Construction Approach

Demolition of the existing buildings at infill sites can be challenging. In the case of this project, one of the two buildings that needed to be demolished was attached to its neighbouring building at foundation level. This made the demolition time longer since particular care had to be taken in order to preserve the structural integrity of the neighbouring building that was to remain in place.

The construction was performed with minimal disruption to the surrounding neighbourhood. The opportunity to use the rear lane for material delivery and staging meant that no street closure was required. This advantage reduced the traffic management burden and saved costs. Smaller equipment was used to facilitate ease of construction on the relatively small and tight infill site (40' x 110').

The construction sequencing was carefully considered in the design of the building and mass timber panels. The assembly strategy included a tilting-up process using a mobile crane that was located at the rear of the property. Forty feet of site area was maintained in the rear of the site to accommodate the construction process and at grade parking. The building utilized a slab-on-grade construction to prevent disruption to the streetcar system along Queen Street East. Together, these strategies helped reduce overall costs.

The mass timber assemblies were stored at a temperature and humidity-controlled facility to protect them from weather and site damage prior to assembly. Once demolition and foundation work was complete, the 6-storey timber structure took approximately five and a half weeks to assemble on site.

The exterior wall assemblies at the property line were completely finished off-site. The CLT side wall panels were prefabricated in 2-storey sections with fire-rated sheathing on the exterior face, exterior insulation and metal siding all applied in the shop. This was necessary due to the limited access at the (nominal) zero side lot line. Once delivered to site, the panels were craned into place and the interior finishing was completed on-site once the structure was assembled.

Interior Design

Wood has been used as a building material for millennia, but it has only been recently that the physical and psychological benefits of incorporating natural elements like wood into buildings have been studied, quantified, and better understood.

Researchers are discovering that wood can directly contribute to the health and well-being of building occupants. The term ‘biophilia’ that we see so often in architectural discourse today literally means ‘the love of living things’ in ancient Greek. Biophilic design is an antidote to humanity’s growing disconnection from nature and the resulting negative human health impacts that have resulted from increasing urbanization.

The mass timber structure of R-Town V6, with exposed wood ceilings and added sound insulation, provides noise attenuation and humidity control for occupant comfort. The design features passive access to natural light and enhanced fresh air circulation with outdoor terraces for each suite. The exposed wood, natural light, fresh air and other biophilic design elements that have been incorporated into the residences will positively impact occupant health and well-being.

Sustainability

SUSTAINABILITY FEATURES:

- Built with wood – a low embodied carbon material
- Electric power rather than gas
- Energy Recovery Ventilators (ERV)
- Green roof
- Light Emitting Diode lighting (LED)
- Storm water infiltration in rear yards
- Grey water recycling
- Energy Star appliances
- Low-flow plumbing fixtures
- Electric Vehicle (EV) charging stations
- Radiant heating and cooling
- Tankless water heater

The R-Town V6 is the first midrise multi-unit residential building in Ontario built in mass timber and it sets a high standard for what new construction should achieve. The building's energy performance exceeds the Ontario Building Code requirement by 47%, with an estimated reduction of 17,684 CO_2e (carbon dioxide equivalent) per year.

The building has enhanced insulation at the foundation slab edge to reduce thermal bridging and includes R-10 under-slab insulation. The high-performance, double glazed, low-e windows with Solar Heat Gain Coefficient of 0.3, in fibreglass frames with warm edge spacers, improve the building's air tightness and reduced the window wall ratio to 16.9% overall.

LED lighting is employed throughout and is supported by daylighting through passive low-solar heat gain south facing windows. The HVAC system includes air source VRF with DX Cooling EER-12 and a heating COP of 3.3, ECM motors, tankless condensing hot water heater for domestic hot water, 60% efficient ERVs and in suite "smart" thermostats. Each suite's through-unit design allows for passive access to natural light, enhanced fresh air circulation opportunities, along with an outdoor terrace or balcony.

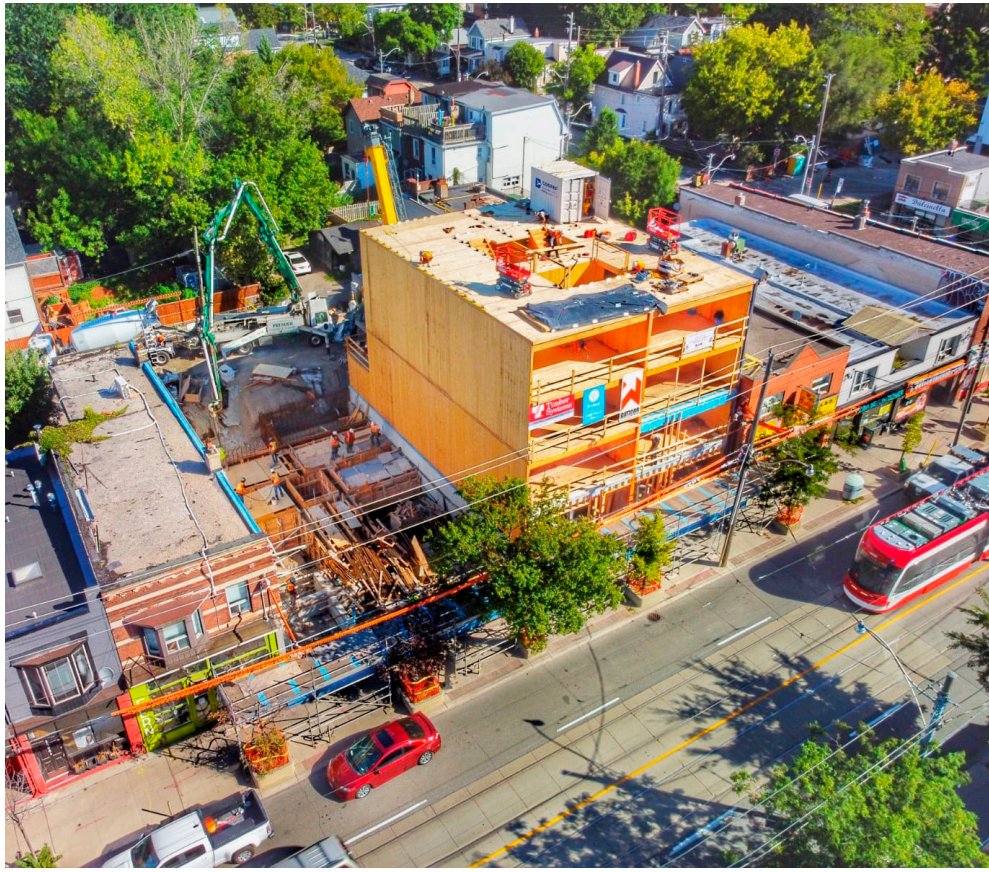
The building also employs sustainable water management approaches that include a semi-permeable exterior parking surface for storm water infiltration, grey water recycling, and a green roof. The exterior surface parking also provides electric vehicle charging stations.

Conclusion

When buildings are developed that have considerable potential to change the landscape of our built environment they can generate a lot of excitement. Prescriptive code provisions that effectively require midrise wood buildings to be of hybrid construction, mixing both materials and trades, impacted midrise residential development of this type owing to the associated increase in complexity and costs. The developer recognized the benefits of an all-wood solution and chose to make the investment in an alternative solutions pathway to code compliance.

By demonstrating that the mass timber exit stair enclosures and elevator cores performed as well or better than the prescribed 'noncombustible' solution, and that CLT could easily achieve the required exterior wall performance requirements in a zero lot line condition, R-Town V6 has made it easier for mass timber to be used in more missing middle infill developments along main street neighbourhoods in Toronto and beyond.

This multi-unit typology offers developers and project owners a new and more sustainable way to create much-needed housing within reasonable timelines, at an appropriate scale, and with minimal disruption to surrounding neighbourhoods. These mass timber buildings are perfect additions to low-density zones where transit and infrastructure are underutilized. The versatile design and modifiable façade can be adapted to match the character of existing neighbourhoods and the prefabricated, panelized solution can facilitate rapid deployment wherever housing need and land opportunities exist.



PROJECT TEAM CREDITS

DEVELOPER
R-Hauz
123 Front Street West, Suite 300
Toronto, Ontario M5J 2M2
www.r-hauz.ca

GENERAL CONTRACTOR
Buttcon Ltd.
8000 Jane Street Tower B, Suite 401
Concord, Ontario L4K 5B8
www.buttcon.com

ARCHITECT
CMV Group Architects
247 Spadina Avenue, 4th Floor
Toronto, Ontario M5T 3A8
www.cmvarch.com

STRUCTURAL ENGINEERS
Moses Structural Engineers
366 Adelaide Street West, Suite LL04
Toronto, Ontario M5V 1R7
www.mosesstructures.com

MECHANICAL & PLUMBING
FitMech Inc.
8250 Lawson Road
Milton, Ontario L9T 5C6
www.fitmech.ca

ELECTRICAL CONTRACTORS
Birnie Electrical Contractors
2209 Dunwin Drive
Mississauga, Ontario L5L 1X1
www.birniehomesafe.com

MASS TIMBER DESIGN, SUPPLY & ERECTOR
Timber Systems Ltd.
120 Bullock Drive
Markham, Ontario L3P 1W2
www.timsys.com

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