WORLD CONFERENCE ON TIMBER ENGINEERING 2025
BRISBANE, AUSTRALIA
Advancing Timber for the Future Built Environment

CONTRIBUTING TO CANADA'S EFFORTS TO DECARBONIZE THE CONSTRUCTION SECTOR USING WOOD

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ABSTRACT: The emergence of engineered wood products in construction, including mass timber as a green building material, continues to gain traction in Canada and abroad. The Government of Canada recognized that to decarbonize the built environment and increase the acceptance of wood products and systems domestically, it is critical to showcase the use of wood in non-traditional applications. This led to several initiatives and programs being launched over the past 15 years to expand the use of wood in construction and increase the number of mass timber buildings across the country.

To support this momentum, the Government of Canada launched the Green Construction through Wood (GCWood) program in 2017 to help expedite market acceptance and foster commercial uptake of wood-based products and systems. The GCWood program builds on the success of the 2013-2016 Tall Wood Buildings Demonstration Initiative which led to the design and construction of two tall wood buildings in Canada including the 18-storey UBC Brock Commons. Sixteen high-rise, low-rise non-residential wood buildings, and timber bridges across Canada were funded under the GCWood program over 5 years (2018-2023). The program also funded critical technical research to support the update of the 2020 edition of the National Building Code of Canada (NBCC) and other education and design tools development. Given the current uptake and success of the GCWood program, the Government of Canada renewed the GCWood program for three more years starting April 2023.

The renewed GCWood program is structured and delivered through two main streams: demonstration projects and accelerating construction transformation (ACT). The ACT stream includes three funding elements: advancing wood education, building capacity, and supporting revisions to building codes and standards. This paper provides an overview of the GCWood program activities, focusing on showcasing the design and construction of several demonstration projects and ongoing efforts and activities funded by the program to accelerate construction market transformation.

KEYWORDS: Mass timber, demonstration projects, market transformation, building codes, wood education.

1 – INTRODUCTION

Construction of buildings represents a significant source of greenhouse gas (GHG) emissions in Canada and around the world. Introducing construction material alternatives, such as mass timber, as a green building material could help address the building sector's contribution and help Canada meet its net-zero goals by 2050.

The Government of Canada recognized that in order to support the acceptance of wood products and systems domestically, it is critical to showcase the use of innovative engineered wood-based products in non-traditional applications. This led to several initiatives and programs being launched in the last 15 years. Funding demonstration projects, advancing wood education and training, and supporting revisions to building codes and standards to allow taller and larger wood buildings are among the Canadian government's efforts to reduce barriers and increase market uptake for wood-based products and systems nationally.

2 – GREEN CONSTRUCTION TROUGH WOOD PROGRAM

The Tall Wood Building Demonstration Initiative (TWBDI) was launched in 2013 by the Government of Canada and funded the design and construction of two tall wood buildings in Canada [1].

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https://doi.org/10.52202/080513-0570

The first was an 18-storey hybrid mass timber student residence (Brock Commons Tallwood House) located in Vancouver (Figure 1), which was the world's tallest hybrid wood building at the time of its completion. By using mass timber instead of traditional building materials, Brock Commons avoided 2,432 tonnes of carbon dioxide [2].

Figure 1. UBC Brock Commons Student Residence (Courtesy of Naturally:wood)

The second was Origine, a 13-storey residential building in Québec City (Figure 2). Overall, it is estimated that the Origine building avoided 3,901 tonnes of carbon dioxide that otherwise would have been incurred by using traditional materials instead of mass timber [3]. Natural Resources Canada funded critical R&D activities required to design, approve, and construct the two demonstration buildings which included fire, structural, and acoustic testing.

Figure 2. Quebec's 13-storey residential building, Origine (Courtesy of Stepane Groleau)

The success of the TWBDI led to new initiatives by the Government of Canada that further encouraged the design and construction of timber structures in non-traditional construction applications. The Green Construction through Wood (GCWood) program was launched in 2017 with $55 million in funding over 5 years, with the main objective of increasing the use of mass timber as a green building material in infrastructure projects, especially in non-traditional construction applications.

The GCWood program had three key components: mass timber and hybrid demonstration projects, supporting research to advance building code revisions, and funding technology transfer and advanced wood education (i.e., post-secondary school courses, design and costing tools, and Life Cycle Assessment (LCA) data and tools).

In total, sixteen high-rise and low-rise non-residential wood buildings and timber bridges across Canada were funded under the GCWood program. Most of the buildings are now completed, and a few are still under construction, or at an advanced stage of design and approval.

2.1 TALL WOOD BUILDINGS

The first Call for Proposals (CfP) was for tall wood buildings (minimum of 10 storeys) which targeted innovative use of advanced wood products and systems in high-rise applications. The choice for the number of storeys was based on close consultation with industry stakeholders and market intelligence data. With the help of an expert evaluation panel, several highly innovative projects that showcase advanced wood-based technologies in their design and construction were shortlisted for funding. The following are some examples of tall wood buildings funded by the GCWood program.

2.1.1 LIMBERLOST PLACE

Limberlost Place is a 10-storey innovative tall wood building located at George Brown College's waterfront campus in Toronto, Ontario (Figure 3). This academic building will serve as a learning space and living laboratory for students while housing a mass timber research and testing facility to study renewable energy systems, fire performance, and durability. Several innovative design features were incorporated in the design including the lateral load resisting system which is composed of a concentric steel braced frame core, erected in tandem with the mass timber superstructure. The structural system employs an innovative 7-ply timber-concrete-composite "slab band" to achieve the 9.2 m spans. Huge glulam columns spanning 3 storeys in height are used for gravity load support. Renewable energy systems, such as rooftop photovoltaic arrays, heat pumps, and rainwater recycling mechanisms are incorporated in the building design. Limberlost Place is poised to keep its air cool and its water hot by plumbing the depths of Lake Ontario and is becoming the latest building in downtown Toronto to hook into the prodigious latent energy of its deep waters. The building will be completed shortly and will be Ontario's first net-zero tall wood, low-carbon institutional building.

Figure 3. Limberlost Place in Toronto (Courtesy of PCL)

2.1.2 2150 KEITH DRIVE (THE HIVE)

As a landmark building in Vancouver, the Hive's distinctive honeycomb design sets this 10-storey mass timber office building apart as it adopts a unique architectural and innovative wood-based structural system. The building features 9 levels of mass timber, on top of a concrete podium, with a honeycomb structure of diagonally oriented glulam braces arranged in a cellular pattern at the building's perimeter (Figure 4). The lateral force resisting system for wind and seismic load is composed of a series of CLT shear walls in the interior and glulam braced frames at the exterior eliminating the need for conventional cast-in-place concrete cores. Exposed wood will be a key element in the building's interior design. This will be the tallest timber seismic force-resisting building in North America, at 45 m. The building will use Tectonus connections which will enhance its seismic resistance and allow the building to self-centre after an earthquake. The building is targeting LEEDGold certification. The building is currently in construction targeting completion in 2025 by which time it will be the tallest timber braced frame and CLT shear wall building in North America.

Figure 4. The Hive in Vancouver (Courtesy of Naturally:wood)

2.1.3 UNIVERSITY OF TORONTO'S ACADEMIC TOWER BUILDING

This 14-storey Academic Tower will be the tallest academic hybrid mass timber building in Ontario once completed, and will serve as an academic and research facility, as well as a living laboratory for the university (Figure 5).

The project is currently in construction. The top 10 storeys of this hybrid building will be made of glulam and engineered mass timber panels, with the lower 4 bottom storeys constructed of both timber and steel. One-way GLT slabs will be used for the deck to offer ample floor space, and to meet the required two-hour fire-resistance rating. The structural design uses glulam super bracing as the lateral force resisting system against wind and seismic loads. Innovative connections engineered for off-site assembly will facilitate faster construction. The design involves partially exposed mass timber structural elements. Extensive engineering analysis and modelling including wind engineering studies have been conducted to support the design and approval of the building. The academic tower will showcase the ability for materials to work together to achieve low-carbon, high performance designs.

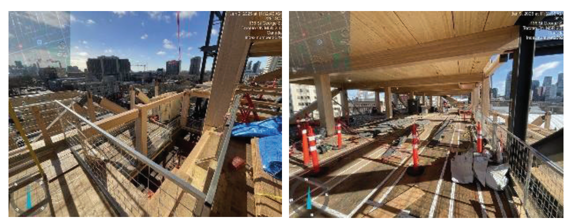

Figure 5. Academic Tower in Toronto (Courtesy of University of Toronto)

2.2 LOW-RISE NON-RESIDENTIAL BUILDINGS

GCWood's second CfP targeted innovative and replicable low-rise non-residential buildings including commercial, industrial, office, and institutional buildings of 4 storeys or less. Thirty applications were received, and ten projects were selected for funding. Below are a few examples of these demonstration projects funded by GCWood program.

https://doi.org/10.52202/080513-0570

2.2.1 YUKON STREET OFFICE BUILDING

The Yukon Street Office Building is a 4-storey hybrid mass timber and steel commercial office building built at the property line (Figure 6). Composite panels accommodate the long spans, providing exposed soffits, and hide required services for the building. The CLT shear walls, as well as elevator and stair core, are specially designed to resist earthquake forces using an advanced seismic resistance hold-down system from New Zealand (Tectonus). CLT walls were prefabricated with the exterior envelope and cladding to minimize access and construction along the tight property line. A Life Cycle Assessment (LCA) was performed on the building which showed a GHG reduction between 26% and 48% with the global warming potential reduced by 52% [4].

Figure 6. Yukon Street Office Building in Vancouver (Courtesy of Michael Elkan)

2.2.2 BAYVIEW ELEMENTARY SCHOOL

Bayview Elementary School is a 2-storey school and is considered one of the first schools in British Columbia to undergo a major seismic retrofit as part of the province's school seismic upgrade program [5]. The design presents a large clear span roof using a combination of CLT panels and glulam webs, creating a “double T” composite action design. The design also incorporates balloon type CLT shear walls that extend throughout both storeys (Figure 7).

The Bayview school is targeting LEED Gold certification. Extensive structural testing on the hybrid floor system and shear walls took place at the University of Northern British Columbia (UNBC) to support the balloon type shear walls design used in this project. This school has a global warming reduction potential of around 8% following an LCA performed after the building was constructed [5]. Certain design features of Bayview School were replicated in another school formally known as, Sir Matthew Begbie Elementary School, now known as wək̓ʷan̓əs tə syaqʷəm

Figure 7. Bayview Elementary School in Vancouver (Courtesy of Michael Elkan)

Elementary School. The construction of both schools has been completed and occupied and have similar global warming reduction potential.

2.2.3 CANADIAN NUCLEAR LABORATORIES

A series of three mass timber buildings is part of a first of its kind infrastructure project in Canada at the Canadian Nuclear Laboratories (CNL) in Chalk River, Ontario. The mass timber buildings include a support and maintenance facility, a Science Collaboration Centre, and the Advanced Nuclear Materials Research Centre (ANMRC).

The Science Collaboration Centre (Figure 8 – Left) is a hybrid mass timber building that serves as a collaboration complex to house a new data center with advanced computing capabilities, a university-style auditorium, library space, roof-top terrace, and sufficient office space and meeting rooms for approximately 450 employees. The design incorporates CLT panels with glulam columns, beams, and purlins as the main gravity structural system. The structure consists of a reinforced concrete lower level, elevator, and stair core. Mechanical, electrical, fibre optics, and life safety distribution system are all concealed within the mass timber superstructure. The lateral bracing system is a hybrid system of concrete shear walls and glulam braced frames, with CLT panels acting as diaphragms to transfer lateral loads to shear walls. The building is complete and presents a reduction of 86% from baseline emissions [6].

The Support and Maintenance Facility is a 2-storey industrial use building which is home to various trades, transportation, and roads and grounds crews (Figure 8 - Right). The design includes a CLT elevator shaft, floors, and roof panels that are supported by glulam timber purlins, beams, and columns as the main structural system. The CLT mezzanine floors are suspended and supported by glulam beams. Glulam cross bracing is also provided to resist lateral loading.

Figure 8. Science Collaboration Centre (left) and Support and Maintenance Facility (right) (Courtesy of CNL)

An Integrated Project Delivery (IPD) approach was used in the design and construction of all mass timber projects at CNL. IPD brings together the full design team, manufacturers of the mass timber products, trades, and the construction manager to work collaboratively to optimize the design, increase value to the owner, and maximize efficiency through all phases of design, fabrication, and construction. The construction of this building is complete and presents a reduction of 93% from baseline GHG emissions [6].

The Advanced Nuclear Materials Research Centre (ANMRC) is currently under construction. This is a hybrid mass timber and concrete structure that houses hot cells, laboratories and offices, and will be the first of its kind to use mass timber in a nuclear lab setting.

2.2.4 TRCA NEW ADMINISTRATIVE OFFICE BUILDING

Toronto and Region Conservation Authority's (TRCA) new Administrative Office Building is a 4-storey mass timber office building located in Toronto, Ontario and is part of the Canada Green Building Council's Zero Carbon Building Pilot Program (Figure 9). The building is designed to achieve a low-carbon footprint through all lifecycle phases, with model simulations predicting a 50% reduction in operating emissions and over 75% reduction in embodied carbon compared to the average office building in Toronto. The construction of the mass timber structure is complete.

The entire building utilizes a mass timber structure including the elevator and stair cores with the foundation and slab-on-grade being concrete. The structural system is composed of CLT mass timber floor panels supported on glulam beams and columns and uses a structural grid of approximately 6 m x 6 m. Metal steel strapping is installed on the top surface of the CLT floor/diaphragm where drag forces are concentrated to transfer the forces from the diaphragm to the shear walls. The vertical lateral force resisting system for the office building utilizes a combination of stair and elevator cores constructed of CLT with lateral glulam bracing. There is no structural concrete utilized above the main floor concrete slab. It is expected the incorporated open loop system will improve energy efficiency by an additional 10-15%, which will lower operating emissions accordingly.

Figure 9. Toronto and Region Conservation Authority Administrative Office (Courtesy of TRCA)

2.3 TIMBER BRIDGES

The GCWood CfP for bridges was launched in the spring of 2018 where 13 applications for both vehicular traffic and pedestrian bridges that had a minimum clear span of 20 m were received. NRCan selected two mass timber bridge demonstration projects for funding with one bridge completed and the other one at the construction stage.

The Duchesnay Creek Bridge in North Bay, Ontario (Figure 10) replaces the original which was closed by the Ministry of Transportation (MTO) in 2019 due to its poor condition. The bridge design is an innovative three-span hybrid glulam girder bridge with precast concrete deck and arched glulam braces at the piers. The use of the glulam braces helps with the reduction of the shear loads experienced by the structure. The bridge is 83 m long and 13 m wide and was opened for traffic in August 2021.

Figure 10. Duchesnay Creek Bridge (Courtesy of MTO)

2.4 RENEWED GCWOOD PROGRAM

The initial GCWood program funding ended in March 2023. Given the uptake of the program's activities by the design and construction industry, the GCWood program was renewed in April 2023 with $38 million in funding over 3 years to continue supporting the use of wood as a low-carbon building material in infrastructure projects. The renewed GCWood program focuses on two key streams:

https://doi.org/10.52202/080513-0570

- Demonstration Projects
- Accelerating Construction Transformation (ACT)

For the demonstration projects stream, a continuous intake process consisting of 4 windows using a 2-phased approach was adopted. Applicants were invited first to submit an expression of interest (EOI) for projects that can demonstrate an innovative way of using wood-based products, systems and building technologies in their design in addition to the use of advanced bio-based materials such as wood fibre insulation and cladding, to help reduce the environmental impact of buildings. The GCWood program received over 140 EOIs across the 4 windows.

The program has leveraged the experience and lessons learned from demonstration projects supported under the first GCWood (2018-23), by pivoting its focus to areas of high growth potential that are regionally representative and are highly replicable. The program is targeting innovative building solutions that utilize prefabrication including modular buildings, retrofit techniques, and design for disassembly/adaptability (DfD/A) using wood-based products and systems. In particular, the program has expanded its focus to fund the demonstration of schematic designs, innovative building systems for wood construction, and the use of advanced bio-products in new and existing buildings.

The GCWood program aims to catalyze a long-term transformational change in which more intensive use of wood becomes a commonly considered option in all construction projects, with broader benefits being realized including greenhouse gas emission reductions and economic growth. To do so, the ACT stream is designed to support non-demonstration activities including advancing wood education, building capacity, and supporting revisions to building codes and standards.

The following section provides some highlights from some of the demonstration projects being funded under the renewed GCWood program.

2.4.1 LES PAVILLONS DU 49E

Les Pavillons du 49e is the first multi-storey residential building in Canada that uses innovative mass timber modular construction techniques. The project is looking to identify and mitigate the risks associated with the integration of this new construction system on the market.

The prefabricated mass timber modules were prefabricated at the plant using a combination of CLT and glulam. The modules were semi-finished in the factory, packaged, stored and finally transported for quick installation and closing on the site (Figure 11). This is the second building of two 4-storey modular mass timber buildings constructed on the same site. Lessons learnt from the design and construction of the first mass timber modular building were adopted in the design and construction of the second modular building. Modular, move-in-ready mass timber construction will accelerate the delivery of affordable housing, particularly in remote communities and in locations where the cost of conventional construction slows real estate development. The structural elements, namely glulam and CLT, are expected to store more than 880 tonnes of CO_2. The construction of the building is almost complete.

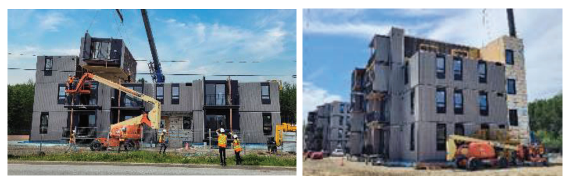

Figure 11. Les Pavillons du 49e modular building (Courtesy of Nordic)

2.4.2 BCIT'S CARPENTRY PAVILION

The Project will deploy innovative wood-based and sustainable building solutions for a Carpentry Pavilion project that will demonstrate sustainability and wood construction innovation for a 2-storey institutional building made primarily out of mass timber (foundation to roof) at the British Columbia Institute of Technology (BCIT) campus (Figure 12).

The building will be a unique Passive House certified mass timber building designed to deliver hands-on training programs in mass timber and hybrid construction, becoming a hub for sustainability and wood innovation on the BCIT campus. The project will consist of several mass timber components such as a CLT roof, second floor, walls, stairs and canopy above the accessible entry bridge. High-performing advanced bio-based products, such as timber façades, and wood fibre insulation will also be incorporated wherever feasible.

As a Zero Carbon, Passive House and LEED Gold certified Mass Timber building dedicated to Mass Timber training and education, the Pavilion will demonstrate the use of innovative wood and sustainability solutions to support the Canadian wood industry, using a local-build approach, and act as a leading example of de-carbonization. In terms of GHG mitigation and reduction, the use of mass timber structural systems as well as a "whole wood" approach is expected to lower the building's carbon footprint by reducing the embodied carbon by an estimated 35%, compared to conventional construction, in addition to operating energy savings.

Figure 12. Rendering of the Carpentry Pavillion, Vancouver (Courtesy of Naturallywood)

2.4.3 RAINWATER CONDOMINIUM

The Rainwater Condominium project design incorporates an innovative hybrid mass timber and steel system that will demonstrate a cost-efficient, sustainable and replicable building solution in a multi-unit residential setting.

The Project involves constructing a five-storey, 38,000 sq ft, 38-unit residential condominium in Barrie, ON, featuring advanced energy-efficient and sustainable design elements that aim for NRCan's Energy Star certification. This will be the first building in Canada designed and built using a new hybrid mass timber and light gauge cold-formed steel (CFS) stud wall called CLT-CFS system which will serve as proof of concept for scalability and replicability of the system in mid-rise buildings, potentially up to 12 storeys or more. The Gravity Load-Resisting System of the system uses CFS walls to support double or triple-span continuous CLT floor panels. The lateral load resisting system consists of steel cross bracing.

The conventional concrete system would have been approximately 11 times more carbon intensive than the new CLT-CFS system that is being used. The avoided emissions are expected to be 358 tonnes of CO_2. The project is currently in construction (Figure 13).

Figure 13. CLT/CFS system with CFS cross bracing

2.4.4 POST LOFTS RETROFIT PROJECT

This project involves retrofitting a 2-storey heritage post office building with an additional nine storeys of mass timber on top (Figure 14). The original building's historic façades and structure will be preserved given its heritage status while integrating glulam posts, beams, and CLT floor slabs (Figure 14).

Reinforcement of the existing foundation will need to be undertaken, however, the weight of the 9 storeys of mass timber is significantly less than an equivalent concrete or steel building. As one of Ontario's first "build on top" projects, it will set a precedent for retrofitting older concrete structures using mass timber and highlight wood's potential as a sustainable, carbon-efficient alternative for taller buildings. Post Lofts will also employ advanced 3D and 4D BIM modeling and optimized construction methods to maintain the heritage structure while ensuring schedule and budget efficiencies.

Initial estimates for mass timber include 879 tonnes of GHG emissions avoided and 2273 tonnes of CO_2 stored in the timber. The project is at an advanced stage of design development and may qualify for LEED certification.

Figure 14. Rendering of Post Loft Retrofit Project (Courtesy of Moriyama Teshima Architects)

3 – EDUCATION, DESIGN TOOLS, AND CODES

During the first iteration of the program, GCWood funded the implementation of a national wood education roadmap developed several years ago by the Canadian Wood Council (CWC). The program also funded the development and deployment of several advanced design tools to assist designers, builders, and decision-makers. Meanwhile, the GCWood program has been funding critical fire and seismic research and development activities to support codes and standards in Canada as related to the design and construction of wood buildings.

https://doi.org/10.52202/080513-0570

3.1 NATIONAL EDUCATION ROADMAP

Until five years ago, only a few Canadian engineering and architectural schools offered wood design courses at the undergraduate level. To address this gap, the GCWood program funded the implementation of a Canadian wood education roadmap, led by the CWC. The goal is to expand wood education at Canadian universities and colleges, and consequently, contribute to the development of the future timber design capacity in Canada.

The architectural and engineering community is always changing, and professionals need access to state-of-the-art tools, resources, and continuing education to ensure the wood products industry remains competitive. Innovation doesn't always start on the construction site, but often through the students and recent graduates who shape the next wave of design and construction. Therefore, expanding the wood education curriculum in Canada requires supporting an engaged network of enthusiastic educators, as they are essential to equip future professionals with a solid foundation of knowledge and skillsets. The focus of the Education Roadmap was to:

1. Build a network to support educators and institutions to increase availability of curricula and wood design information.
2. Develop new curriculum, manuals, course materials, presentations, lectures, design exercises, and sample calculations.
3. Develop several teaching modules, interactive case studies, hold site visits and tours, and host student competitions.

Three new sets of teaching manuals were developed: Wood Design for Architects, a Wood Handbook for Builders, and an Advanced Wood Engineering Manual. So far, project activities have led to the addition of wood design and construction curricula at 11 accredited Civil Engineering, Architectural and Construction Management programs across Canada with significant uptake by students. These efforts led to the development of "WoodSmart" program (https://woodsmart.ca/) by the CWC which is intended to support post-secondary institutions, educators, and students to ensure future architects and construction professionals have the knowledge and skillset in the design, manufacture and assembly of advanced wood buildings.

3.2 DESIGN TOOLS

To support the deployment of mass timber construction in Canada, the GCWood program has funded the development and deployment of several advanced design tools to assist designers, builders, and decision makers. Overall, the program supported the development of over 10 new design guides, tools, and datasets. This includes advanced wood design handbooks, carbon calculators, and LCA data and tools to demonstrate the environmental benefits of building with wood. To further the government's carbon accounting goals, GCWood provided funding to a 4-year Low-Carbon Assets through Life Cycle Assessment initiative led by the National Research Council of Canada (NRC). This initiative focused on developing a national Life Cycle Inventory (LCI) database and whole building LCA guidelines. The LCI data and LCA guidelines will be used to facilitate procurement policies at the federal and provincial levels, and by the design and construction industry. Meanwhile, the program continues to work closely and coordinate with colleagues at NRC on the *Platform to Decarbonize the Construction Sector at Scale*, *Construction Sector Digitalization and Productivity Challenge* program on offsite construction and the *Low Carbon Built Environment Challenge* program.

3.3 UPDATES TO CANADIAN BUILDING CODES

The 2020 edition of the National Building Code of Canada (NBCC) was published in the Spring of 2022 and allows for Encapsulated Mass Timber Construction (EMTC) up to 12 storeys. Several jurisdictions including British Columbia, Ontario and Alberta have adopted the EMTC provisions in their respective codes. In addition, extensive efforts are being invested in transitioning the NBCC to become more performance based in the future.

Several research projects (mainly on fire and seismic performance) were conducted at the NRC in close coordination with CWC and FPInnovations, with funding from GCWood, to support the EMTC code change provisions at the time. This also included developing research to support a performance-based code, targeting the 2025 and 2030 editions of the NBCC. The fire testing focused on the allowable percentage of exposed mass timber that should be permitted in EMTC buildings, and the effectiveness of water mist systems compared to conventional sprinkler systems that are commonly used in tall buildings.

Additional research is ongoing to develop seismic design guidelines for mass timber shear walls for tall wood building applications. A technical guide was developed and published recently by the Canadian Construction Materials Centre (CCMC) which will be used to support future code change provisions for tall wood buildings. The guidelines presented in the CCMC Technical Guide were

https://doi.org/10.52202/080513-0570

used to refine the current seismic design provisions in the 2024 edition of the Canadian Timber Design Standard CSAO86 [8].

More recently, several jurisdictions in Canada including British Columbia and Ontario, amended their building codes to allow EMTC up to 18 storeys for residential and office buildings from the previous 12-storey limit. The amendments also allow for more exposed mass timber in buildings, depending on the building's height and use. For example, residential buildings up to eight storeys tall can have more exposed mass timber. Moreover, EMTC will now be allowed in a wider range of building types including schools and light/medium industrial facilities. It is anticipated that the NBCC and other jurisdictions in Canada could adopt similar provisions in the future.

NRCan has been funding critical research and development activities to support the NBCC code change process since 2010 and will continue to support future developments of the NBCC targeting a more performance-based code by 2030.

3.4 MASS TIMBER FIRE DEMONSTRATION TEST

To support current and future code change proposals on mass timber, a national research project focused on demonstrating the fire performance of mass timber in tall wood buildings applications was conducted in Canada from 2021-23. The project was led by the Canadian Wood Council, and was funded jointly by federal and provincial governments, including NRCan, NRC, and the provinces of Ontario, Quebec, British Columbia and Alberta. The project's main objective was to support the approval of tall wood buildings in Canada and future building codes revisions.

The project comprised of two main phases: Phase One involved conducting a series of pilot fire performance demonstrations, which were carried out successfully in Vancouver in June 2021 and represented typical construction fire scenarios. Phase Two was focused on testing a full scale 2-storey open office space mass timber structure. Findings from the pilot demonstration under Phase One were used to refine the design of a full-scale mass timber structure and were used to support the approval of several tall wood buildings in British Columbia.

In August 2022, five different fire scenarios were conducted on the full scale 2-storey mass timber structure designed and built at NRCan's Canadian Centre for Mineral and Energy Technology (CANMET) in Ottawa. The tests investigated among other things, the fire performance of partially exposed mass timber, fire dynamics, construction fires, and garbage bins fires. The first major test conducted in Phase Two was the world's largest mass timber fire demonstration to date.

Test results have successfully indicated that the fire performance of the mass timber structure was similar to that of non-combustible construction and confirms that mass timber can perform well under rare fire scenarios in which the sprinkler system fails, and the fire department is unable to respond.

A key goal of the fire tests was to demonstrate to a host of construction decision makers that the fire performance of mass timber construction can meet, or even exceed, the performance achieved by non-combustible construction as permitted in the building code. Over 150 experts from across Canada, including fire officials, building regulators, insurance industry representatives, engineers, and architects (including those from governments), witnessed the test to learn about the behaviour of mass timber construction under fire conditions.

Test results are being used to support current and future code change proposals, including performance-based codes and the development of alternative solutions and new fire suppression systems.

Figure 15. 2-storey Mass Timber Fire Demonstration Test

4 – CONCLUSIONS AND RECOMMENDATIONS

Given the current interest and commitment by the Canadian government and industry at large in supporting the decarbonization of the construction sector as a major emitter of GHG emissions, the Government of Canada has been investing in expanding the use of wood as a low-carbon building material in Canadian infrastructure projects. Through demonstration projects and strategic construction market transformation activities focused on advancing wood design education, building capacity, and supporting science-based codes and standards revisions,

https://doi.org/10.52202/080513-0570

the GCWood program is catalyzing greater market and regulatory acceptance of wood in non-traditional construction applications across Canada.

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