Sustainability Case Study Limberlost Place

LOCATION
Toronto, Ontario

CLIENT
George Brown College

PROJECT TEAM
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CONTEXT

To have meaningful impact on the urgent climate emergency, building design must not only adapt and innovate but aspire to change the culture and expectations of all those connected to the building. This includes everyone from those involved in the act of building and design, to the end users themselves. Architecture can influence our daily lives and behaviours, and architects, builders, and clients not only have responsibility but also agency in shaping this. Recently, the conversation on sustainability has been shifting from energy to carbon – this is a sound and necessary shift, however, the job of reducing energy consumption is not done yet, and it will be years before the transference to clean grids in our urban centres is realized. Holistic approaches to reducing consumption, and seeking renewables in all aspects of a building, must be considered as industry and infrastructure makes its transition to decarbonizing.

Moriyama Teshima Architects have been working on a number of high-performance buildings that take a multi-pronged approach to achieving sustainable targets. The façades play a significant role in not only the performance of the building, but in making the building operations intuitive for its users and occupants. We feel this is one way of addressing the issue of changing expectations and culture.

One of these projects is Limberlost Place (formerly The Arbour) for George Brown College, designed in collaboration with Acton Ostry Inc.. This buildings is a mass timber structure, and achieves the highest levels of our municipal targets, well in advance of the 2030 TEDI, TEUI, and GHGI reductions. Key project team members in achieving these are targets are Fast + Epp structural engineers, Transsolar KlimaEngineering, and Introba. The constructor is PCL Construction with internal George Brown College Project management.

SECTIONAL DIAGRAM

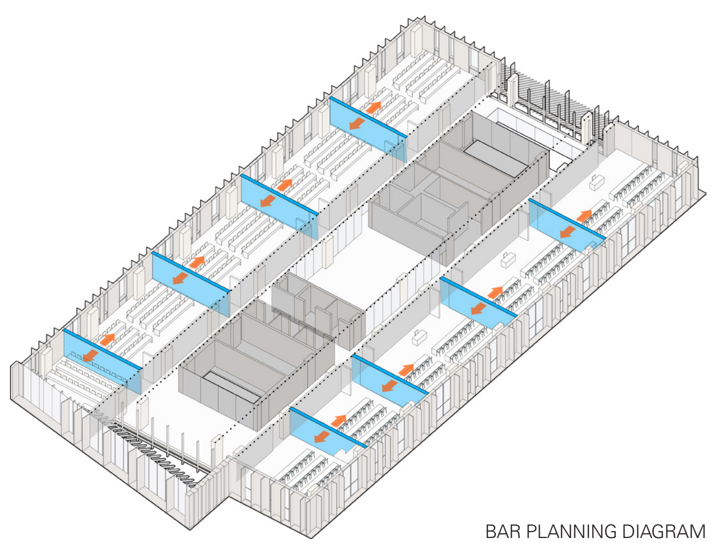
Diagram is representative of competition design.

BREATHING ROOMS

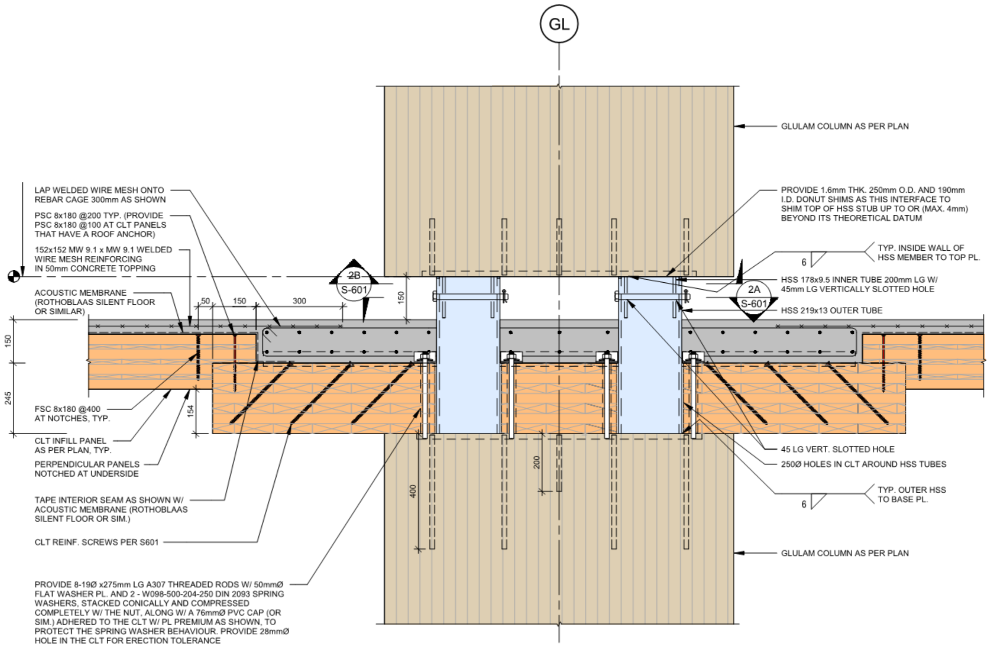
Limberlost Place is organized sectionally around "breathing rooms" or social spaces distributed throughout the vertical expanse of the 10-storeys of the building. Recognizing the challenge of vertical campuses to draw the student life up and through the building, we distributed higher volume spaces at a variety of scales to have the social life of the community permeate all levels rather than contain it solely to a centralized volume. The "breathing rooms" are located at the perimeter of the building on the north, east, and west sides, animating Queens Quay Boulevard and offering views to Lake Ontario and the developing East Bayside waterfront community. The first "room" is the learning landscape, a tiered space that rises three-storeys along Queens Quay Boulevard. From the fourth floor onward, rising in a skip pattern, are cozier two and three-storey rooms, bookending each floor, and meant as informal gathering spaces for students.

3-BAR PLAN

The project is organized around a 3-bar plan. The dark program, cores, services, and vertical circulation, occupy the middle bar protecting the perimeter for classrooms and breathing rooms. In doing so we arranged the building to be able to maximize access to daylight and reduce artificial lighting loads in the occupied areas rather than placing the public and teaching spaces deep into the floorplate. This organizational pattern fits well into a regular repeating grid as the classrooms are only restricted in one direction by structure. This contributes to the futureproofing or resiliency of the project whereby lightweight non-structural demising walls can be relocated over time as needs and programs change contributing to the long-term life of the building. The planning is further refined to limit all computer labs to the north side of the building to avoid the large energy draws from being further taxed by southern heat gain.



BAR PLANNING DIAGRAM



TYPICAL TIMBER CONCRETE COMPOSITE (TCC) SLAB BAND SECTION DETAIL AND COLUMN CONNECTION

COLUMN-FREE CLASSROOMS

Despite the focus on flexibility and the communal space of the project to organize the design, the critical success factor for this building was to achieve excellent classrooms to support the core function of the building. The criteria for a typical section module, 40 to 50 student classrooms, was to achieve the following:

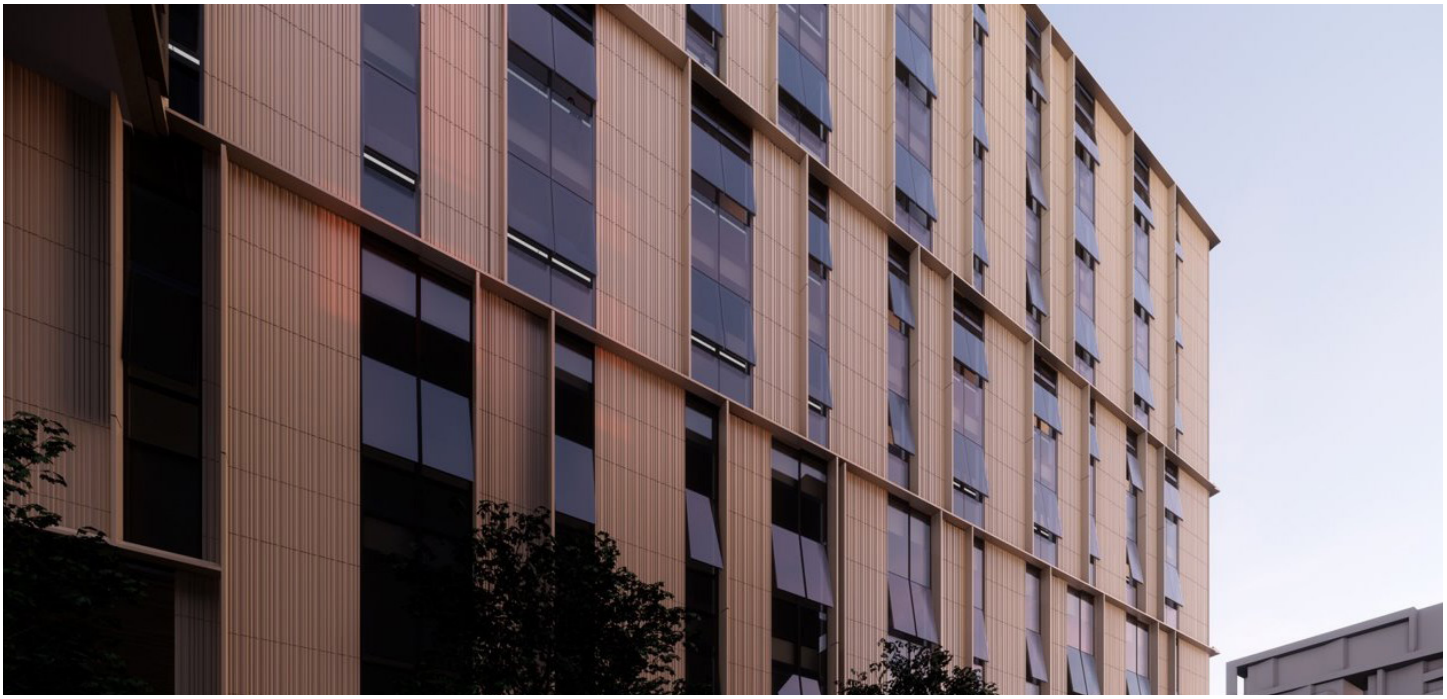
- Column-free spaces for good sightlines
- Acoustic separations
- Access to daylight and view
- Generous supply of fresh air
- Comfortable thermal conditions
- Good lighting for writing surfaces
- Flexible use and accessible furniture
- Advanced audio-visual equipment

The most challenging of these in the context of a mass timber building was to achieve a 9m span which would allow for these column-free spaces for 40-50 students within the cost and height restrictions on the site. In the East Bayfront community at Waterfront Toronto there is a strict 38m street wall along Queens Quay Boulevard, the main thoroughfare, that is intended to establish continuity of the urban fabric in the newly developing area.

The resulting solution was to seek a “beamless” system that could liberate and maximize space for use but achieve a minimum 9m span in 1 direction. Fast + Epp Engineering created a 3-component mass timber solution that is extremely shallow for this span, with a system that is comprised of bespoke glulam columns and main CLT/concrete composite spanning elements called “slab bands” and standard CLT infill panels. As described by Fast + Epp Engineering:

From level 2 to level 9, Cross Laminated Timber (CLT) panels are used as the primary floor system. To eliminate the use of beams and create more head clearance as well as the space for mechanical and electrical components, 7-ply CLT panels span 9.2m in the north-south direction to act as slab bands on which thinner 7-ply CLT panels will bear in the perpendicular direction. The typical 430x1178 columns, supporting the main CLT “bands” are designed to resist their weak axis bending induced by the thinner CLT panels. As shown in Figure 1 below, 50mm non-structural and 150mm structural concrete topping is added on top of the CLT panels not only for an architectural purpose, but also to further reinforce the panels. The engagement of the concrete topping with the timber below will be maximized using various steel connections.

The connections to the concrete were the subject small-scale, half-scale and full-scale testing conducted in collaboration with UNBC and Beiberech University. This research which is publically accessible through the Federal agency NRCAN who funded the research has further advanced our collective understanding of timber concrete composite systems and the connection details between the two materials. The research demonstrated that the most economical of the systems, a metal bar friction fit into the top lamination of the slab band was the preferred connector.



RENDER OF BUILDING ENVELOPE

BUILDING ENVELOPE

A major advantage of a mass timber construction is the speed with which it can be erected in comparison to traditional cast-in place concrete or steel counterparts. Alongside the efficiencies afforded to the structural elements themselves, a prefabricated building envelope can further accelerate overall construction schedules. A fast enclosure limits weather exposure to the structure and protects the wood from staining.

There are a number of additional benefits to utilizing prefabricated envelope systems including, enhanced design assist opportunities, greater quality control (as the panels themselves are constructed in a conditioned and well-monitored environment), reduced construction waste generated at the building site (most waste being produced in the factory where it is easier to handle and to divert to the appropriate recycling streams), and full system warranty. Together, these two systems exploit just-in-time principles for a quiet and clean job site that minimizes neighbourhood construction noise and disruption resulting in an exemplary model for urban construction in high density, zero lot line situations.

Prefabricated envelope systems also provide enhanced safety measures during manufacturing and installation. Manufacturing takes place in a safe and secure factory setting and panels are installed by craning and guiding them into place while standing inside the building with no need for swing stages or scaffolding. This type of construction methodology further translates to reduced labour on site, with only two tradesman and a crane operator required to carry out panel installation.

In the case of Limberlost Place, the vertical banding of the design lent itself to a vertically oriented two-storey prefabricated panelling system. Several design considerations defined the development of this panelling – namely the building's floor-to-floor heights ranging from 4.2 metres to 6 metres, the large areas of unitized curtain wall integrated with prefabricated panel, the complex geometry of the solar chimneys and angled roofs, operable window size limitations, rainscreen principal design, and extremely ambitious energy performance required to meet Passive House requirements.

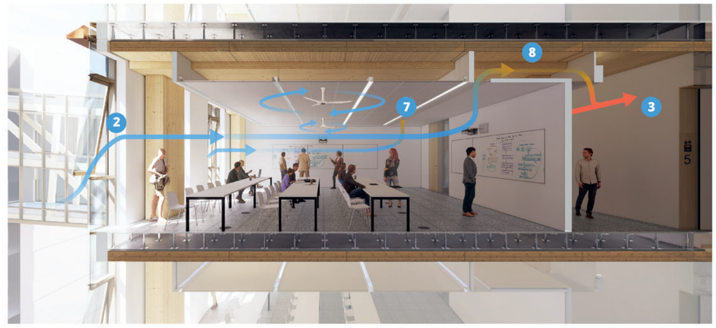
BUILDING FORM

Perhaps one of the unexpected revelations about the design of Limberlost Place is that one of the primary elements contributing to the sustainability of the project is the form of the building. While, from a planning and design perspective, the project's proximity to Sherbourne Commons – a public park, gives opportunity to consider a striking profile that will be legible in perpetuity because the adjacent property will not be developed. The most striking form, the significant peak of the project, is derived from 3 major sustainability measures:

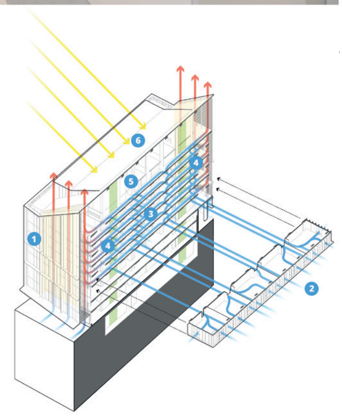
1. The east and west façades of the building act as passive solar chimneys allowing fresh air to be drawn from operable windows in classrooms and offices, through the corridors and then out to the solar chimney at each floor. This solar chimney starts on the second floor and continues up above the building roof creating a non-fan enabled stack effect and becomes part of the architectural profile.
2. The building stretches up to the north to maximize the north light to the upper floors and slopes to the south to minimize heat gain on the upper floors from the south.
3. The slope becomes a natural armature for the solar PV, utilizing attachments to the standing seam roofing rather than a full secondary armature to create the slope.

The building envelope is also organized to consider the future needs of the project. There are expanses of curtainwall strategically located to take best advantage of the views and contribute to an active waterfront community. The main body of the building is envisioned as a protective high performance prefabricated envelope to protect the timber and provide a well-insulated sealed envelope targeting just over a 40% window to wall ratio. Windows placed every 3 meters support the idea that demising walls can move. Even the smallest foreseeable unit, an office space, could have access to natural light and air. The R-value of the solid portions of the envelope are designed to R-30. In the context of a prefab envelope the weak point are the seams between panels currently under careful development as the design progresses and are resolved through use of gasketed seams.

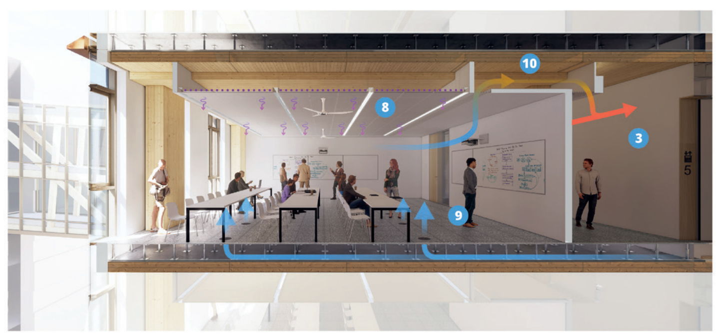
PASSIVE MODE



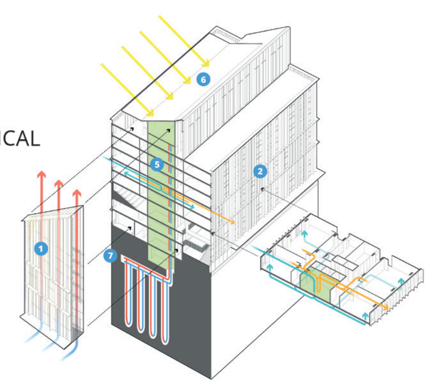
1 SOLAR CHIMNEY
2 OPERABLE WINDOWS
3 VENTED HALLWAYS
4 BREATHING ROOMS
5 DE-CENTRALIZED MECHANICAL
6 SOLAR HARVESTING
7 CEILING FANS
8 ACOUSTIC TRANSFER VENT



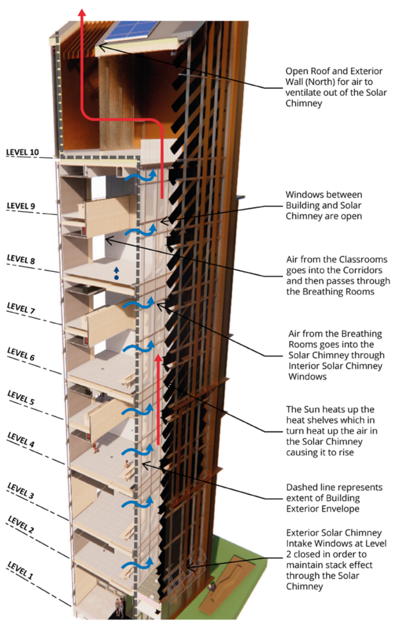
ACTIVE MODE



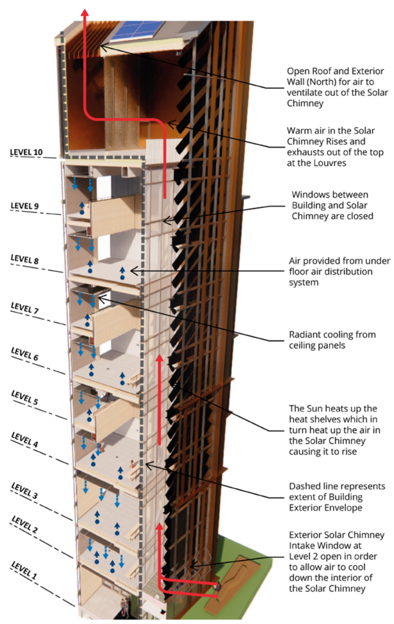
1 SOLAR CHIMNEY
2 OPERABLE WINDOWS
3 VENTED HALLWAYS
4 BREATHING ROOMS
5 DE-CENTRALIZED MECHANICAL
6 SOLAR HARVESTING
7 DISTRICT ENERGY
8 RADIANT PANELS
9 SUPPLY AIR
10 ACOUSTIC TRANSFER VENT



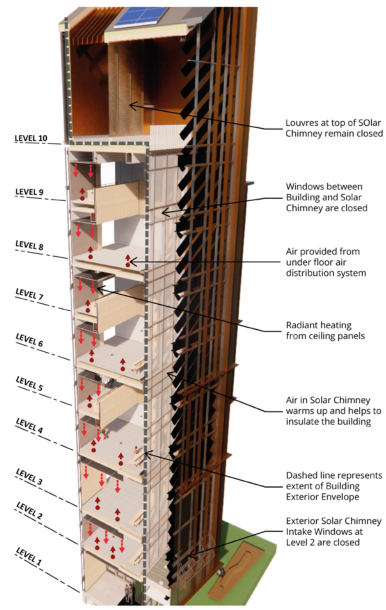
LIMBERLOST PLACE SUSTAINABLE HEATING AND COOLING STRATEGIES



1 PASSIVE - NATURAL VENTILATION MODE



2 ACTIVE - COOLING MODE



3 ACTIVE - HEATING MODE

SOLAR CHIMNEY OPERATION MODES

NATURAL VENTILATION

Natural ventilation was an additional consideration in the design of Limberlost Place. The prefabricated envelope incorporates a natural ventilation system through both powered and manual operable windows. A rooftop weather station sends wind speed, air quality, and temperature readings to the building operating system to control the opening and closing of the windows when appropriate conditions arise. The operating system includes control wiring for operable windows that are integrated into the prefabricated panels themselves. During passive mode, air will travel through operable windows into classrooms, offices, and meeting rooms, then into the corridors through acoustically lined transfer grilles where the air makes its way into the east and west solar chimneys. Stack effect then pulls the air through the solar chimney to 1.5-storeys above the highest occupied floor and vented out the roof. When the system is in passive mode, mechanically operated ventilations systems shut down, reducing energy usage. Due to the unique and innovative nature of the solar chimneys, an Alternative Compliance was required to approve its use on the project.

	TORONTO GREEN STANDARDS V3 TIER 4	LIMBERLOST PLACE
TEUI	65 kWh / m^2 / year	54.2 kWh / m^2 / year
TEDI	15 kWh / m^2 / year	12.8 kWh / m^2 / year
AIRTIGHTNESS	No Requirement	0.4 AC/hour (estimated)
GHGI	5 KG C0$_2$ e / m^2 / year	2.5 KG C0$_2$ e / m^2 / year

LIMBERLOST PLACE NORTH ENTRANCE

LIMBERLOST PLACE ‘BREATHING ROOM’ COLLABORATION AREA ADJACENT TO SOLAR CHIMNEY