10 Reasons To Build With Mass Timber

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Are you considering using mass timber as a structural system for your next building project? If so, you will want to check out the ***10 Reasons To Build with Mass Timber*** *below along with the* ***10 Things To Watch Out For****.*

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Many of our clients are now asking us about whether they should consider using mass timber as a structural system for future building projects, and how best to do so. Mass timber provides a great many benefits but also comes with some material-specific challenges that need to be considered for a successful project outcome.

To help our clients and others in their consideration of mass timber as a structural system, we have put together a list of ten key benefits of building with mass timber as well as ten things to watch out for. Before we get started, here is a quick primer.

Here is a good example of a community college building with a mass timber structure. Located on Centennial College Progress Campus in Scarborough, Ontario, the A-Block Expansion Building (design by DIALOG in association with Smoke Architecture with EllisDon Constructor and team leader) will have the potential to become the first net-zero carbon, mass timber, LEED® Gold higher-education facility in the province of Ontario when it is completed in 2023. It will also embody the College's deep commitment to truth and reconciliation.

What is Mass Timber?

Mass Timber is a structural building material fabricated from wood pieces or "lamella" glued together under pressure to form larger structural elements such as floor or roof decks as well as structural columns and beams. The Mass Timber Institute describes mass timber as structural materials that "... are fabricated by gluing, nailing or doweling smaller pieces of wood together to create larger structural members."[1] Mass timber can be an alternate to steel and concrete in low and mid-rise buildings and can be used in combination with concrete and steel in a hybrid system for taller structures.

The two primary types of mass timber that you've probably heard about are Glue Laminated Timber (GLT or Glulam) and Cross

Laminated Timber (CLT) panels. With Glulam, the grain is in the same orientation with each successive layer while with CLT the grain is alternated to increase strength. In total, there are eight engineered wood products that are typically described as mass-timber materials:

- Cross-Laminated Timber (CLT)
- Glue-Laminated Timber (Glulam/GLT)
- Dowel-Laminated Timber (DLT)
- Laminated Veneer Lumber (LVL)
- Nail-Laminated Timber (NLT)
- Mass Plywood Panel (MPP)
- Laminated Strand Lumber (LSL)

Here is an example of a community education facility with a mass-timber structure. Heralded as one of the most sustainable buildings in Canada, the Bill Fisch Forest Stewardship and Education Centre (BFFSEC) promotes the significance of forest ecosystems through spaces

for education, corporate, and community meetings. The Centre has a mass-timber structural systems and has taken on the most vigorous sustainability certifications in the world and has already achieved LEED® Platinum, is Petal Certified by the International Living Future Institute, and is the first Living Building Challenge project in Canada. Design by DIALOG.

Procuring mass timber for your project

There are a number of suppliers across Canada and many more in Europe (when this article was written we were touring the key manufacturers in Europe. Given the current 2-year backlog in Canada, you may want to include these suppliers in your procurement plans; please contact us for an overview of the primary European manufacturers). It's important to do your due diligence when it comes to procurement.

For example, different manufacturers have different capabilities of producing mass timber in longer spans, so you will want to design your structure for CLT and GLT dimension that can be manufactured by a number of manufacturers so to ensure you some competitive supplier choices.

And not all mass timber is made using the same species or grade. Products can be manufactured from spruce, pine, larch, Douglas-Fir or other species that are available to each manufacturer. Different species and grades will have different strength properties. Different species will vary in colour. If you are going to use different species for different structural components, make sure you consider the strength profiles of the species being used, as well as how the different colours will work in your design scheme.

In addition, not all CLT is manufactured with the same lamella dimensions. Some manufacturers build their 5 ply CLT out of 5 equal 35mm material (35/35/35/35/35) for a total thickness of 175mm, while others alternate thinner material (35/17/35/17/35) for a total thickness of 139mm. This also holds true for 3, 7 and 9 ply CLT members. So make sure you know what you want and what you can obtain from the manufacturers you are considering.

All this is to say that you need to do your homework and know your supplier/manufacturer.

Building a qualified consultant team

As we assembled this list, we realized that it is a simpler task to outline the benefits of mass timber than to explain the challenges. Many of the benefits can be discovered with a thorough search online; identifying and managing the challenges is something one needs to learn by doing.

One of the key things you will want to do to be successful in designing and building with mass timber is to bring together a team with the necessary mass-timber expertise and experience. For example, unless you have deep knowledge of mass-timber construction, how would you know which membrane works best between CLT and concrete topping? No membrane means the wood soaks up the moisture of the topping, while a membrane that’s too impermeable means the concrete takes longer to dry. It’s a goldilocks problem. Experience is therefore key to success.

Indeed, it's critical to ask your consultant team hard questions about the challenges of building with mass timber.

10 Reasons To Build With Mass Timber

Interior view of Bill Fisch Forest Stewardship and Education Centre in York Region. Design by DIALOG.

1. Light, economical structure

Mass timber is significantly lighter in weight compared with concrete and steel, even though it is designed to achieve similar high strength levels. A pure mass-timber building is lighter than conventional construction, requiring less concrete in the foundation, and thus reducing both the cost and amount of embodied carbon. Taller structures can be hybridized; increased heights come from steel columns and concrete core.

2. Reduced on-site construction time and on-site labour

Prefabrication can significantly reduce on-site construction time as well as reducing the number of constructors on site. There is additional benefit on tight job sites with little space for lay-down, concrete delivery/mixing and/or steel fabrication.

3. Lower embodied carbon vs. steel or concrete

There are two components that contribute to the lower embodied carbon in mass timber versus steel or concrete: the first is avoided carbon from not using concrete or steel, both of which are difficult to decarbonize. The second is from the biogenic carbon sequestered in the wood (see next section). A life-cycle analysis on our Hybrid Wood Tower prototype (winner of Fast Company's 2021 World Changing Ideas Award in Architecture) revealed that avoided emissions accounted for about one-fifth of the embodied carbon reduction, and biogenic carbon the other four-fifths. Floor systems represent the majority of embodied carbon in a structure and are good candidates for mass timber or hybrid mass-timber solutions.

4. Carbon stored in wood

As noted above, a significant part of the lower embodied carbon of wood is due to the biogenic carbon stored in the wood. It is estimated that one cubic metre (m3) of mass timber sequesters one tonne of carbon dioxide from the atmosphere. By contrast, it is estimated that every tonne of manufactured cement produces about 0.47 tonnes of carbon dioxide, and every tonne of steel manufactured produces about 0.6 tonnes of carbon dioxide. Therefore, the use of mass timber in place of concrete and steel significantly reduces the embodied carbon of construction.[2]

5. Self-protection from fire

Unlike steel, mass timber is self-protecting during fire; the timber chars on the outside to create a layer of insulation that protects the interior from damage. The rule of thumb for the charring rate of solid wood and glue laminated lamella members is 0.6 mm per minute (1½" per hour) and will vary depending on the timber density. A 2-hour floor rating can be achieved through a thicker assembly (197mm vs typical 175mm). The North American market requires more stringent glues that have better properties against fire. These glues are approximately 5% more costly. However, most international Mass Timber suppliers are aware of this requirement.

6. Quieter & cleaner construction on-site

Prefabrication means that noise and toxic dusts are managed mostly in the factory rather than on site, where there are more options for mitigating these effects. This makes mass-timber construction projects more of a "good neighbour" than traditional construction, a benefit that is especially valuable in densely populated areas or on sites which need to continue to function during construction (e.g., a university campus).

7. Less waste

As much as 30% of materials in typical construction end up as waste.[3] Prefabricated mass timber produces much less waste than steel or concrete construction, which saves time, money and carbon.

8. Material reclamation

It is possible to disassemble prefabricated mass-timber components for reuse or re-fabrication at end-of-life. This requires foresight and planning, and benefits from modularity and standardization, but makes mass timber ideally suited for circular design[4] or buildings as materials banks.[5]

9. Improved seismic performance

Timber has been used in the construction of traditional buildings in earthquake-prone areas for centuries. Mass timber's light weight makes it a good performer in seismic events; because it is approximately 25% to 45% of the mass of comparable concrete buildings, mass-timber buildings reduce seismic forces. Mass timber's significant strength for its weight enables it to be much more effective in earthquakes than steel or concrete.

10. Biophilic effect of exposed timber

Biophilic qualities make mass timber an attractive material to use for work and living environments. A 2006 Canadian study revealed that people prefer "completely wood dominated" interiors, describing them as more "warm," "inviting," "homey," and "relaxing" than other tested materials.[6] Additional studies have shown that wood interiors lower blood pressure and heart rates, reduce stress and anxiety, and increase positive social interactions, including in school environments.[7],[8],[9]

Here is an example of a university student centre that used a hybrid structure of concrete and mass timber. This is the University of British Columbia's Student Union Building, the Alma Mater Society (AMS) Nest. It is a LEED® Platinum certified mixed-use facility designed by DIALOG in collaboration with B+H. The program represents a broad range of the student-operated food, beverage, and retail services that generate income. Atypical features include an art gallery, radio station, roof-top garden, climbing wall, and numerous unstructured learning spaces.

10 Things to Watch Out For

No structural system is perfect, and every system comes with its challenges. Below we have listed ten things that you will want to watch out for when you are considering designing a mass-timber structure.

1. Immature supply chain in North America

While we have extensive forests in Canada, the mass-timber industry here is still playing catch-up to the more mature European market; there are currently just four CLT and six Glulam

manufacturers in all of Canada. Depending on their capacity and demand, there may be time and cost premiums; for example, at the time of publication, there is a 24 month wait time at Canadian manufacturers. A number of European mass-timber fabricators, however, do export to Canada.

2. Potential complexity creep

Unless your design team has the requisite experience and expertise in mass-timber construction, designs can often become overly complex, due to an unfamiliarity with the material and/or an over-exuberance towards its design potential. This can be managed through a series of strategies including simplifying and reducing the number of member-to-member connections; avoiding complex connection details; planning for mechanical and electrical services with a higher plenum to clear up clutter; and implementing modularity and standardization. Simplifying details can result in cost savings on site.

3. Tighter column grid

The most economical bay sizes of mass timber differ from those of concrete and steel framing. Depending on the floor loading, a tighter column grid is typically anticipated; a typical bay size for a 175mm thick 5 ply CLT and Glulam structure would be approximately 5.5 metres x 8 metres, whereas a steel frame or concrete grid would be closer to 9 metres by 9 metres.

4. Costs to reduce vibration

Mass timber floors have a high strength-to-weight ratio. The benefit (as noted in the *"reasons to build with"* section above) is a lightweight system, however, the lower weight means that vibration is a more significant factor and therefore vibration design is a key driver of mass-timber framing system costs, as greater floor thicknesses are required to reduce vibration.

5. Need to protect connectors from fire exposure

Mass-timber structures meet or exceed existing fire and seismic codes in the jurisdictions in which they are built. Though charring layers can be added to the design of mass timber to provide the necessary fire ratings, the steel/aluminium connectors must also be protected from exposure to fire. Therefore, careful attention to detailing the connections is required.

6. Water issues during transportation/construction

Water can be a significant issue on any construction site, but wood is particularly vulnerable to water. Although moisture monitoring shows that mass-timber elements exposed to water during construction can in most cases dry sufficiently after construction,[10] it is preferable to prevent the sustained presence of water during transportation and construction. Special care needs to be taken in protecting mass-timber elements during their transportation to the construction site as well as during construction. For temporary protection of vertical and horizontal surfaces self-adhered waterproofing membranes can be used. Liquid applied membranes can also be used for floor surfaces that will be covered by a concrete floor topping. The presence of moisture

during construction can swell the exposed timbers thus requiring the placement of judicial gaps to allow for this swelling.

7. Protection of timber members exposed to weather

Mass-timber frames are the finished exposed product, resulting in the beautiful wood post-and-beam aesthetic. Interior timber members will be exposed to weathering or UV light during shipping and construction, so they need to be coated and sealed, and exposed finished edges need to be detailed/specified in advance as typically they are rough finished unless specified otherwise. It's also wise to have a restoration strategy should the outer veneer be damaged (e.g., someone carves their initials in the wood.)

There continues to be much discussion in the industry about whether and how mass timber can be exposed to exterior conditions. Our advice to clients is that exterior mass timber must always be clad to protect it from moisture and UV. However, there are surface treatments available to provide protection against termite, fire, moisture or just to change colour, but we advise clients to think twice before exposing mass timber to the elements.

8. Coordination of unionized trades

When designing hybrid mass-timber structures, coordination of construction trades is important and often a challenge. In a typical hybrid structure where mass timber connects to conventional framing (concrete foundations, concrete elevator core walls, steel trusses or steel columns for larger spans), unionized steel and concrete trades may refuse to work with the mass-timber elements.

The responsibility of each trade must be clearly identified to avoid conflicts.

9. Building code challenges

Mass-timber buildings may not always meet the prescriptive requirements of the provincial building code (size of building, occupancy, building classification, flame spread rating/combustibility requirements of roof, etc.). An alternative solution may be required to demonstrate that the performance requirements are being met. However, some code requirements are non-negotiable, for example, timber must be covered with drywall in residential buildings, negating the biophilic potential of the wood.

10. Logistics of prefabricated panels

Care needs to be taken when planning for the moving and lifting of mass-timber panels. Panels must be within size limits for highway transport and should be shipped upright, otherwise constructors will need to flip the panels over with a crane on site which may damage them.

Here is an example of a commercial office building with a mass timber structure. 2150 Keith Drive by DIALOG is an innovative 10-storey mass timber building targeting high-performance environmental standards and will regenerate an emerging industrial neighbourhood. A cellular mass timber exoskeleton gives the building its striking appearance and provides a direct expression of its unique braced frame structural system. It will be the tallest braced frame mass timber project in North America.