Allianz Commercial

Mass timber

Emerging Risk Trend **Talk 2**

Emerging risks have unique characteristics that require specialist technical, management and organizational skills. Our Risk Consulting expertise across different industries and lines of insurance business around the world is key to helping companies understand and mitigate these exposures. In our Emerging Risk Trend Talk series, we address such topics, highlight loss events, and look at targeted loss prevention measures.

What is mass timber?

Mass timber is a relatively new type of engineered construction in which the majority of products are comprised of multiple wood pieces laminated (glued with adhesives) or nailed together to form larger, stronger members which can be used for columns, beams, roofs, floors, walls, etc. They are typically built off-site. There are a number of mass timber products that are widely used in the market for a variety of purposes, such as cross laminated timber.

Mass timber construction has been developed to address the limitations of solid sawn heavy timber, which is often not available in large sizes and may not be structurally efficient due to natural defects like knots and checks.

It is often combined with traditional non-combustible structural materials (steel and concrete) to create a hybrid mass timber construction style, allowing high-rise timber structures (e.g., more than 20-stories high) to be built more sustainably.

Mass timber is generally a lighter weight than other materials and can be used in prefabricated timber elements that are assembled off-site and delivered ready to the construction location, offering time and cost savings.

Hazards to watch

- **Fire**
- **Water damage**
- **Termites and insects**
- **Natural hazards**
- **Manufacturing, transportation and supply chain issues**
- **Workmanship issues**
- **Cost of repairs and rebuilding**

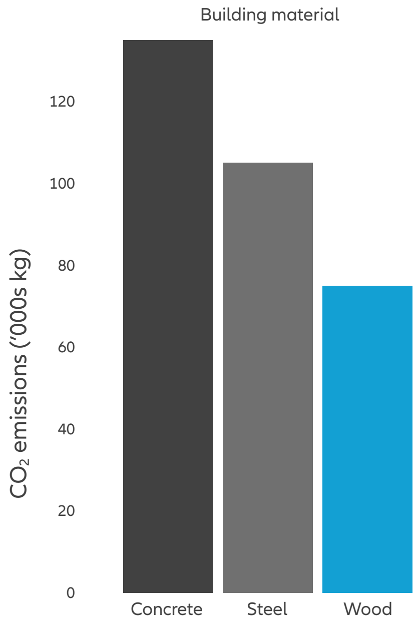
The trend

Offering significant economic opportunities in terms of cost and reduction in construction time, mass timber has the potential to be a critical building component for cities of the near future.

The global mass timber construction market is driven by factors such as the growth in awareness of the carbon footprint of steel and concrete construction. The building and construction sectors are among the largest contributors to Co2 emissions, accounting for over 34% of energy demand and around 37% of energy and process-related Co2 emissions in 2021[1]. The reduction of such emissions is essential to meet climate change commitments around the world.

As such, the emergence of mass timber as an alternative to concrete and steel represents a significant short and medium-term opportunity for the sector to reduce its carbon footprint *(see graphic)* while also satisfying a demand for construction that is more cost-efficient and as durable as steel and concrete construction.

Wood can reduce construction CO_2 emissions



Source: Forest Business Network, International Mass Timber Report 2022

From mixed use developments to hotels to schools, an emerging market is already being realized in mass timber buildings. According to a report by Allied Market Research, the global mass timber construction industry generated US$857mn in 2021, and is anticipated to generate $1.5bn by 2031, with a CAGR of 6.0% from 2022 to 2031[2]. However, as mass timber buildings evolve with greater height and intricate designs, they will pose new challenges in terms of risk mitigations.

Advantages of using mass timber

Material characteristics
- Lighter weight material that meets the same load capacities as concrete structures
- Predictable performance under fire exposure
- Better thermal resistance, resulting in lower heat loss.
- Wood is a renewable resource
- Aesthetic appeal.

Design characteristics
- Enhanced quality control / quality assurance (QC/QA) through prefabrication and integration of services in a controlled factory setting.
- Structural wood products that could double as interior finishes.

Cost competitiveness
- Construction costs may be lower than with traditional concrete and steel materials and methods due to less construction traffic and fewer workers.

  Expanding mass timber manufacturing/fabrication capacity will generate more cost-competitive bids.

Construction process
- Faster construction of superstructure (up to 25% faster)
- Quiet and safer construction sites.

Three timber takeaways

→ There were 139 mass timber buildings around the world of eight stories or higher, with 70% of these in Europe, as of February 2022.[3]

→ The height of the world's tallest timber building has tripled in just 10 years. The 85-meter Mjøstårnet in Brumunddal, Norway, was the tallest all-timber building in the world, of February 2022.[4]

→ More than 2,000 multi-family, commercial, or institutional mass timber projects were in progress or built in the US, as of December 2023.[5]

What are the main risks?

Fire

Mass timber is still wood, and fire remains the first concern raised with regards to structures.

Building with mass timber is relatively new and research and testing are ongoing to establish a methodology for determining the performance of structural elements during a fire. The risk of collapse during the cooling phase of a fire may be particularly critical for timber elements.

Design phase

The primary goal of building design for fire safety is to protect people (life safety) and manage the consequences of accidental fires. However, the regulatory frameworks for large mass timber projects are not yet fully standardized. Some countries only mandate life safety in their fire safety laws, while others include property protection as well.

In addition, some designers often need to develop prototype solutions. It can be unclear who is responsible for clarifying specific details, and experience in large mass timber projects is still limited.

Construction phase

Buildings with combustible elements are at the highest risk of fire during construction.

They combine exposure to ignition sources (such as arson, hot works, smoking, temporary equipment, hazardous operations, combustible materials) with an incomplete fire protection level (e.g., fire protection measures like sprinkler systems are not yet fully installed and operational and there is a lack of fire compartmentation, etc.,).

Compliance with loss prevention measures is therefore crucial during the construction phase.

Download

- Wood Construction Information Request
- Wood Construction Liability Information Request

Photo: Envato

Operational phase

Once a building is in operation, the risk of fire can increase depending on factors such as the type of occupancy, storage and interior fittings.

Sources of ignition in mass timber buildings include electrical wiring and cabinets, hot works, lighting and electrical equipment, heating or heating, ventilation and air conditioning (HVAC) equipment. The increase in fuel loads, which includes decorative materials, furniture, and equipment, also contributes to fire risk.

External exposures such as arson, wildfire, outdoor storage, utilities, and car parks also pose challenges.

If it is not encapsulated, exposed wood can form large parts of a timber building's surface area, contributing significantly to the fire/fuel load and changing the fire dynamics in a building.

Exposed timber can also increase the water requirements for firefighters and the radiated heat flux to neighboring buildings.

The use of glue also creates challenges including potential delamination, which occurs when the bond between individual wood pieces breaks down, typically at temperatures exceeding 250°C. Delamination can cause multiple flashovers, rekindling the fire and increasing the heat release rate. Proper manufacturing practices using heat-resistant adhesive can help mitigate this risk.

Metal connections exposed to fire can conduct heat into the timber member with which they are in direct contact, reducing the strength of the member and causing potential failure. Concealing all metallic components of a connector so they are not exposed to a fire and cannot transfer heat directly into the timber greatly improves fire resistance.

The presence of combustible concealed spaces/voids creates one of the greatest challenges. Fires in these spaces can develop and spread beyond the reach of sprinkler systems and other automatic fire protection measures. The correct design of joints, penetrations, and opening details is crucial to prevent the spread of fire.

Very tall timber buildings should be designed to minimize fire spread and structural collapse, ensuring the safety of occupants and firefighters and then property protection.

Photo: Envato

Allianz Risk Consulting Risk Mitigation and Loss Prevention Measures

Design phase

- Understanding the design concept is important for assessing technical exposure and conformity with building codes and regulations. Selection of contractors is key as they can reduce fire risk through value engineering and adherence to local public-law requirements. Select reputable and qualified contractors, early in the design process, with relevant experience and capacity. Ensure they utilize Building Information Modeling (BIM) and have effective fire safety policies and a realistic time schedule that includes buffer time for unexpected events.
- Hybridization of conventional and newer buildings can mitigate fire risks by considering the location of wet rooms and electrical intakes, alternating cross-laminated timber floors, and building the first floor in concrete.
- A minimum two-hour fire resistance rating is expected for bearing walls, structural frames, floor protection and at least one-hour fire resistance for roof protection, or even higher depending on the height and number of building stories. High-rise buildings should have a minimum three-hour fire rating. **Guidance for type IV-A/B/C from the International Building Code (IBC)** should be taken as a reference.
- To achieve fire resistance, encapsulation of wood elements using fire-rated gypsum board or other approved materials is recommended. The degree of encapsulation should increase with the height of the structure. Exposed wood surfaces should be limited and separated by non-combustible materials.
- Avoid easily flammable wood and use flame-retardant wood. Adhesives for structural purposes should meet heat resistance standards. Use non-combustible materials for external facade and insulation. Take special precautions when hot exhausts or pipes cross walls with wood components.
- Fire walls should be installed to separate different occupancy areas and prevent fire and smoke spread. Special precautions should be taken at the parapet of the exterior wall to prevent fire spread to the roof. Fire walls and emergency exit/stairways should be made of non-combustible materials.
- Maintain high workmanship standards to prevent unseen spread of fire in cavities. Horizontal and vertical sealing of void spaces with cavity barriers/fire stops or filling them with non-combustible fiber insulation is recommended. The fire brigade should also have access and equipment to extinguish fires in these spaces.
- Vertical utility shafts should preferably not have combustible shaft walls, but, if present, horizontal fire subdivision and the installation of fire extinguishing systems are recommended. Regular inspections and maintenance of fire-resistant sealants and barriers are important to ensure their effectiveness.
- Use mechanical assembly methods to eliminate hot work operations. Connect steel elements in a way that protects them (not exposed) from fire.
- Consider the repairability of key building components in the early design phase, documenting possibilities for post-fire repair and associated costs and timeframes. Simplify construction methods for easier repair.

The combustibility of the building's facade or external finishing system (cladding) is also crucial in determining the scope for external fire spread and ingress internally:

- Wood facades should not be installed in high-rise buildings or in any building where the upper facade level cannot be reached by hose streams.
- Ventilated facades contribute to fast fire spread, so structural horizontal barriers or fire arresters inside double facades should be provided at each floor level of multi-level buildings. No combustible material should be present inside the void.
- Even for one-story industrial production and warehouse buildings, a horizontal cavity barrier/fire stop should be provided at a maximum of 5m vertically or on every floor.
- Non-combustible panels can be used to break up the wood facade, with a maximum height of combustible panels set at 2.4m and non-combustible panels provided in between for heights greater than 5m.
- Precautions should be taken to prevent the spread of fire from one floor to the one above at the facade of buildings with multiple floors or high-rise buildings. This can be achieved by using horizontal projection such as aprons to direct hot gases and flames away from the facade.
- Combustible materials, including wood, should not be used on roofs.

For solar photovoltaic (PV) systems, the following guidance should be considered. Consult an Allianz Commercial risk engineer prior to installation:

- Roof-mounted PV systems are not recommended on mass timber high-rise buildings.
- Only approved or listed PV modules with glass back sheet panels should be used.
- It is crucial to have a non-combustible thermal barrier installed beneath the roof membrane before installing these systems on mass timber roof decks. This can be achieved with a non-combustible gypsum cover board or a similar material like mineral wool or expanded glass.
- An approved/listed linear heat detection should be installed on top of the roof cover and below the PV modules.
- Sufficient aisle spaces should be provided between PV arrays and adjacent ones, adjacent fire walls, rooftop equipment, penetrations etc.
- Appropriate emergency response and firefighting equipment (manual/fixed) should be adequately designed for the fire department.

Download
Fire Hazards of Photovoltaic (PV) Systems


Photo: Envato

Construction phase

Fire safety planning steps should include:

- Designate a responsible person or group for fire safety management.
- Conduct a fire risk assessment and create a fire safety management plan.
- Establish emergency procedures and train subcontractors.
- Develop a layout plan indicating escape routes and fire hydrants.

Fire Safety Coordinator:

- Assign a Fire Safety Coordinator to oversee fire safety issues.
- Ensure their duties include developing the fire safety plan, inspecting equipment, and coordinating with local fire services.
- Clear safety instructions and training should be provided to contractors and suppliers.

Control of ignition sources and combustible materials:

- Minimize hot work, implement a proper hot work management program and use proper equipment and fire extinguishers. Monitor hot work activities after completion.

Download our client-training module
Hot Work Management

Download
ARC Hot Work Management During Construction

- All electrical supply installations, both permanent and temporary, must be installed and maintained in accordance with relevant standards. Temporary electrical wiring should be minimized, properly installed, and provided with overload protection. This should be kept away from combustible materials and turned off during non-working hours and when the site is unattended. Portable electrical devices and extension cords should be regularly inspected, and any faulty or damaged equipment should be removed from the site. A fire-resistant area should be provided for battery charging.
- Improperly installed or used temporary heaters can be a major cause of fires, especially in mass timber construction. Temporary heaters should be properly installed and located away from combustible materials. Alternative solutions, such as placing heaters outside the building or using hot water heating units should be considered. The building's permanent heat source is also preferred.
- Implement a non-smoking policy and designated smoking areas.
- Assess risks to adjacent buildings and develop a plan to mitigate them.

- Safely store combustible materials and remove waste promptly. Combustible material should not be located at the outer wall.
- Remove any dry vegetation for a distance of 20m (65ft) from mass timber buildings.

Implement a security policy:
- Implement a security policy including fencing, good lighting, guarding, CCTV and intruder alarms.

Download
Construction Site Security
A Contractor's Loss Prevention Guide

Regarding vehicles on the construction site:
- Prohibit parking of cars, trucks, etc., in buildings or near the construction site, except for loading or unloading operations.
- Vehicles, including cars, electric vehicles, and E-Bikes, should not be parked at exterior walls, maintaining a minimum distance of 5m (16ft), including utilities and E-vehicle chargers.
- Do not store or handle fuel inside or near buildings.
- Recharge electric vehicles in designated areas without combustible storage.
- Protect buildings and equipment against accidental impacts.

For roofing operations:
- Take fire prevention precautions during roofing operations involving open flames or hot processes.
- Refer to NFPA 241, Chapter 9, for safeguarding roofing operations.

Download
Safeguarding Roofing Operations

When it comes to temporary buildings:
- Keep them well detached from the building under construction, preferably at least 15m (50ft) away.
- Construct temporary buildings with non-combustible materials when possible.
- If eating facilities are provided, choose microwave ovens over other cooking equipment.

For fire detection and fire protection during construction:
- Install and maintain a temporary fire detection system in areas like temporary buildings, storage areas, and where combustible construction materials are used.
- Consider an interlinked fire alarm system, wired or radio-based, complying with applicable standards. Number or name all call points and detectors for easy fire location.
- Install an adequate number of fire extinguishers across the site and regularly audit and update their condition.
- Provide a temporary or permanent fire protection water supply before combustible material accumulates on-site.
- Install and activate fire hydrants quickly, consulting with the local fire department.
- Integrate an automatic sprinkler system as part of the fire protection strategy. It is highly recommended to install sprinkler systems as soon as possible and avoid moving combustible materials into the building until this is in service.
- In addition to sprinklers, it is essential to keep fire protection systems operational throughout the construction process. Regularly patrol sprinkler-protected areas for any water leakage or flowing sprinklers and ensure that sprinkler system water flow alarm supervision is operational when the systems are in service.

Operational phase

From the property insurance perspective, all fire prevention measures, and management programs developed for the Design and Construction phases should still be implemented and enforced.

Fire protection is crucial to ensure the safety of occupants, protect property, and prevent significant financial losses, including:
- **Installation of sprinkler systems** – Allianz Commercial supports the use of wood in construction, provided the building is fully adequately sprinkler protected. When designing sprinkler protection for mass timber buildings, the sprinkler system should have a minimum density based on the occupancy hazards and must not be less than the density required for an Ordinary Hazard class 2 as per NFPA 13 Standard (Ordinary Hazard class 1 may be acceptable as a minimum only for areas with ceiling heights ≤ 9m), whichever is greater.
- If the mass timber walls are not encapsulated, it is recommended positioning the first sprinkler row close to them.
- For high-rise buildings, it is strongly recommended to have a secondary water supply that is fully redundant for both the sprinkler and standpipe systems. This additional water supply should be sufficient and dependable to ensure the reliability of all fire protection systems within the building.
- Regular inspections and testing of automatic sprinkler systems are essential to maintain their reliability and efficiency.
- Any other alternative protection concepts (e.g., water mist systems which may help to reduce water damage in multi-story buildings, exposure sprinkler facade protection such as water curtain etc.,) should be evaluated on a case-by-case basis by an Allianz Commercial risk consultant.

Photo: Envato

Water damage

Mass timber is highly vulnerable to water damage, including flood, water ingress and plumbing leaks.

Design phase

The moisture content of timber can vary with temperature and humidity, leading to swelling when exposed to excessive wetting. Water can cause significant damage to the structure, especially when the end grain is near the ground. Cross-laminated timber, which is at least three layers of lumber that are cross-oriented and bonded with adhesives to form a wood panel, is less prone to swelling due to adhesives and alternating wood layers. However, water exposure can lead to potential delamination.

To mitigate water damage, mass timber elements can be manufactured with reduced moisture content and stored in controlled atmospheres.

Water management and high-quality analysis are crucial for ensuring the durability of wooden structures.

Construction phase

During construction, surface wetting is acceptable as long as internal surfaces remain dry. Moisture content below 20% is considered low risk, while exceeding 20% increases the risk of fungal decay. Protective measures like cladding, screening, proper drainage, and regular checks should be implemented to prevent moisture intrusion and termite infestation.

Prolonged water exposure can lead to swelling, discoloration, and microbial attack. Mold growth is possible if components are exposed to precipitation under limited drying conditions. Plastic wraps and coatings provide temporary protection against water ingress. Temporary tents or heat application can aid in drying. However, these measures can contribute to fire risk and should be managed carefully.

Proper weather protection and storage conditions should be considered in the construction phase.

Operational phase

Once operational, mass timber structures are vulnerable to water damage from various sources, including construction entrapment, failure of the building envelope, plumbing leaks, wet rooms, flooding, condensation, and sprinkler leakage. These sources can impact the structural integrity, function, and aesthetics of timber through primary (glue denaturing, delamination, swelling, staining) and secondary (rot, molds, fungus) mechanisms, which may be challenging to detect due to floor coverings.

Allianz Risk Consulting Risk Mitigation and Loss Prevention Measures

Design phase

Designers should account for both long-term and short-term escape of water events and incorporate fluid systems that can safely drain and discharge water.

In the design of water piping systems, certain measures should be taken, such as avoiding installation in concealed, inaccessible spaces and considering non-combustible thermal insulation for pipes under water in high-risk condensation areas.

It is important to install failsafe plumbing fittings, provide additional drains in areas with water pipes, and have rapid means of system isolation and water-stop type detection devices.

Download
Water Leak Monitoring For Active Construction Projects

Water Damage Prevention Solutions

Good design is crucial to control water ingress, and ventilation requirements should be considered to prevent condensation in buildings.

A high-quality standard is required for water piping systems, including easy repair and maintenance, compliance with regulations and standards, involvement of qualified professionals, pressure testing, risk assessment, and proper documentation.

In sensitive areas, hybridization of conventional and newer buildings can help mitigate flood exposure.

This includes locating wet rooms within a concrete core and floors, building the first floor with concrete for improved flood resilience, and using concrete slabs instead of wooden slabs for roofs or waterproof terrace roofs.

Photo: Envato


Photo: Envato

Construction phase

A comprehensive water/moisture management plan should be developed in collaboration with the contractor and subcontractor to keep the building as dry as possible. This plan should be updated throughout construction and after any moisture event.

Mitigation measures to minimize water exposure and protect the integrity of the structure include:

- Installing wooden building components during the dry season whenever possible. Designing the structure and assemblies to minimize trapped moisture and promote drying of the wood.
- Assigning a dedicated rain crew to remove water from horizontal surfaces.
- Using engineered wood products with enhanced moisture resistance or treated wood.
- Implementing measures to prevent water migration, such as temporary curbs/flashing, caulking spline cover plates, taping joints, and applying waterproofing membranes or ice-water protectors.
- Developing an envelope/dry-in strategy to seal the building from water intrusion.
- Implementing strategies to manage water used during construction, including wet work permitting and clean-up protocols.
- Controlling and monitoring interior humidity levels to prevent excessive moisture accumulation.
- Monitoring and documenting the moisture content of exposed timber members.
- Proper on-site storage to prevent water damage.
- Leveraging technology solutions for monitoring environmental and building water systems.
- Shutting off plumbing water piping systems when unoccupied.
- Ensuring site security measures are in place to prevent unauthorized access and water-related incidents.
- Monitoring weather and climate change and implementing emergency response plans for adverse weather.

Download

Water Damage During Construction,
A Contractor's Loss Prevention Guide

Water Leak Monitoring for Active Construction Projects

Wet Work Management and Permitting
During Construction

Operational phase

- Conduct infrared thermography of the roof cover, deck, and walls constructed of mass timber every three years. If the roof is protected with an ice-water protector or an active leak detection system, the infrared thermography can be conducted every six years.
- Install a dry or pre-action sprinkler system for sensitive areas to limit or prevent water damage after accidental sprinkler activation. In freezing conditions, a dry or pre-action system should always be used.
- Plan and manage any works that could affect the sprinkler system, ensuring appropriate management of sprinkler impairment when the fire protection system needs to be out of service.
- Adequately install and route sprinkler piping to prevent damage from forklifts or other large vehicles.
- Properly locate sprinkler heads to avoid mechanical damage/impact or non-fire activation. Consider using sprinkler guards or concealed sprinkler heads (only for light hazards).
- Avoid using sprinkler systems as hangers or for anchoring hangers.
- Maintain adequate security levels for the property, especially related to access to the fire pump room and handling of control valves.
- Implement appropriate inspecting, testing and maintenance programs for building systems according to recognized standards (e.g., NFPA).
- Create a documented emergency water leakage and mitigation response program to quickly remove water from any exposed wood. Ensure the system can be readily isolated.
- Conduct regular inspections of building systems like HVAC, electrical, and plumbing to identify potential fire hazards and reduce the potential for water damage.

Termites and insects

While not common in all areas of the world, termites and other wood-boring insects may pose a significant threat to mass timber buildings, potentially causing extensive structural damage over time.

Design phase

Direct contact between structures and the ground creates an attractive entry point for termites, so it is important to prevent such contact by using appropriate foundations or physical barriers.

Construction phase

Termite infestation usually occurs gradually and given the speed of construction of structures, there may not be time for an infestation to occur.

The exposure of notable damage during the construction period is therefore low compared to the operational phase. However, if a timber structure is in a termite-prone area, pre-treatment should be taken to minimize the risk of damage from infestation (e.g., soil treatment, use of termite-resistant materials etc.).

Dry storage of timber is also necessary to prevent termite infestation.

Operational phase

Termites thrive in moist environments, so controlling moisture levels in and around buildings is crucial. Proper ventilation, drainage, and moisture barriers can help prevent excessive moisture accumulation.

Maintain a clear zone around the building's perimeter by removing any vegetation or debris that could serve as a food source for termites.

If neighboring properties have a history of termite infestation, there is a higher risk of termites spreading to nearby structures. Regular monitoring and preventive treatments may be necessary in such cases.

Photo: Envato

Allianz Risk Consulting Risk Mitigation and Loss Prevention Measures

As termites are most likely to attack decaying timber in buildings, it is important to ensure timber does not have long periods of contact with water by implementing sufficient protective measures.

Design and construction phases

To protect timber against termites and insect exposure during the design and construction phases, the following steps should be taken:

- Comply with local regulations regarding termite exposure and treatment.
- Elevate wood structures from damp ground by using concrete for the first story of the building.
- Implement additional measures depending on the location and termite-prone area:
  - ✓ Soil-applied liquid termiticides: Apply liquid treatments to form a continuous chemical barrier in the soil around the structure. Repeat treatments if the soil is disturbed during construction activities.
  - ✓ Wood treatments: Use chemically treated wood members near and in contact with the soil. Pressure-treat or surface-treat lumber with chemicals that inhibit termite attack.
  - ✓ Stainless steel mesh: Wrap Termi-mesh stainless steel mesh with a specific aperture around foundations, pipes, and posts to prevent termite intrusion.
  - ✓ Barrier materials: Ongoing research is being conducted on materials placed around the foundation as physical barriers to termite invasion. Options include sand with uniform size particles, stone (such as Granitgard®), and termite baits.
- Conduct regular inspections for the presence of termites and perform checks on the moisture content of the mass timber.

Operational phase

To protect timber against termites and insect exposure, the following steps should be taken:

- Conduct regular inspections of the building to detect signs of termite or insect activity.
- Seal any cracks or openings in the building's foundation, walls, windows, and doors.
- Ensure proper drainage to prevent moisture buildup.
- Maintain ventilation and control humidity levels to make the building less attractive to pests.
- Consider treating existing wooden structures with appropriate chemicals.

Natural hazards

Earthquake

Mass timber construction, while lacking codified design options for regions prone to earthquakes, offers several seismic advantages. Wood's flexibility, lightweight nature, ductile connections, redundant load paths, and strength/stiffness make it suitable for seismic zones.

Integration of low-damage design concepts, such as rocking wall cores, can enhance resilience and reduce repair costs.

However, due to the relatively new concept of high-rise timber buildings, caution and conservative approaches are necessary until more data and experience are available.

Consulting experts, following building codes, and conducting thorough testing are essential for ensuring the safety and resilience of mass timber structures in earthquake-prone areas.

Storms, tornadoes, cyclones and hurricanes

Mass timber construction can transfer lateral loads and resist wind pressures due to its stiffness, strength, and numerous nailed connections. However, extreme wind forces, especially during tornadoes or hurricanes, can potentially affect beams, columns, and panels, posing a risk of widespread damage. Additionally, water damage from torrential rains and floods should be considered regardless of the building's design for wind loads.

Flood

Floods, including river floods, flash floods, and storm surges, pose a significant risk to timber buildings. Timber buildings exposed to floods may require structural controls, drying, and repairs, impacting expected operating losses.

Allianz Risk Consulting Risk Mitigation and Loss Prevention Measures

Earthquake

The following factors should be considered to mitigate earthquake exposure:

- **Building codes and regulations:** Ensure compliance with recognized building codes to ensure structural integrity during earthquakes.
- **Seismic design philosophy, analysis, and design:** Consider factors such as soft stories, peak ground acceleration, natural frequency of the structure, gaps between surrounding buildings, lateral stability, shear walls, and avoiding short columns and hinges in steel columns.
- **Damping and energy dissipation:** Evaluate damping, base isolation, and the ductility of the structure.
- **Underground – soil condition:** Understand the ground conditions and associated risks, including liquefaction potential. Parameters such as mass density, soil strength modulus, damping ratio, and shear wave velocity are important for assessing soil response.
- **Soil parameters:** Check soil parameters such as plasticity index, effective stress analysis, over-consolidation ratio, impedance contrast ratio (ICR), and depth of soil strata over bedrock. These parameters influence seismic amplification and the risk of liquefaction.

It is important to note that some parameters can fall into multiple categories and that the classification may vary depending on the specific project. Ground/soil conditions and liquefaction potential are particularly important factors to consider for seismic structures. Soft soils can amplify shaking, and the period of the soil should be considered in relation to the building's natural period to avoid excessive acceleration.

The potential secondary damages to water, fire, and utility systems following an earthquake should also be considered.

The following measures can be taken to reduce secondary damages:

- Support utility networks on non-rigid supports to allow for damping and flexibility.
- Consider the use of flexible hoses to minimize leaks in water and gas systems.
- Implement seismic upgrades for sprinkler systems, such as lateral and longitudinal sway bracing and retaining straps.
- Install seismic automatic safety shut-off valves for combustible/flammable liquid and gas piping.
- Having an effective emergency plan in place can help minimize property damage and business interruption caused by an earthquake. At a minimum, it should include the following: a designated person-in-charge, restoring fire protection equipment, safe shutdown of processes and utilities, site survey for leaks and damage, monitoring of equipment in operation, provisions for salvage and clean-up operations, contact information for vendors and contractors, emergency equipment and supplies, and securing the site after the earthquake.

Download
Earthquake Checklist

Storms, tornadoes, cyclones and hurricanes

During the design phase, it is important to consider storm exposure and prepare for potential extreme weather events. Contractors should monitor the weather forecast daily and have clear organizational structures in place for efficient preparation and loss prevention. Measures such as strengthening temporary bracing, closing external openings, inspecting and repairing waterways and drains, and securing equipment are recommended.

During the construction phase, there are several key recommendations to minimize the impact of storms. These include securing loose construction site materials, stabilizing formwork, elevating materials above the ground, regularly cleaning the site, and prioritizing critical work. It is also important to secure non-removable materials, anchor containers and storage boxes, address roof defects, and prepare cranes for strong winds.

During the operational phase, implementing a windstorm emergency response plan is crucial. This should include a person-in-charge, preparation activities, safe shutdown of processes and utilities, inspection of roof coverings, provisions for salvage and cleanup operations, and securing the site. Having an effective emergency plan can minimize property damage and business interruption.

Download
Windstorm Checklist

Construction Site Hurricane Protection Checklist

Hailstorm Checklist

Flood

During the design phase, it is essential to conduct a thorough assessment of flood risk and avoid building in flood-prone areas.

Building the first floor in concrete or steel and locating key plant and emergency units above the maximum immersion depth can greatly help prevent flood damage.

Using engineered wood products with enhanced moisture resistance, incorporating flood-resistant design features, and enhancing the waterproofing of the building envelope are also recommended.

During the construction phase, implementing effective site grading and drainage systems, installing gutters and downspouts, and elevating critical electrical equipment above the flood level are important measures. Using water-resistant or flood-resistant electrical components and locating mechanical systems in flood-resistant areas or designing them with flood mitigation measures are also necessary.

During the operational phase, developing a flood emergency response plan, educating occupants and building management about flood risks, and conducting regular maintenance and inspections are crucial. Collaborating with the local fire service for salvage plans and ensuring the functionality and flood resistance of electrical and mechanical systems are additional considerations.

Download
Flood Checklist

Protect Your Employees and Business from Flood Damage

Manufacturing, transportation and supply chain

Off-site manufacturing is commonly used for mass timber projects, with timber elements such as columns, beams and panels being manufactured in factory environments and then erected on-site. This approach offers advantages such as high levels of accuracy, regulated QA and QC systems, and improved efficiency compared to conventional on-site construction.

Mass timber construction has a unique supply chain and manufacturing process that differs from traditional concrete and steel framing.

However, there are some challenges. Mass timber is typically made to order and cut to specific dimensions, with additional processing required to fit adjacent panels or beams and accommodate hardware. As a result, there is no off-the-shelf option for purchasing mass timber, and developers, architects, and contractors often need to engage a mass timber supplier early in the project planning phase.

The experience and coordination of project participants are crucial, as well as careful planning of time schedules and construction processes. Due to just-in-time delivery, thorough logistic planning and management of building materials are essential.

One significant disadvantage of the assembly line manufacturing process is the potential for a serial loss scenario. If a particular batch of mass timber elements contains poor quality lumber or defective adhesives, multiple elements positioned throughout a structure or across multiple project sites may be affected. Countries without a culture of off-site construction may face design errors, requiring adaptations to ensure effective control over both off-site and in-situ manufactured elements. Discovering and removing these defective members can have a major impact on the project timeline and cost.

Contingent business interruption (CBI) exposure is also a consideration with mass timber manufacturing. The use of timber in large-scale construction is not as common as steel or concrete and requires specialized production facilities. This poses challenges in transferring engineering drawings and specifications to alternative manufacturers, as it is uncertain if they will have sufficient capacity or capabilities to fulfill orders and may lack experience.

The composite nature of mass timber products involves various industries in the value chain, posing additional product liability risks. These risks can result in long-tail issues, deficiencies in adhesive products, indoor emissions, aesthetic deviations, and challenges in dismantling and installation.

Allianz Risk Consulting Risk Mitigation and Loss Prevention Measures

To ensure smooth transportation and supply chain management for mass timber construction projects, several recommendations should be followed:

- Implementing a comprehensive quality program that extends beyond the project site is important to ensure coordination and communication with all parties involved in the manufacturing process.
- Effective communication channels should be established between manufacturers, shipping/trucking companies, and installers to monitor material movement and protect them during transport.
- Before shipment, applying a moisture-resistant coating and individually covering each panel with a waterproofing membrane is recommended.
- Managing supply chain concerns can be achieved by manufacturing a surplus of prefabricated elements and establishing a repair methodology with the mass timber supplier and structural engineer.
- QA/QC programs should be established for materials receipt and storage on-site. This includes defining a logistics plan, documenting the process for receiving and accepting deliveries, and developing a storage management plan that supports individual beams and panels off the ground. Ongoing inspections and maintenance of stored panels should also be carried out.

In terms of project coordination, upfront collaboration is crucial, especially during the early stages of the process:

- A well-defined QA/QC coordination program should be established with the manufacturer and project consultants to address any unique considerations specific to mass timber.
- Planning for quality practices beyond standard construction practices, such as installing connections, conducting inspections, capturing photography, and using checklists, is important. Functional mockups should be prioritized for trade coordination and reference during construction.

Photo: Envato

Workmanship issues

Construction firms may face challenges in finding experienced work crews for mass timber construction as it is relatively new. This can lead to productivity issues and safety-related concerns as crews navigate the learning curve of working with mass timber.

Improper installation can result in damage to the finished product, which can have significant financial implications for repairs or replacements.

It is crucial for building contractors to hire experienced subcontractors and properly trained work crews to avoid re-work, accidents, construction defects, and delays that could impact the overall success of the project.

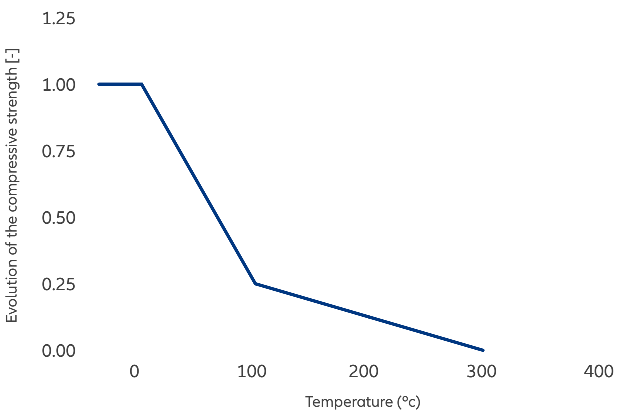
Cost of repairs and rebuilding

There is limited knowledge regarding the repairability of mass timber construction but it is highly likely that the cost of repairing or rebuilding structures could be significantly higher than conventional construction materials.

One unique property of timber is that it may lose its strength when exposed to high temperatures. Even after a fire has reached its peak temperature and starts to decrease, certain areas of the wood may continue to increase in temperature.

Unlike steel, which regains its strength as it cools down, timber gradually loses its strength as its temperature rises. According to Eurocode 5 (EC5), the loss of softwood mechanical properties with temperature is very fast, with all strength being lost at a temperature as low as 300°C.

Decrease of compressive strength of softwood according to EC5



Source: World Conference on Timber Engineering 2023, Natural Fire Tests on GLT Columns Including the Cooling Down Phase

Some irreversible phenomena occur during heating, such as moisture evaporation, pyrolysis, and combustion, which raises doubts about the feasibility of rehabilitation.

Further research needed

Further research is needed in several areas related to mass timber construction.

This includes studying the performance assessment of mass timber elements during the whole duration of a fire as special attention needs to be paid to the risk of collapse during the cooling phase.

Other areas include the performance of mass timber connections exposed to natural fires, understanding the impact of closely spaced screws on charring rate, evaluating fastener embedment strength under fire tests, examining connections between hybrid construction of steel beams and timber panels, and investigating the effects of intumescent paint on steel-to-timber connections.

Certifying materials and establishing certification methods for green wall cladding systems are also areas that require attention and consideration.

References

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2 Allied Market Research, Mass Timber Construction Market to Reach $1.5 Billion Globally by 2031 at 6.0% CAGR, May 3, 2023

3 Council on Tall Buildings and Urban Habitat, The State of Tall Timber: A Global Audit, February 2022

4 Council on Tall Buildings and Urban Habitat, The State of Tall Timber: A Global Audit, February 2022

5 WoodWorks, Wood Products Council, Mapping Mass Timber

Conclusion

Timeframe to emerge	0-3 years / 4-10 years / >10 years All lines of business/industries: 0 to 3 years Liability: 0-3 years (Professional Liability) / > 10 years (long-tail risks on latent defects)
Impact on Insurance	Low / Medium / High Property: Medium-High Natural Resources and Construction: Medium MidCorp: Medium-High Liability: Low-High The assessments in this table are based on the level (and severity) of potential claims activity that could emerge from this emerging risk.
Allianz Risk Consulting Assessment	Low / Average / High / Very High **Inherent hazard per line of business / industry** Property: High Natural Resources and Construction: Average MidCorp: High Liability: High to Very High The assessments in this table are based on a combination of the 'timeframe to emerge' and 'impact on insurance' criteria with the result being the inherent hazard per line of business / industry sector for this emerging risk.

Further information and contacts

For more detailed information on mass timber please contact your regional Allianz Commercial risk consultant(s).

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