DANISH TECHNOLOGICAL INSTITUTE

Moisture Management for Timber Construction

A practical guide

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Built by Nature (BbN) is a not-for-profit organisation, with a mission to lead a global transformation of the built environment by accelerating the responsible use of timber and biobased materials.

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Contents

> **Active moisture management is crucial to avoid damages like visual staining, mould or fungal growth when building with timber.**

Introduction

Effective moisture management is fundamental to the success and long lifespan of timber structures. Unlike concrete and steel, timber is a biobased material that actively interacts with moisture in its environment, making it sensitive to water and humidity throughout its life – from design and construction to occupancy and beyond.

Moisture-related issues such as staining, dimensional changes, mould growth, and fungal decay can compromise both the performance and appearance of timber structures. These problems not only threaten structural integrity and indoor air quality but can also lead to costly repairs and project delays if not addressed proactively.

This guide provides a comprehensive framework for managing moisture in timber construction at every stage, from initial planning to long-term maintenance. It presents practical tools, technical knowledge, and real-world examples to help stakeholders – including architects, engineers, contractors, and building owners – identify risks, develop protection strategies, and implement targeted solutions. The focus is placed on both preventing and responding to moisture-related issues, ensuring timber remains at optimal moisture levels throughout the construction process and building life.

Creating a strong moisture management plan needs teamwork and clear communication among all project members. By taking a structured approach to moisture management, it will improve the durability, safety, and sustainability of timber buildings.

Based on experience

The information in this guide is based on practical experience gained from the construction of the Build-in-Wood Demonstrator at the Danish Technological Institute (see page 62), as well as from involvement in other wood construction projects – particularly while serving as a moisture advisor.

This guide was made possible thanks to the support of Built by Nature.

Download example sheets and checklists

A QR code is provided on page 21 and 61, giving access to moisture management example sheets and checklists for download.

Background:
Understanding timber and moisture in construction

When building with timber, it is vital to understand its moisture-related properties and interactions to ensure durability, preserve structural integrity, and prevent damage.

The two fundamental objectives of moisture management in timber construction projects are:

1. Prevent contact with water.
2. Avoid prolonged exposure to high relative humidity.

To prevent moisture-related problems like discoloration, warping, mould growth, or fungal decay, it is crucial to consider these key points. Construction timber meant for indoor use should ideally maintain a moisture content of no more than 16% during the construction process.

Relevant terms in moisture management

- **Relative humidity (RH):** The percentage of water vapour in the air
- **Moisture content (MC):** The percentage of water in the timber relative to the timber's dry weight. Note that timber MC can therefore exceed 100%.
- **Equilibrium Moisture Content (EMC):** Timber constantly exchanges moisture with its surroundings until it reaches a balance known as the EMC. EMC varies depending on the surrounding relative humidity (RH) and temperature. For example, in a very humid environment, timber absorbs moisture and has a high EMC, while in a dry environment, it releases moisture and has a low EMC.
- **Absorption and desorption:** Uptake or release of water in the timber. Timber absorbs water and humidity faster through the end grain compared to the other surfaces. The difference can be as much as 100 times. Softwood (like spruce, pine) typically absorbs water faster than hardwood (like oak, walnut). Softwood also desorps/dries faster.
- **Fibre saturation point (FSP):** Timber can retain water both within its cell walls and in the intercellular spaces. It primarily retains moisture in the cell walls, but once these are saturated, any additional moisture is stored between the cells. The point at which the cell walls are fully saturated is called the FSP. Dimensional changes due to moisture content occur below the FSP but not above. For spruce, the FSP is approximately 30% MC, though it varies a bit by species.

Timber absorbs water in various directions

- End-grain (longitudinal direction): Rapid absorption of liquid water due to the capillary effect.
- Radial and tangential surfaces: Liquid water is absorbed at a slower rate than through the end-grain and duration of drying is increased.
- Gravity: Water can accumulate on flat surfaces and may flow into depressions or cavities.
- Capillary forces: In narrow openings, such as cracks or joints between components, water can penetrate deep below the surface.

The table presents equilibrium moisture content in timber corresponding to various levels of relative humidity at 20°C.

Equilibrium moisture content in timber at 20°C and various relative humidities.

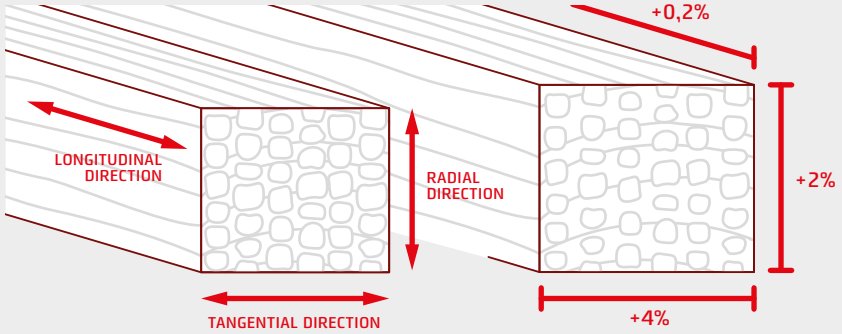
Relative humidity	Equilibrium moisture content
30 %	7 %
40 %	8 %
50 %	10 %
60 %	12 %
70 %	15 %
90 %	23 %

Mould free humidity

When the relative humidity is below 65% and there are no liquid water sources, mould growth is prevented.

Moisture related dimensional changes in wood

Changes in moisture content can cause significant dimensional changes to wood. The figure shows approx. dimensional changes in spruce when going between 8% and 18% moisture content.



Spruce at 8% moisture content

Spruce at 18% moisture content

Moisture-related risks

Moisture-related risks in timber construction include the risk of fungal growth, mould dimensional changes, aesthetics, and structural risks.

Risk of mould or fungal growth (decay)

- Blue-Stain can develop in the early stages after cutting the timber. They cause visual staining but do not affect the structural or mechanical properties of the timber and have no implications for human health.
- Mould can rapidly develop on the surface layers of timber when exposed to moisture. It causes visual staining and may trigger respiratory or allergic reactions in humans. However, mould does not affect the mechanical performance or structural integrity of the timber.
- Decaying fungal growth develops more slowly and is generally not found in timber with a moisture content below 20%. Decay fungi break down the structure of timber, significantly reducing its mechanical strength and stiffness.
- Fungal spores are present in nearly all timber and in the air. Fungal spores only develop if the moisture content of the timber becomes sufficiently high. The kiln drying process effectively eliminates all micro-organisms in the timber, preventing fungal development unless re-wetted.

Mould grows quickly
Mould can appear in as little as 3 days if conditions are favorable.

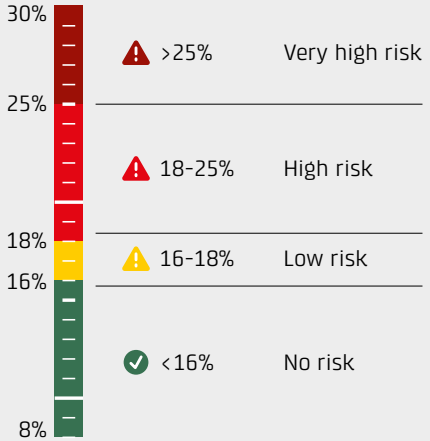
Risk of dimensional changes

- Timber swells when it absorbs moisture and shrinks as it dries.
- Dimensional changes occur primarily across the grain (radial and tangential directions) rather than along the grain (longitudinal).
- A change in timber moisture content from e.g. 8% to 18%, translates to a tangential change of 4 mm per 10 cm meter for solid timber such as Scots pine and Norway spruce, while CLT (cross-lamination) experiences only one-tenth of that change.
- Dimensional changes can influence the tolerances during construction and in the finished building.
- Changes in dimensions can lead to deformations such as warping, twisting, cracking, and splitting. Water can accumulate in cracks and splits, increasing the risk of further water absorption.
- Surface treatments and coatings may be at risk of cracking due to the dimensional changes in the timber substrate beneath.
- Rapid changes in humidity, or changes across large components can result in large differential changes in dimension. This can lead to distortion and internal stresses sufficient to cause splits to form parallel to the grain.

What moisture levels pose a risk for mould?

A moisture content below 16% is in general considered safe with respect to mould growth, while levels above 18% are considered risky. The range of 16-18% moisture content is a grey area, where lower percentages are recommended to be on the safe side.

Short-term high moisture content can lead to mould growth, long-term high moisture content (above 20%) to timber-decaying fungal growth.

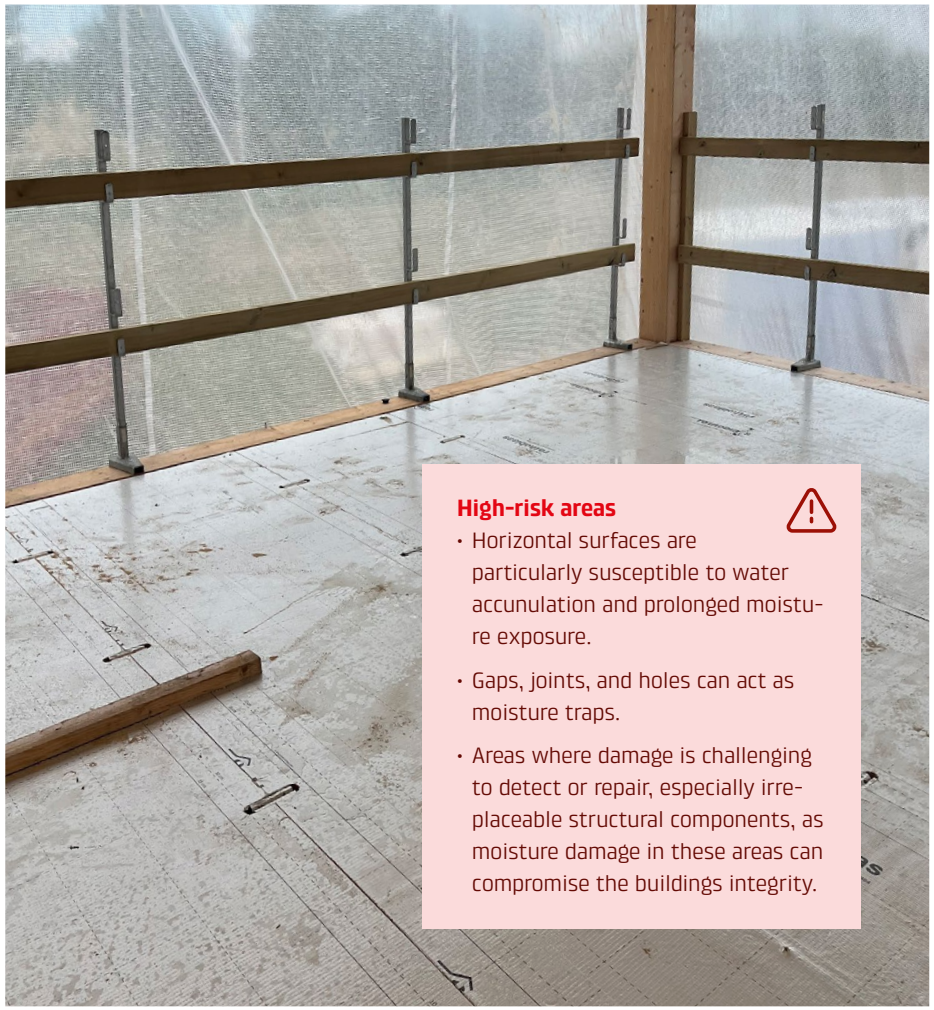


Aesthetic risks

- The movement of moisture through the timber can transport natural extractives and re-deposit them in concentrated locations, resulting in visual staining.
- Mould will also lead to discoloration of the surface.

Structural risks

- High moisture content results in a decrease in the mechanical properties of timber, such as strength and stiffness as well as its tendency to creep.



High-risk areas

- Horizontal surfaces are particularly susceptible to water accunulation and prolonged moisture exposure.
- Gaps, joints, and holes can act as moisture traps.
- Areas where damage is challenging to detect or repair, especially irreplaceable structural components, as moisture damage in these areas can compromise the buildings integrity.

Common sources of moisture

The moisture content in timber construction components can become excessively high due to several factors, including:

- High moisture content upon delivery at the construction site, often caused by inadequate drying or exposure to moisture during transport.
- Exposure to rain, snow, dew, ground moisture, or floods resulting from poor storage conditions.
- Insufficient or damaged protective coverings and inadequate ventilation during storage or construction.
- Elevated relative humidity, particularly when combined with insufficient ventilation.
- Contact with wet materials, such as freshly poured concrete.
- Water condensation on metal connectors or due to cold bridges during construction, poor insulation, or design flaws.
- Inadequate drainage systems both during construction and afterward.
- Leaks in roofs, heating, or plumbing systems, particularly in kitchens, bathrooms, and laundry rooms.

Protective products and temporary measures

To prevent high moisture content, it is essential to implement protective measures on timber products right from the end of production. Various protective products and temporary measures are available at both the product and system/construction levels. A general overview is provided on the following page.

Strategic investment

Investing in moisture protection may seem like an extra cost at first. Proper implementation from the beginning can lead to significant savings in both time and money.

Roofs and tents

Roofs and tents are designed to shield stored timber or entire construction sites. This offers an extra level of protection, thereby reducing the need for individual component protection.

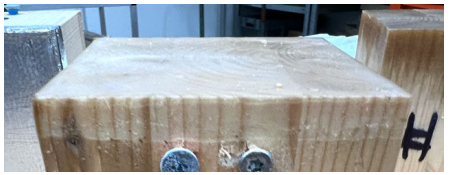
End-grain covers

Metal or plastic caps provide effective protection for exposed end grains, such as in outdoor applications like truss ends, fence pillars, or façade cladding. They act as a barrier against moisture absorption.

Tapes

Self-adhesive tapes, available in various widths, are utilized to seal gaps between timber products, cover pits, or protect entire end-grain surfaces. They effectively safeguard vulnerable areas against moisture exposure and the ingress of liquid water.

Lacquer, wax



Lacquer or wax coatings applied to end-grains protect timber by minimizing water absorption and slowing moisture uptake. It is crucial to ensure that the timber has the desired moisture content before sealing, as these coatings can limit the timber's ability to dry.

Tarps and foils

Tarps and foils are essential for protecting stored timber products and temporarily covering construction sites. Ensure they are securely fastened to withstand storms while allowing for adequate ventilation.

Weather protection membranes

Weather protection membranes are frequently provided by CLT manufacturers for use during construction. They cover the upper surface to prevent water ingress and are effective against standing water. For optimal performance, they should be used in conjunction with tapes to seal joints.

How to measure and monitor moisture content?

Types of moisture meters

A moisture meter measures the moisture content in timber. Two of the most common devices for measuring timber moisture content are resistance moisture meters and capacitance moisture meters.

Measurements depend on the timber species and ambient temperature. Readings must be converted or the device set correctly before use. If the meter is not set correctly, or if materials other than timber (such as gypsum) are measured, the results may be inaccurate and should only be used for comparative purposes.

It is crucial to understand the accuracy of each measurement technique and to use the data accordingly. For instance, if the measurement accuracy is +/-2% moisture content and a reading of 16% moisture content is obtained, the true moisture content could be as high as 18% moisture content.

It is important to note that the moisture content can vary throughout the thickness of the timber and across different components. Moisture requires time to penetrate timber, leading to potential discrepancies between the moisture content of the surface and that of the core. The surface reacts more quickly to changes in moisture levels, while the core may take months to reach equilibrium, particularly in larger pieces.

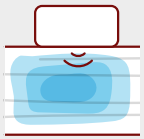
Depth deception

Resistance moisture meters with **uninsulated pins** register the highest readings along the full length of the pins. As a result, it is difficult to determine the specific depth where the maximum moisture content is present.

Capacitance moisture meter

- Non-destructive surface measurements.
- Measures an average value close to the surface (0-3 cm)
- Good for locating the area of a moisture damage.
- Not as accurate as resistance measurements, primarily due to dependency on timber density.
- Set wood density and material thickness or use table to translate measurements.

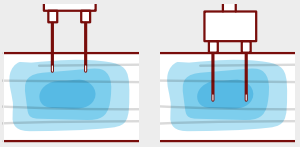
Meter position

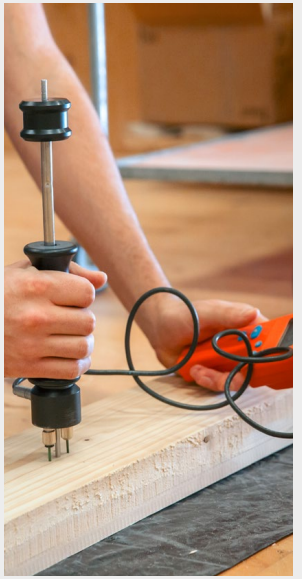


Resistance moisture meter

- Destructive in-depth measurements.
- Measures via two pins (electrodes). If the pins are insulated, it measures moisture content in the depth of the tip. If the pins are not insulated, it measures the highest value along the entire length inserted into the wood.
- Good for documentation.
- Set wood species and temperature or use table to convert electrical resistance measurements to moisture content.

Pin position





How to use a resistance moisture meter

1. Ceck the settings or table for the appropriate timber species and ensure the correct timber species is set.
2. Verify the settings or table for temperature and adjust it to match the ambient temperature.
3. Position the insulated pins parallel to the grain direction, avoiding knots and metal pieces, as these can distort the measurement.
4. Measure using a single piece of timber; do not measure across gaps or joints.
5. Assess moisture content both near the surface and at greater depths. For example:
   - Measure the surface value at a depth of 1 cm.
   - Measure the core value at half the depth of the component.

These guidelines are general and can be adapted for different timber dimensions. For thicker timber elements, the length of the pins will determine how deep one can measure, with a minimum recommendation of 8 cm.

First, measure the position close to the surface, then assess the deeper layers, as measurements taken during withdrawal may be less accurate due to reduced contact. A moisture meter will only provide accurate values if it is properly calibrated.

Hidden wetness
Wood that feels dry might still be wet – use a moisture meter to be sure.

“Accurate measurement of moisture content is the first step to protecting timber structures – what is measured, can be managed.

Pre-construction planning:
Developing an effective moisture management plan

It is essential to address moisture issues during the design phase and to develop a comprehensive moisture management plan prior to any construction project. Each construction project is unique, and consequently, each moisture management plan will vary accordingly.

An effective moisture management plan should include at least the following parts, which will be elaborated upon in the subsequent sections:

1. Moisture management strategy
2. Risk assessment and proactive moisture management strategies
3. Monitoring procedures and inspection plans
4. Roles and responsibilities

Once the building design and moisture management planning are complete, the final moisture management plan must be submitted to the construction project leader before site activities commence to ensure effective implementation.

Moisture management strategy

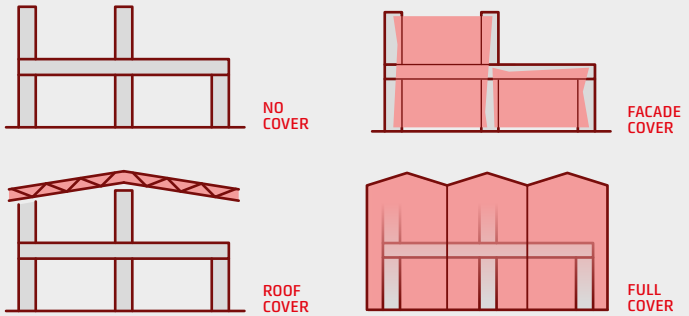
It is important to address moisture management from the very early stage of a project, when deciding on the construction design, construction methods and scheduling which lays the foundation for the moisture management strategy. Choosing the right construction method and principles directly influences the moisture risks and building speed.

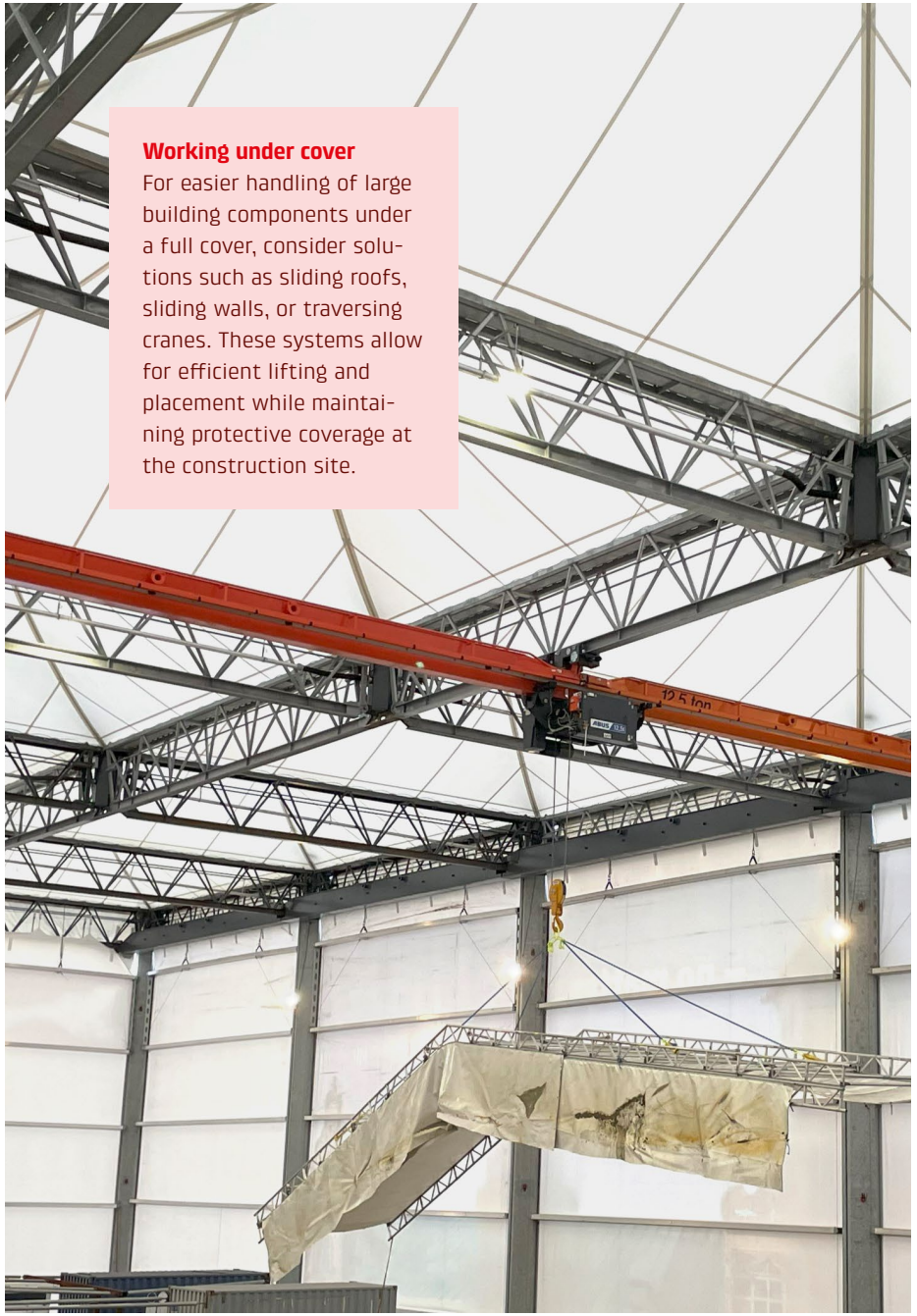
In timber construction, building vertically allows for quicker weather proofing with smaller sections, reducing exposure to moisture. Prolonged periods of open construction – such as during horizontal building processes – significantly increase the risk of water ingress. A well-organized construction schedule is essential, planning for in-time deliveries, quick enclosure, and less exposure to weather.

The construction method and principles form the foundation of the moisture management plan, as this will help decide whether a full cover is needed or what the overall moisture management strategy of the construction should be. Choices made early in the process have a significant impact on the risk of water entry and the need for protective measures. The following pages consist of two checklists with some key questions to address the overall moisture management strategy.

Include design principles in the moisture management plan.

Temporary building cover





Working under cover
For easier handling of large building components under a full cover, consider solutions such as sliding roofs, sliding walls, or traversing cranes. These systems allow for efficient lifting and placement while maintaining protective coverage at the construction site.

Checklist
Construction principles

- ☐ When considering construction strategies, it is crucial to determine whether a horizontal or vertical approach is more suitable. The integration of construction strategies with weatherproofing measures during the design phase is essential for identifying the most effective options. Generally, a vertical design approach is associated with a reduced risk of moisture-related issues.
- ☐ Is there sufficient space for complete on-site coverage?
- ☐ Is there adequate room for crane operations?
- ☐ How will large or prefabricated components be positioned?
- ☐ What assembly method will be employed? Assembled components require additional protection, as water can infiltrate joints and insulation.
- ☐ What types of wood-based products will be utilized? For instance, solid timber can withstand more moisture compared to fibreboards.
- ☐ How are the joints designed? Could they accumulate any moisture?
- ☐ Is there a potential for cold bridges to form during construction? Cold bridges or metal components can lead to condensation.
- ☐ Will timber be situated near cement-like materials that may introduce water? Consider the use of membranes.
- ☐ Can drainage points in the completed building be utilized during construction?
- ☐ Will the timber elements be ventilated behind other coverings such as gypsum or concrete? Will they be covered on one side or both? Timber must achieve the appropriate moisture content before being enclosed in unventilated spaces.
- ☐ Ensure that timber is ordered with the correct moisture content.

Include the construction principles
in the moisture management plan

Checklist
Construction schedule and weather risk

- ☐ How long will the entire construction process take? Additionally, how long will each floor remain open to weathering? Prolonged exposure increases the likelihood of moisture ingress.
- ☐ Which seasons will be significant for the project? Take into consideration what the average weather conditions and relative humidity are during construction, as moisture protection and drying strategies can depend on this information.
- ☐ When is the delivery of timber elements scheduled? Just-in-time delivery is advisable. If just-in-time delivery is not feasible, can the delivery be segmented into smaller batches?
- ☐ What measures can be implemented if just-in-time delivery is unsuccessful? How can additional storage capacity be quickly established to meet requirements?
- ☐ Where is the most suitable location for storing timber? A hard surface and/or a roof cover are ideal.
- ☐ What volume of space is required for storing timber components and other moisture-sensitive materials, such as gypsum boards, fibreboards, and insulation, at the construction site?
- ☐ What is the timeline for drying and conditioning materials, including the heating schedule for the building? Consider both duration and energy costs.
- ☐ Stay informed about the weather forecast throughout the construction phase. Avoid installing highly moisture-sensitive materials when the building is exposed to adverse weather conditions.

Include the construction schedule
in the moisture management plan

> **The best defence against moisture damage starts with understanding where a construction is most vulnerable.**

Risk assessment and proactive moisture management strategies

Every timber structure is vulnerable to moisture damage if not managed properly. Once the overall moisture management strategy for the construction has been defined, it is essential to conduct a risk assessment to identify and understand the construction system and each component's specific vulnerability to moisture-related damage. Implementing active moisture management and proactive strategies, such as incorporating protective measures in the design to shield materials from moisture, can significantly mitigate moisture risks.

A risk assessment involves identifying moisture sources and evaluating vulnerable areas, as well as moisture transfer mechanisms in joints and surfaces throughout the entire building system and each individual element or component. It is crucial to consider an elements or component's contact points with other materials or assemblies in the assessment, as these may represent high-risk areas. Following the risk assessment, a comprehensive plan for active moisture management, along with the use of protective and temporary measures, should be developed and included in the Moisture Management Plan.

Include the risk assessment and proactive strategies in the moisture management plan

Prefabricated elements or on-site assembly

It is crucial to keep moisture-sensitive materials, such as insulation and fibre panels, dry.

Risk assessment of construction system and components

When assessing building moisture risks, evaluate how much each material or component might come into contact with water (exposure to moisture) and how easily it could be damaged if it gets wet (component vulnerability). This assessment should be done for both the entire building and individual parts, as design and construction methods affect moisture risks.

The risk matrix below categorises components into three risk classes based on their need for moisture protection. Since some components, like CLT, can be used in different ways, always consider each specific use and pay extra attention to areas like end grain and horizontal surfaces. Risk classes can also change e.g. during storage, installation, and before the building is fully enclosed, so assess all stages.

More guidance on how to assess "Exposure to moisture" and "Component vulnerability" to determine the risk class (RC), is provided on the following page.

Risk matrix

⚠ Engage a moisture expert

Component vulnerability	Exposure to moisture: LOW	Exposure to moisture: MEDIUM	Exposure to moisture: HIGH
MEDIUM	Risk class 1	Risk class 2	Risk class 3 ⚠
HIGH	Risk class 2	Risk class 3 ⚠	Risk class 3 ⚠

Exposure to moisture

The following table describes different levels of moisture exposure for building components and construction processes. Assess the level of moisture exposure based on the mentioned conditions. In case there are any uncertainties, select the higher level.

Low moisture exposure	Medium moisture exposure	High moisture exposure
• Covered and dry during transport and storage. • Construction is carried out under full protection, e.g. in a factory and/or under total enclosure • Construction process does not include water- or moisture-containing building materials like drying concrete or other construction products with elevated moisture content (moisture content not higher than corresonding to 75% relative humidity).	• Covered and dry during transport and storage. • Risk of occasional climatic exposure, e.g. packaged/covered materials are incorporated without the building being covered. • Construction process involves intended but limited water or moisture content in building materials, e.g. self-drying concrete.	• Building materials have been at risk of moisture exposure during transport. • Storage under suboptimal conditions. • Significant risk of climatic influence, e.g. unpackaged building materials are installed without covering. • Construction process involves significant water or moisture content in building materials, e.g., casting of concrete.

Component vulnerability

The vulnerability of building components to moisture depends on how easily the component materials absorb moisture, their risk of mould growth, and how much time is available for them to dry. Materials that do not absorb moisture, such as concrete, are considered to have low vulnerability. Since timber can absorb moisture, it is always considered to have at least medium or high vulnerability, depending on the potential damage if it gets wet.

	Medium vulnerability	High vulnerability
Example of components based on ability to absorb moisture	Timber with the possibility for drying: • Solid timber, CLT, Glulam • Cladding (untreated, treated or midified	• Prefabricated floor, roof or façade elements (closed), box modules • Wood-based panels (e.g. MDF, OSB, plywood) • Mineral-based and biobased insulation • Gypsum boards
Risk of mould growth*	Some risk	High risk
Amount of drying time allocated	Tight schedule, but focus on drying	Tight schedule, difficult to achieve sufficient drying

*See risk of mould growth at various moisture contents on page 11.

Actions and recommended protective measures

After identifying the risk class (RC) of each construction component, the following table gives appropriate protective measures to help mitigate the risks.

⚠ Engage a moisture expert

Risk class	Actions and protective measures	Pay attention to
RC 1	• Moisture content measurements at critical times • Proper storage with proper air flow • Air flow around load-bearing structures during construction • Tapes on floor joints • Drip off edge on cladding • Ground clearance (cladding)	• Depth of fasteners in cladding
RC 2	In addition to all points in RC 1: • Continuous moisture content measurements • Weather protection • End-grain sealants on all timber • Tapes and membranes on joints • Use membranes to separate from cement-like materials • For concrete after-treatment, use a protective cover against drying instead of extra humidification or heating. • Regularly inspect weather protection • Plan for just-in-time delivery or storage under roof	In addition to all points in RC 1: • Removal of standing water • Moisture content before installation • Assess specific potential moisture problems • Sufficient drying time if moisture content is too high Components of high vulnerability: • Ensure they never get wet • Ensure weather protection is used and is intact at all times (transport to construction)
RC 3 ⚠	In addition to all points in RC 1 and RC 2: • Engage a moisture expert already during design (pre-construction) • Conduct needed calculations or moisture simulations during design	All points in RC 1 and RC 2

Checklist
Protective measures

Address the following questions regarding protective measures and exposure for each product in the moisture management plan:

- ☐ How is the entire construction covered?
- ☐ When will the cover be installed?
- ☐ How is the storage area protected?
- ☐ What type of ground surface is present?
- ☐ How is the storage ventilated?
- ☐ Will there be contact with casted cement-like materials?
- ☐ What type of delivery method is chosen?
- ☐ Exposure of each timber product
- ☐ What protective measures are implemented during production?
- ☐ What precautions are taken during transport and upon arrival?
- ☐ What steps are followed before installation?
- ☐ What protection is used after installation?
- ☐ What protection is applied before materials are enclosed in concrete, plaster, or gypsum boards?

Include plan for use of protective measures in the moisture management plan

Identify water pathways

To effectively evaluate risks and prevent moisture-related damage, it is essential to understand the sources of water, its flow patterns, and areas where it tends to accumulate. This understanding enables the selection of appropriate protective measures to safeguard timber from water damage.

Key steps in moisture protection include:

1. Identifying interfaces

- Pinpoint contact points between different materials, such as timber and concrete.
- Assess the risk of capillary suction and moisture traps at these interfaces.

2. Identifying moisture entry points

- Analyze how water may come into contact with timber, including sources like rain and concrete casting.
- Consider the natural flow of water, which typically moves downward from higher levels unless managed properly.
- Be aware of water ingress through cement-like materials, such as concrete or mortar, which can retain and transfer moisture.
- Evaluate the implications of the protection measures and the altered water pathways.

3. Recognizing patterns

- Look for recurring components and their interactions with the surrounding environment.
- Analyze individual instances of recurring elements and apply the insights gained to all similar cases.

The details make the difference

Pay attention to the small details: moisture issues often arise in overlooked areas, making it essential to thouroughly inspect every aspect. It is insufficient to assess the building as a whole even if 99% of the structure is dry, the remaining 1% can lead to significant problems, resulting in delays and extra costs.

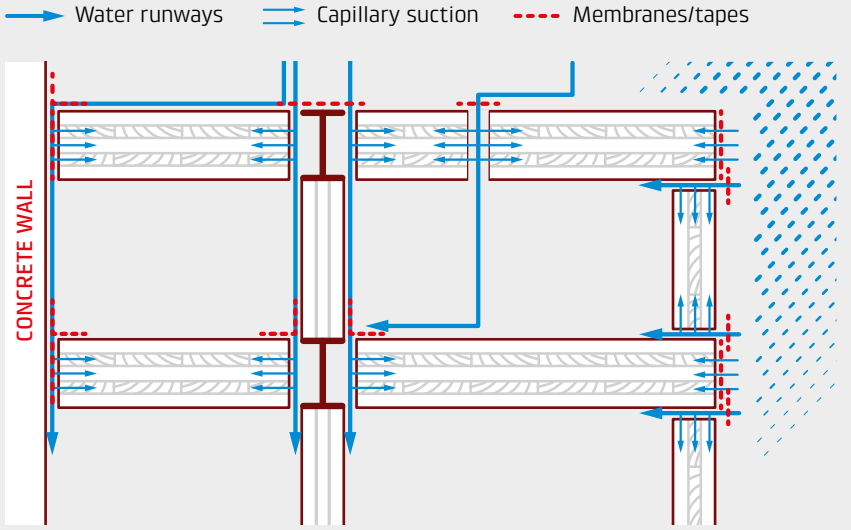
Drainage

Implement a temporary drainage solution during construction to ensure water is directed away, even during heavy rainfall. Protect the areas along the drainage path to avoid damage to the material. The drainage solution should prevent water leakages inside the structure. Prefer overflow systems over electrical pumps, as they are more reliable during extreme weather events.

Unforeseen circumstances

It is essential to allocate a budget for unforeseen circumstances, such as drying time following water ingress or construction delays caused by adverse weather conditions.

Typical water pathways



Risk areas of timber columns

The risk areas are marked in the image with suggestions for appropriate actions.

Risk	Action
Standing water on floor?	Tape joints immediately after installation when dry.
Open end grain and holes can absorb water. Accumulation of standing water or capillary suction.	Protect end grain, for example with a coating or a temporary cover. Tape holes/cutouts temporarily.
Will edges/faces also be covered or are they coated? It might prevent the wood from drying out.	Measure the moisture content in the column before coverin

Common water risks with various timber elements

Different timber elements are exposed to various risks. This overview highlights the issues and protective measures associated with different solid timber products.

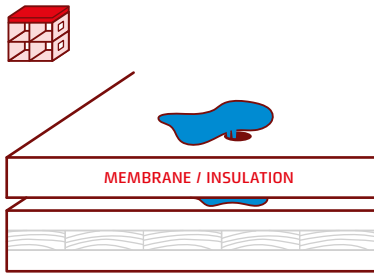
Roof

Common issues

- Leakage.
- Condensation.
- Capillary suction

Protective measures

- Clever design and good insulation.
- Slope of roof as steep as possible.
- Slope of CLT elements as steep as possible.
- Double membrane system.
- Tape and seal element joints.



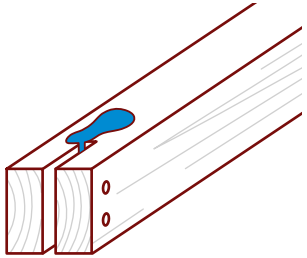
Beams

Common issues

- Accumulation of standing water on the surface.
- Presence of water in joints.
- Cold bridges created by metal beams and brackets.

Protective measures

- Design joints to facilitate water drainage.
- Cover the building site to guard against rain.
- Provide insulation in necessary areas.



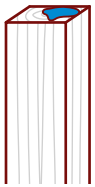
Columns

Common issues

- Accumulation of standing water at both the top and bottom.
- Water absorption through the end grain.

Protective measures

- Design joints to facilitate water drainage.
- Apply sealant to the end grain before exposure to moisture, ideally prior to installation
- Use tape to seal any gaps.
- Use temporary protection for the top end grain.



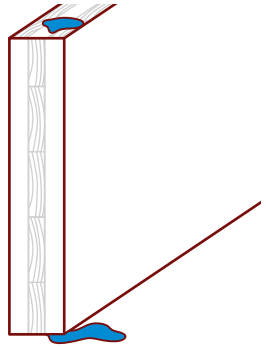
Walls

Common issues

- Standing water on the top and bottom.
- Water absorption through the end grain.

Protective measures

- Apply salant to the end grain before exposure to moisture, ideally prior to installation.
- Use tape to temporarily seal any gaps at the bottom.
- Use temporary protection for the top end grain.
- Use a membrane to separate timber from cement-like materials.



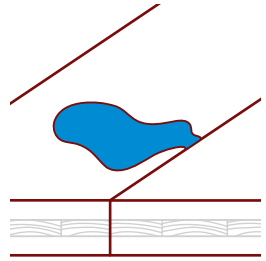
Floors

Common issues

- Standing water on top.
- Water running into joints and pits.
- Cement-like layer that brings in extra water.

Protective measures

- Protection of the building site against rain.
- Removal of standing water immediately.
- Taping of all joints and pits before exposure to moisture.
- Cover the outer end grain with foil or sealant.
- Add a membrane before pouring the cement-like layer.



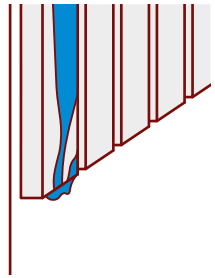
Facade cladding

Common issues

- Regular weathering that does not drip off sufficiently.
- Exposed end grain on top and from too deep inserted fasteners.

Protective measures

- Ensure a drip-off edge.
- Select durable timber.
- Choose appropriate coating.
- Use corrosion-free fasteners and ensure correct installation depth.
- Leave gaps between boards to accommodate dimensional changes.
- Use a solid top cover



Examples of moisture pathways and traps

Standing water in pits

Standing water in pits can lead to moisture accumulation in various parts of the structure, such as pits, gaps, joints, and holes. This moisture is primarily absorbed through the end-grain of the timber and facilitated by capillary forces within the joints.

Bad practice

In this scenario, rainwater infiltration was not promptly removed, leading to absorption in the end grain. This local increase in moisture content poses a significant risk for mould development.

Good practice

It is advisable to plan and apply protective tape prior to any exposure to water. Once timber becomes wet, the adhesive properties of the tape are compromised. Therefore, it is essential to promptly replace the tape if it becomes damaged.

CLT on concrete

Contact with cement-like materials can lead to unnecessary uptake of water. Moisture barriers need to be placed correctly to prevent this.

Bad practice

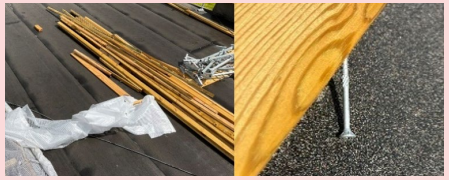
A moisture barrier installed between Cross-Laminated Timber (CLT) and Expanded Polystyrene (EPS) was inadequately sized, resulting in exposed edges of the CLT. This oversight allows for potential water infiltration, which can lead to elevated moisture levels and subsequent discoloration of the timber.

Good practice

Implement a protective membrane, particularly when interfacing cement-like building materials with moisture content and timber. Ensure that all membranes are cut to a width exceeding the timber dimensions by 2 cm. Design them to curve downwards to prevent water accumulation in the space between the membrane and timber.

Puncture of membranes

Membranes serve as protective barriers for timber and various materials. Inadvertent placement of tools, screws, or other sharp objects on these membranes can lead to damage, potentially undermining their protective capabilities.



Bad practice

The installation of building materials on the roof was executed improperly, as they were placed directly onto the membrane. Additionally, protruding screws posed a significant risk of puncturing the membrane, compromising its integrity.

Good practice

To enhance safety during work in the area, apply a protective layer, such as plywood or rubber mats, over the membrane. This precaution ensures the membrane remains protected in the event of accidental dropping of tools or material.

Membranes taped when wet

Membranes are generally ineffective when applied to wet surfaces, as most tapes, foils, and membranes adhere best to dry materials. When timber is damp, these products may fail to bond properly and can potentially trap moisture, compromising the protection of the timber.

Bad practice

The membrane was installed after the timber had been exposed to rain, resulting in inadequate adhesion. Additionally, the membrane was not removed, preventing the underlying timber from drying properly.

Good practice

Apply tape and membranes promptly after installation of timber components. In the event of rain, allow the timber to air dry adequately before proceeding. Verify that the timber has reached an appropriate moisture content before applying tape and membranes. If the membrane is damaged, repair or replace it immediately.

> **Consistent moisture management relies on a clear control plan — and on everyone's commitment to use it at every stage.**

Monitoring procedures and control plans

After assessing the moisture risks linked to construction and its components and implementing strategies to mitigate these risks through protective measures, it is crucial to formulate a comprehensive plan for monitoring and inspecting timber materials to ensure effective moisture management.

Operational plans for moisture content are vital. They include the following:

- **Control Surveillance Plan:** This entails continuous monitoring of moisture content in timber to ensure it remains below a specified threshold, such as 16%, before project completion, along with providing necessary documentation for the client.
- **Contingency Plan:** This outlines strategies for unforeseen events, detailing decision-making processes and appointing a moisture specialist to address any issues that may arise.
- **Maintenance Plan:** This guarantees regular inspections and ongoing care of the building during its occupancy, fostering a healthy indoor environment and ensuring the durability and longevity of construction components.

Stick to the plan
Regular monitoring is essential. Don't skip inspections, and keep records up to date.

Sensors for leakage detection

Sensors serve as a valuable enhancement to manual inspections, particularly for identifying leaks in high-risk, hard-to-reach, and vulnerable areas. They can be integrated into prefabricated elements during production or installed on-site during construction.Once the building is operational, sensors are especially effective for monitoring and detecting leaks in roofs and around pipes, thereby helping to prevent long-term damage.

Moisture control surveillance plan

The Moisture Control Surveillance Plan provides a structured approach to monitoring moisture risks associated with products and elements throughout the construction process. Its main goal is to ensure consistent tracking of moisture levels, allowing for early detection of potential issues so that corrective actions can be taken before problems develop.

A comprehensive moisture control surveillance plan should include the following components:

1. Surveillance points

Based on the risk assessment, identify which products, components, elements, interfaces, and other potential risk areas should be regularly monitored for moisture.

2. Monitoring methods

Select appropriate moisture detection tools for each surveillance point:

- Handheld moisture meters
- Installed moisture sensors with data logging or alert capabilities
- Visual inspections for signs of leaks or condensation

3. Monitoring schedule

Develop a systematic schedule with clear instructions for conducting moisture checks, as a minimum including the following times:

- Delivery – upon arrival
- Storage – bi-weekly (if dry)
- Installation – immediately prior
- Routine control of installed elements – weekly
- Closing – immediately prior
- After finishing construction – last round of control measurements

4. Thresholds and response actions

Specify acceptable moisture content thresholds for each product type and outline procedures to follow if measurements exceed acceptable levels (See checklist below).

5. Document measurements and actions

Maintain detailed records of all moisture readings, inspections, corrective actions, and favorable results to demonstrate compliance with established standards.

6. Weather data monitoring

Schedule moisture assessments following rainfall events, utilizing a precipitation log to track weather conditions.

7. Assign responsibilities

Clearly define who is responsible for conducting surveillance at each stage, reviewing data, and initiating responses.

8. Monitoring systems

Ensure that all monitoring equipment is calibrated and maintained throughout the construction period.

All points should be included in the moisture management plan

Where and when to measure

Measure upon arrival of wooden components.

Check regularly randomly and additionally in critical zones.

Consider sensors in risk zones that is hard to reach.

Permanent monitoring for leakage detection.

Checklist

Acceptable moisture content

It is essential to establish clear objectives regarding the acceptable moisture content (MC) of timber products. This ensures that material suppliers deliver at appropriate levels and that responsible individuals can effectively monitor moisture levels within the established limits.

The following questions regarding timber products, components, and elements must be answered and included in the moisture management plan:

- ☐ What is an acceptable MC at the time of delivery?
- ☐ What is an acceptable MC during storage?
- ☐ What is an acceptable MC prior to installation?
- ☐ What is an acceptable MC during routine inspections?
- ☐ What is an acceptable MC before enclosure?
- ☐ When and how frequently should MC be measured during each phase?
- ☐ What steps are followed before installation?
- ☐ What protection is used after installation?
- ☐ What protection is applied before materials are enclosed in concrete, plaster, or gypsum boards?

Include acceptable moisture contents in the moisture management plan

Contingency plan

The contingency plan addresses unforeseen events such as late deliveries, adverse weather conditions, and leaks. In the event of such occurrences, enhanced measures per batch and daily monitoring are necessary compared to the standard control surveillance plan, until moisture content stability is attained. All drying processes must be monitored at least every third day and again following any potential water ingress. It is crucial that all stakeholders can access and comprehend this plan.

The contingency plan should delineate the steps to be taken, including drying, cleaning, replacing, or repairing damaged components if timber moisture levels rise excessively.

Checklist
A contingency plan should at least cover:

- ☐ Responsibility: Clearly identify which company (and individual) is accountable for each emergency action.
- ☐ Direct actions: Prevent water from entering, eliminate standing water, and safeguard affected areas.
- ☐ Inspection: Examine all parts exhibiting visible water damage, such as discoloration, and assess adjacent areas and the floor beneath.
- ☐ Timing of checks: Inspect affected parts daily until conditions improve, as moisture can increase for several days after damage.
- ☐ Additional checks: Include affected parts in the routine moisture control plan. Do not cover wet items before they are dry.
- ☐ Action plan: Take necessary actions like drying, cleaning, mould removal, replacing, or repairing damaged parts.
- ☐ Control: Check how well the mitigation actions, including mould removal, are working.
- ☐ Record all actions taken and plan follow-up checks.

Include the contingency plan in the moisture management plan

Maintenance plan

Effective moisture management, even after construction is complete, is essential for ensuring the durability and longevity of a building.

Provide the building owner with a maintenance plan that includes the points listed below, as well as essential user manuals containing necessary practical information to carry out effective long-term moisture management.

Checklist
The maintenance plan should at least cover:

- ☐ A plan for routine inspections: Regularly check for issues and measure moisture levels as necessary.
- ☐ If moisture sensors are installed: Monitor them for alerts. Establish clear procedures for responding to sensor notifications, including inspection and remediation steps. Regularly verify that the monitoring system is functioning correctly.
- ☐ Weather monitoring: Stay informed about weather conditions and take proactive measures during severe weather events.
- ☐ Indoor climate: Maintain temperature and humidity within acceptable ranges.
- ☐ Ventilation: Ensure adequate airflow to keep moisture levels between 30-65% relative humidity.
- ☐ Emergency response: Develop quick response plans for any issues.
- ☐ Documentation: Maintain detailed records of all moisture management activities.

Include the maintenance plan in the moisture management plan

Roles and responsibilities

Effective communication among all stakeholders – architects, engineers, construction workers, building owners, etc. – is crucial for successful moisture management throughout the entire process. As roles and material handling evolve during the project, it is vital to maintain effective communication and clearly define responsibilities. Prompt action can reduce costs, making it essential for relevant personnel to have the authority to make decisions.

In the moisture management plan, clear responsibilities should be established for both the design and planning phases (as illustrated in diagram 1) and the construction phase (as shown in diagram 2). It is important to identify who will contribute to moisture management and who will monitor moisture levels during construction. Ensure that all parties involved reach a consensus on strategic decisions before the construction begins. Additionally, it is advisable to connect with a moisture expert who can validate the proposed measures and provide immediate support during any unforeseen critical situations.

Incorporate the allocation of responsibilities into the moisture management plan

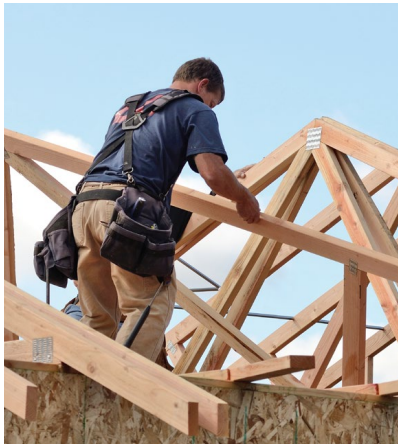


Diagram 1. Planning Phase

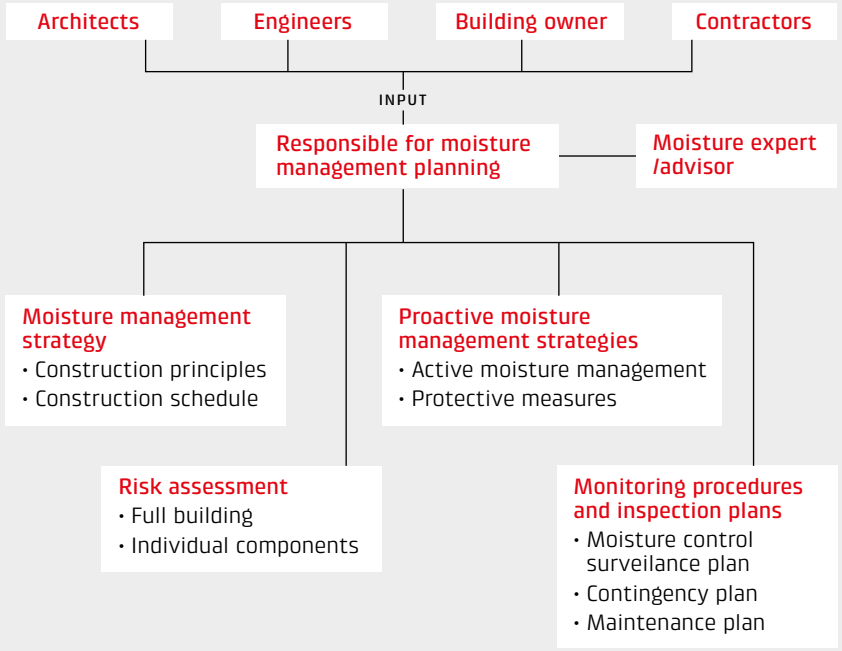
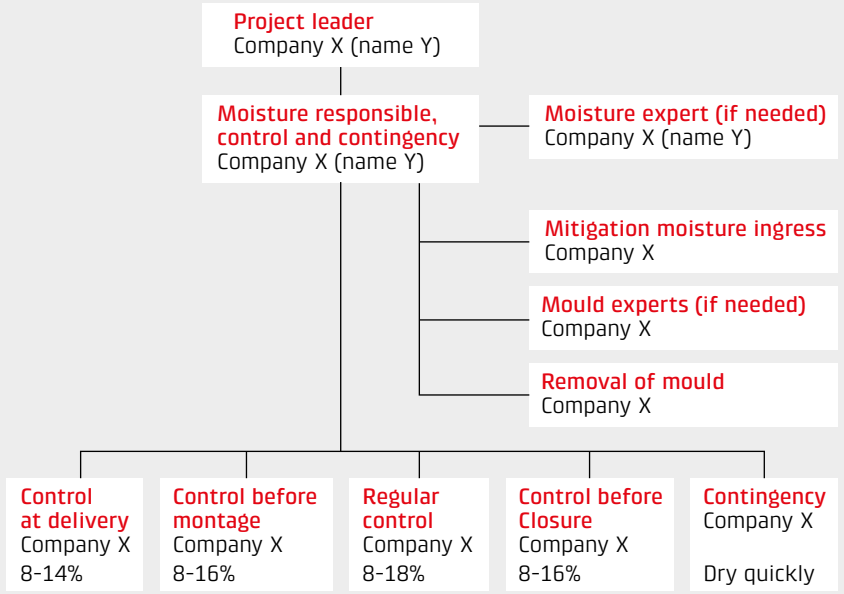


Diagram 2. Construction Phase

Who is responsible for what regarding moisture management during the construction process?



Construction phase:
Implementing the moisture management plan

Prior to commencing the construction phase, the finalized moisture management plan must be presented to the project leader for implementation.

It is crucial that every aspect of the moisture management plan (MMP) is executed and adhered to. All actions should be meticulously recorded and documented within a quality assurance system that integrates seamlessly with current operational protocols and control activities.

Checklist

Implementation of the MMP, follow these steps:

- ☐ Assign responsibilities for all tasks and brief the team before start.
- ☐ Install protective measures as specified in the MMP.
- ☐ Routinely monitor and control moisture according to the MMP.
- ☐ Activate contingency measures immediately if moisture problems occur.
- ☐ Apply mitigation strategies promptly to minimize potential damage.
- ☐ Encourage team members to report moisture issues immediatley.
- ☐ Document all actions taken for quality assurance and traceability.
- ☐ Verify correct installation of all membranes and protective barriers. Look out for condensation risks when applying or adjusting.
- ☐ Repair any damage to protection systems as soon as it is identified.
- ☐ Ensure timber is adequately dried to the approved moisture level before enclosing it in the structure.
- ☐ Investigate leaks by identifying the water source and stop it.
- ☐ If a moisture problem is discovered, assess for similar issues elsewhere. Update the moisture control plan with new inspections and actions as additional risks are identified.
- ☐ Conduct additional inspections in areas identified as high-risk to ensure ongoing protection.

Proper storage of timber

Proper storage of timber products and components is crucial for maintaining their quality and structural integrity. Correctly storing timber safeguards, protecting it against moisture, warping, decay, and pest infestations, ensuring it remains strong, stable, and ready for use when required. Inadequate storage can undermine the performance and durability of timber in construction.

Enclosed or Unventilated Spaces

In unventilated spaces, such as tightly wrapped storage, unfinished construction under full cover, or enclosed buildings, air movement is often restricted. Heating is frequently used during winter, which can lead to increased relative humidity when wet materials, such as paint or concrete, are introduced into th environment. To enhance air circulation and reduce relative humidity, it is essential to ensure adequate ventilation.

Excessively low moisture content is often caused by excessive heating during winter. In such cases, it is advisable to lower the temperature, and if the relative humidity drops below 40%, consider using a humidifier.

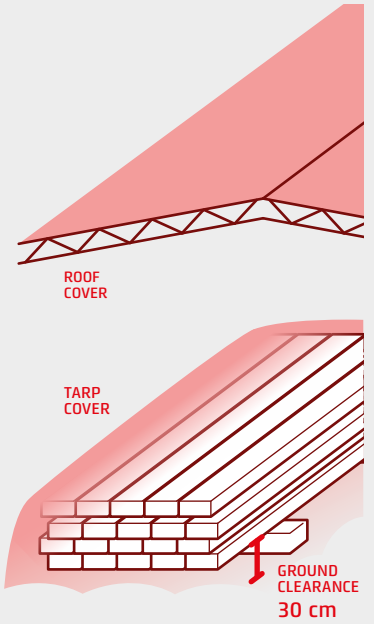
Outdoor storage

To prevent moisture uptake, always store timber at least 30 cm above the ground. Opt for hard surfaces like asphalt or metal for storage, as they are less likely to retain moisture compared to grass or soil. For added protection, place a waterproof membrane beneath the timber to block moisture from below.

During outdoor storage, natural wind exposure typically provides air movement, and heating is not an option.

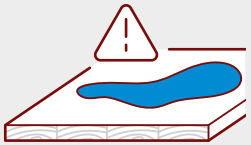
To protect timber from rain and snow, store it under a roof or cover it with waterproof tarps. Ensure adequate ventilation by leaving space between the timber pieces and between the tarp and the timber to prevent condensation. Finally, secure the tarps properly to avoid displacement or damage from wind.

Covers



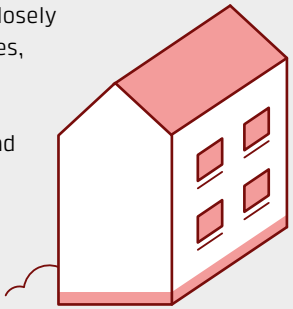
Remove standing water

Avoid puddles of water also on top of covers. Remove immediately from wooden surfaces.



Tight membranes

It is essential to closely monitor membranes, especially those located on roofs, at ground level, and around windows. A damaged membrane can allow water to infiltrate.



Moisture content surveillance

Continuous monitoring of the moisture content of timber products and components is crucial, as outlined in the moisture control surveillance plan. Special attention should be given when moisture content measurements reach 16% or higher, ensuring that timber components have adequate time to dry before construction proceeds.

It is essential to refrain from using timber products or elements until the moisture content is at an acceptable level, as dimensional changes or fungal growth can result in significant problems later on. Timber does not dry quickly, particularly in depth.

Conduct weekly checks and exercise patience. Components should only be covered with coatings, tapes, membranes, etc., once the timber has reached an appropriate moisture content. Covering can restrict ventilation, potentially causing issues if the timber is too wet or too dry when covered.

High moisture content (>18%)

Mosture content exceeding 18% is often a result of liquid water from various sources, including rain, concrete casting, or ground moisture. It is crucial to remove the water promptly and assess the extent of moisture ingress. If significant areas are wet, relying solely on natural drying may be insufficient and could pose risks. Therefore, consider enhancing ventilation. While dehumidifiers and heaters can be beneficial, they should be used judiciously, as excessive drying may lead to an overly dry timber surface, resulting in cracking.

Document measurements
It is essential to record and document all measurements to provide evidence, even when the moisture content falls within the acceptable range.

Moisture traps
Be cautious regarding the critical areas and potential moisture traps.

Where to measure moisture content?

The quantity of control measurements should meaningfully correspond to the batch size, e.g. 1/1 or 20/100 (indicating the number of measurements per number of elements in a batch). Batches are defined as groups of timber products that share common characteristics, including product type (e.g., beams, walls) and construction stage (e.g., delivery, storage, installation).

The following figures illustrate the appropriate locations for measuring moisture content in specific products and during various stages of construction.

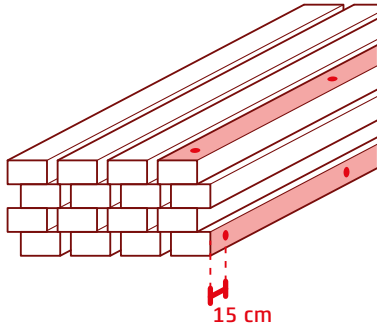
Targeted inspections

When inspecting a batch, prioritize elements most likely to have been in direct contact with water.

Always take measurements if there are any visible signs of water ingress (e.g. upon delivery or during routine insepctions.)

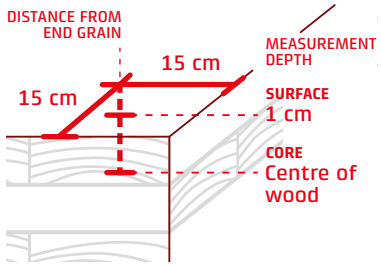
Moisture content at delivery

Measure pieces at the top and bottom of stacks. Measure 15 cm from the ends and mid-length.



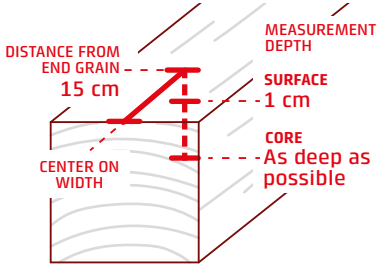
Floors, roof, walls

Measure close to a corner 15 cm from the end grain.



Beams and columns, prefabricated elements, cladding

Measure mid width 15 cm from the end grain.

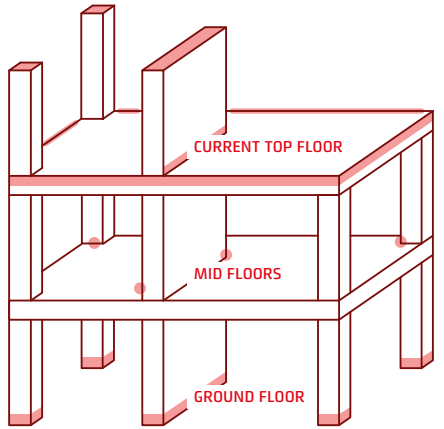


Routine control

Current top floor: Check the top and bottom of the elements – especially before installing the next floor above.

Mid floors: Random checks on elements, especially close to the floor and the underside of the top floor.

Ground floor: Regular checks on elements, especially close to the ground.



Actions for timber products at various moisture content levels

Timber components are delivered to the construction site with a specified moisture content that should ideally be maintained at or slightly below this level throughout the construction process. The following table shows various timber products, and their expected moisture content (MC) at time of delivery. It is also specified when each of the products is considered too dry and too wet, and what the main risks are in these cases.

If the moisture content deviates from the acceptable range, it is crucial to determine the cause and seek expert advice if necessary. Active moisture management may be required, which could involve drying or humidifying the timber components. Only when the moisture content is within the acceptable range construction can continue.

Should the difference in moisture content between the surface and core of solid timber (solid timber / CLT / glulam, also solid timber in prefabricated elements etc.) exceed approximately 3%, it is recommended to wait until this discrepancy decreases. The following table offers guidelines if various moisture contents are measured throughout the thickness of these types of timber products.

Main risks for specific products at different moisture levels

MC = Moisture Content

	Typical MC at time of delivery	Too dry (MC)	Acceptable (MC)	Too wet (MC)	Main risks
Flooring	Around 8%	<8%	8-10%	>10%	Dimensional change, deformation, cracks
Solid timber / CLT / Glulam	Around 12%	<8%	8-16%	>16%	See table the following page
Cladding	Around 16%	<12%	12-20%	>20%	Dimensional change, deformation, cracks

CLT/GLT/solid timber – Main risks and actions at various MC levels in surface and core

AMM = Active Moisture Management EMC = Equilibrium Moisture Content
MC = Moisture Content
⚠ Engage a moisture expert if initiating AMM

MC Surface	MC Core	Status	Main risk	Action
<8%	<8%	Too dry	Dimensional change, deformation	Initiate AMM ⚠
	8-16%	Too dry	Dimensional change, deformation	Initiate AMM ⚠
	>16%	Too dry and too wet	Cracks, mould growth	Find out what caused the MC in core and surface. Initate AMM. ⚠
8-16%	<8%	Too dry	Dimensional change, deformation, cracks	Wait for EMC.
	8-16%	Acceptable	-	Continue construction
	16-20%	Too wet	Mould, timber decay, cracks	Find out why the core is wet. Wait for EMC. Consider initiating AMM. ⚠
	>20%	Too wet	Mould, wood decay, cracks	Initiate AMM ⚠
>16%*	<8%	Too wet and too dry	Mould, cracks	Find out what causes the high and low MC in surfac e and core. Depending on the result, either - wait for EMC, or - initiate AMM. In any case, check for mould. ⚠
	8-16%	Too wet	Mould	Find out what causes the high MC in surfac e. Depending on the result, either - wait for EMC, or - consider initiating AMM. In any case, check for mould. ⚠
	16-20%	Too wet	Mould	Find out what causes the high MC in surface and core. Initiate AMM. Check for mould. ⚠
	>20%	Too wet	Mould, timber decay	Find out what causes the high MC in surface and core. Initiate AMM. Check for mould, wood decay. ⚠

* High MC in surface can be caused by water ingress. See next page: "Responding to water ingress".

Responding to water ingress

In the event of water ingress, follow this 7-step guide to address the situation:

1. Visual Inspection

Start by visually inspecting the timber to identify the source of moisture and any visible signs of water exposure. Also check around pits, cracks, and joints that could be potential moisture traps.

2. Measurement of moisture content

Measure the moisture content in the affected area as well as in surrounding materials and components. Focus on measuring discolored areas and visible moisture stains to determine the source and extent of moisture penetration. Be sure to measure both at the surface and in-depth and remember to remove any standing water before taking measurements.

Additionally, inspect the floors below and the underside of wet elements, and assess non-timber moisture-sensitive materials as well.

3. Stop water ingress

Identify and eliminate the moisture source. Remove nearby materials such as wet insulation or wet gypsum to allow structural components that cannot be removed to dry properly.

4. Assess drying needs

Determine whether drying is essential before proceeding with further construction activities. If necessary, establish appropriate conditions to facilitate effective drying. Often, simply enhancing ventilation can help lower the timber moisture content. If the relative humidity surpasses 75%, consider using additional heaters or dehumidifiers. Strive for a relative humidity of 55-65% to ensure optimal drying speed. Exercise caution against drying too rapidly (below 40% relative humidity), as this may result in cracks and distortions.

5. Monitor the drying process

During the drying process, closely monitor the moisture content in the affected area until it reaches an acceptable level. Check the relative humidity regularly to ensure the drying is progressing at a good pace.

6. Clean the affected area

Water ingress can lead to surface staining on timber. If discolouration occurs, elevated moisture content for several days is likely, or if visible mould or a damp smell is detected, it is advisable to consult a specialist for further assessment.

Experts can assist in determining the presence of mould, identifying its type, and recommending appropriate next steps.

Based on their evaluation, a comprehensive plan can be formulated to eliminate the mould and prevent its recurrence.

7. Document the process

Keep a detailed record of all actions taken to address moisture and mould problems, including:

- Moisture measurements.
- Cleaning methods and mitigation steps.
- Corrective actions implemented.

Important: Remember to document all actions!
Record all moisture measurements, observations, interventions and any other action.

Use an organized system to ensure all data is systematically documented.

Methods for mold removal

- Chemical cleaning with scrubbing: Apply appropriate cleaning agents and scrub the affected surfaces as directed.
- High-temperature steam cleaning with scrubbing: Utilize high-temperature steam in conjunction with scrubbing to eliminate mould.
- Mechanical sanding: Sand the affected area to remove mould. Ensure proper dust containment by shielding the work area to prevent the spread of spores. Use a vacuum cleaner equipped with a HEPA filter to collect the dust. Always wear a suitable mask for protection.

Control and verification

- After cleaning, test the surface for mould to ensure it is fully removed.
- Do not proceed with construction work in the affected area until the tests confirm a clean surface.

Methods for removing other surface staining

Restore the timber's appearance by:

- Cleaning with soap and water: Gently clean the stained area with a soft brush and mild soap solution. Rinse and allow to dry.
- Light sanding: If stains persist, sand lightly with fine-grit sandpaper. Remove dust and reapply finish if needed.
- Commercial timber cleaners: Use timber cleaners or timber bleach for stubborn stains, following the manufacturer's instructions. Test on a small area first.

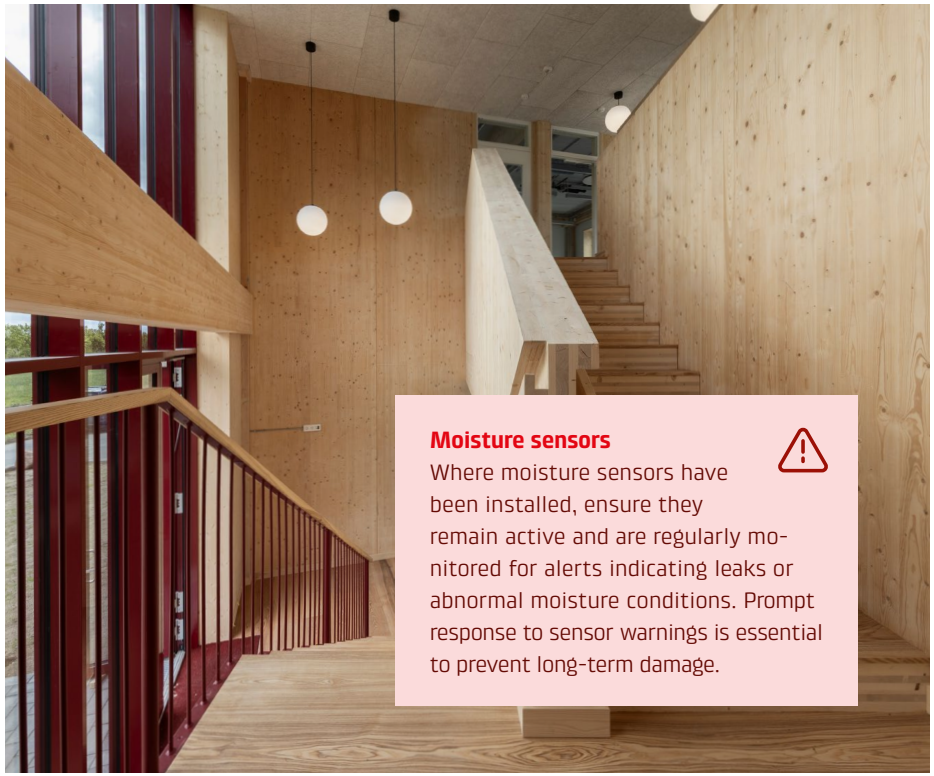
After removing stains

- After cleaning, test the surface for mould to ensure it is fully removed.
- Do not proceed with construction work in the affected area until the tests confirm a clean surface.

Post construction and occupancy: Maintenance and long-term moisture management

Effective moisture management extends beyond the completion of construction. The long-term durability and performance of timber buildings rely on ongoing attention to moisture management even after the project has finished.

It is essential to provide the maintenance plan to the building owner, clearly explaining its contents, intended use, and the significance of continuous moisture management post-occupancy. By adhering to the maintenance plan, building owners and occupants can contribute to a healthy indoor environment and ensure the longevity of the timber structure.



Moisture sensors

Where moisture sensors have been installed, ensure they remain active and are regularly monitored for alerts indicating leaks or abnormal moisture conditions. Prompt response to sensor warnings is essential to prevent long-term damage.

Summary:
Moisture management checklist

Checklist
Moisture management for timber construction

Know your material

- ☐ Understand key moisture risks and why active moisture management matters.
- ☐ Learn how to protect timber from moisture at every stage.
- ☐ Use correct methods to measure and monitor timber moisture content.

Pre-construction

- ☐ Address moisture management from the earliest design phase.
- ☐ Specify an overall moisture management strategy.
- ☐ Conduct a risk assessment for the entire construction and all component types.
- ☐ Plan proactive protective measures where needed.
- ☐ Specify monitoring procedures and make control plans
- ☐ Develop a clear, structured Moisture Management Plan.

During construction

- ☐ Implement and follow the moisture management plan during all stages.
- ☐ Store timber correctly – keep it dry and well-ventilated.
- ☐ Monitor moisture content regularly as specified in the surveillance plan.
- ☐ Respond immediately to any water ingress; never cover or enclose materials until they are properly dry.

Post construction

- ☐ Continue to monitor and manage moisture as outlined in the maintenance plan to ensure long-term durability.

Scan QR code to download example sheets and checklists

Build-in-Wood Demonstrator:

Flexible testing for timber construction

The development of this guide was partly based on experiences gathered during the construction of the Build-in-Wood Demonstrator, in Taastrup, Denmark. The Build-in-Wood Demonstrator is an open-access, full-scale, test and demonstration building designed to advance sustainable, timber construction. Its core purpose is to accelerate the development, validation, and adoption of innovative, biobased building solutions.

Flexible and component-based design

All parts of the building – floors, walls, façades, and roof – are component based and easily exchangeable. The flexible structure enables direct comparative testing of a range of materials, components, connections, lay-ups, and structural systems under real-world conditions.

Integrated digital twin and data monitoring

The Build-in-Wood Demonstrator is supported by a digital twin, which enables real-time monitoring and collection of key performance data such as moisture content, indoor climate indicators, and heat transfer from a network of distributed sensors. Automated moisture alarms allow for rapid intervention, helping prevent damage. The digital model enables predictive maintenance and detailed analysis of material behavior during practical use.

Versatile testing and demonstration capabilities

The Demonstrator supports a range of test and demonstration possibilities, e.g.:

- Moisture and thermal behavior: Tracking and comparison of moisture movement and thermal behavior of various building elements, components, and weatherproofing options.
- Acoustics: Measurement of airborne and impact sound insulation between internal and external assemblies.
- Indoor environment: Monitoring of temperature, humidity, CO_2, VOCs, and other parameters to ensure healthy indoor environments.
- Structural and mechanical testing: Facilitation of tests and demonstration of load bearing solutions, connections, and disassembly scenarios.

Documented results and industry collaboration

All prototypes and tests are thoroughly documented and evaluated, reducing risk and supporting best practices for new wood technologies. The facility also functions as a platform for product demonstrations, collaborative research, and standardization.

Future-oriented "Open-access laboratory"

The Demonstrator serves as an open-access test and demonstration resource for both industry driven product development and demonstration as well as publicly funded research and innovation projects. It supports robust moisture management and contributes to the creation of safer, healthier, and more sustainable buildings. The Build-in-Wood demonstrator has been co-funded by the EU as an outcome of the Build-in-Wood Horizon 2020 project. Stakeholders interested in gaining access or learning more about the test possibilities in the Build-in-Wood Demonstrator should contact Niels Morsing, Director in Wood and Biomaterials at the Danish Technological Institute.

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