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Observations of Moisture Damages in Historic and Modern Wooden Constructions

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1 Introduction

With the introduction of new building products made of planar glued board lamellas, the cross laminated timber (*CLT*), the restriction of load-bearing structures to linear and thus additively used load-bearing members was abolished. As a result, new, technically determined boundary conditions for moisture management in the interior of buildings have arisen. Due to the emergence of massive, planar wall and floor components as in concrete construction, the integration of building services technology in timber construction must now take place differently than was traditionally the case, see Figure 1. In addition, it can be observed that the damage to building components is increasing, the detection of moisture damage is becoming more difficult and, ultimately, the consequences and risks are not yet foreseeable. The study focuses on the cause-effect relationship of increased water input and uses selected examples to reveal the problem of moisture exposure in the interior of buildings with planar load-bearing structures, the damage mechanisms and direct consequences set in motion. This paper shows the necessity for moisture protection measures in modern timber structures in comparison to traditional ways to construct with timber. It shows where moisture intake with modern structures must be considered and avoided from the engineering perspective in order to minimize the risk of moisture damage, see Table 1.

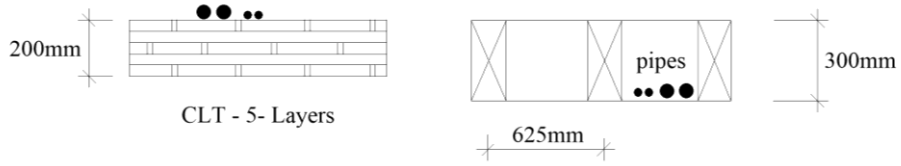

Figure 1. The two main different types of timber floor systems, a *CLT* plate with 2-axial structural span (left) and a traditional framed floor of joists with a 1-axial span (right) showing installation of water pipes.

Historic timber construction is dominated by the use of beams. The functions, room enclosure, and load bearing are separated from each other. Due to the separation of the functional layers, there is minimal moisture absorption from the member, which guarantees structural safety. Therefore, if an early detection of unwanted moisture intake is recognized the moisture load does not necessarily affect the load-bearing structure. In case the repair of a joist floor is necessary, there is enough geometric space available for structural alteration and improvement. By extended lower damage, a clearly visual load transfer, separation of the functions, enhanced accessibility and reduced effort for engineering and constructing a required repair it can be realized with a reduced risk. **Modern timber construction** is dominated by a high number of planar components, used for load-bearing plates. In this type of constructions, the enclosure and the load-bearing capacity are combined into a multifunctional layer.

When recognized too late, unwanted moisture intake is the consequence of timber floors with low permeability and high moisture absorption capability. For this type of constructions, the entire cross section is used for load bearing, and no geometrical space is available for repair or additional reinforcement. In the event of damage, the load transfer path cannot be definitively predicted. Such damage leads to costly repair measures with a high amount of engineering and construction work.

Table 1. Categories of exposure and related reasons.

Scale & Time category	Reason	Explanation
large & suddenly	pipe burst, household applicance burst, sprinkler	- (unexpected event)
small & long-term (water source related)	pipe and fitting leakage, pipe connections	material damage, (quality management)
	complex and integrated installations	water leakage not detectable, water supply (leakage)
small & long-term (construction technology related)	type of structures in mid-rise housing	large areas with flat slabs, thick slab dimensions, seldom beam structures
	ducts crossing different units without necessary barriers (air stops)	missing awareness & planning, expensive task, complex on-site work, no quality management, difficult maintenance
	type of indoor climate conditions	warm, humid, no or limited air-flow, no dry-out capacity

A constant and sustainable use of wooden construction products and components is strongly coupled with moisture influence. There are numerous construction components, which are known, exhibited to moisture influence. In order for these materials to keep their durability, they must be capable of draining large volumes of water. One of the extreme examples is wooden shingles as roof claddings, which show usage periods of 20 to 30 years and sometimes even longer.

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