

Biological durability

Biological durability refers to the resistance of wood and wood products to wood-destroying fungi and other microorganisms as well as to wood-destroying insects and marine organisms. A distinction is made between natural durability and conferred durability, achieved by preservative treatment, modification or other processes. Natural durability is based in particular on the extractives, anatomical characteristics and the specific material composition of the wood. Conferred durability is based on treatment-related changes in the properties of the wood or the introduction of effective substances.

For the application of thermally modified timber (TMT), wood-destroying fungi are particularly important. These include brown and white rot fungi (basidiomycetes) as well as mould

rot fungi. The prerequisite for wood degradation by fungi is sufficient and longer-lasting wood moisture. Mould rot fungi usually require higher wood moisture levels than basidiomycetes and occur in particular when they come into contact with the ground. According to EN 350, the durability against wood-destroying fungi is divided into five durability classes (DC), from DC 1 „very durable“ to DC 5 „not durable“.

The durability is organism-specific and can therefore differ between different groups of wood-destroying organisms. For example, a DC 1 against wood-destroying brown and white rot fungi does not necessarily mean a DC 1 against wood-destroying rot fungi.

Use classes and durability requirements

The use classes (UC) according to EN 335 describe the installation situation of wood and wood products and the associated moisture exposure as well as the risk of infestation by wood-destroying organisms (Table 1).

TMT is mainly used outdoors without contact with the ground (UC 3), for example for façade cladding, windows, fences and decking. A distinction is made between UC 3.1 with limited humidification and rapid re-drying and UC 3.2 with stronger or longer-lasting wetting. The classification depends largely on the design and the actual humidity conditions. The use of TMT in contact with soil or fresh water (UC 4) as well as in contact

with seawater (UC 5) is generally not recommended or is not common.

As the use class increases, biological exposure increases and thus also the requirement for biological durability of wood and wood products. EN 460 provides recommendations on the durability requirements depending on the use class and the intended service life. The design conditions must also be taken into account. As a simplified guide, TMT should have at least durability class DC 3 when used in UC 2 and at least DC 2 in UC 3 against wood-destroying brown and white rot fungi (basidiomycetes) without additional protective measures.

Table 1: Use classes according to EN 335 and their significance for the application of TMT

UC	Typical situation of use	Relevance for TMT
1	Interior, dry	application possible
2	Interior, or under cover, not exposed to the weather Possibility of water condensation	application possible
3.1	Exterior, above ground, exposed to the weather limited wetting conditions	typical, preferred application (e.g. cladding)
3.2	Exterior, above ground, exposed to the weather prolonged wetting conditions	typical, preferred application, increased requirements (e.g. decking)
4	Exterior in ground contact and/or fresh water	no typical application, not recommended
5	Permanently or regularly submerged in salt water	no typical application, not recommended

Testing and classification of biological durability

The biological durability of TMT is determined by laboratory or field tests and classified according to EN 350. In laboratory tests against wood-destroying fungi, the resulting loss of mass or bending strength serves as an assessment criterion. Field tests primarily record wood degradation on the basis of visual assessments of the degree of destruction compared to

reference woods. Laboratory tests take about five months, field tests several years. The results of suitable field tests take precedence over laboratory results in the classification according to EN 350. Table 2 provides an overview of the most important test methods.

Table 2: Test methods for determining the biological durability of wood (excluding insects)

GK	Risk by	Laboratory test	Field test
3	Brown and white rot fungi (Basidiomycetes)	EN 113-2 (usually after prior leaching exposure acc. to EN 84)	EN 12037 (in future: Bundle test acc. to Brischke et al. 2023, current EN standardisation project)
4	Brown and white rot fungi (Basidiomycetes)	EN 113-2 (usually after prior leaching exposure acc. to EN 84)	EN 252
	Soft rot fungi and other soil-inhabiting microorganisms	CEN/TS 15083-2 (in future: EN 807-2, current EN standardisation project)	
5	Marine organisms	-	EN 275

Durability of TMT against wood-destroying fungi

Thermally modified wood usually has an increased durability against wood-destroying fungi than the corresponding untreated wood. This is due to chemical and physical changes in the wood, in particular the degradation of hemicelluloses and reduced moisture absorption. The equilibrium moisture is often reduced by about 50 % with TMT. The durability achieved depends on the type of wood, the starting material as well as the modification process and the treatment intensity. Differences can also occur within a TMT assortment, for example between sapwood and heartwood. Hardwoods often require lower treatment intensities than softwoods in order to achieve comparable durability. For the most common application of TMT – outdoor use without contact with the ground (UC 3), for example for terrace decking and façade cladding – the durability class DC 3 „moderately durable“ or better against wood-destroying basidiomycetes is usually sought. Reference values for suitable treatment temperatures for different types of wood are contained in the ThermoWood® handbook of the International Thermo-

Wood Association (ITWA). The information refers to an open (pressureless) modification process. For example, Thermo-D treatment temperatures are 212 °C for pine and spruce, 225 °C for hemlock and 230 °C for radiata pine, as well as 190 °C for iroko, 208 °C for ayous and 212 °C for ash. The actual durability achieved must be proven for the respective wood species and the modification process used by appropriate tests. In thermally modified conifers, the brown rot fungus *Rhodonia placenta* often leads to a durability classification that is one to three levels worse than other test fungi (Jacobs and Scheiding 2023). In the case of hardwoods, however, this fungus is not one of the mandatory test fungi according to EN 113-2. The causes of the increased susceptibility to *R. placenta* have not yet been fully clarified. It is also unclear to what extent this increased susceptibility reflects the actual risk of infestation under practical conditions. Results from field tests indicate that thermally modified softwoods may have a higher durability under practical conditions than the laboratory results with *R. placenta* suggest (Brischke et al. 2026).

Durability of TMT against wood-destroying insects

Thermally modified wood generally has an increased durability against wood-destroying longhorned beetles and furniture beetles, which use the wood as a breeding and food substrate. Furniture beetles include, for example, the common furniture

beetle (*Anobium punctatum*), colloquially known as „wood-worm“. Increased durability against termites has not yet been proven.

Resistance of TMT to superficial growth and microbial discolouration

A high durability against wood-destroying fungi does not mean that TMT is protected from superficial growth. Mould and blue stain fungi, bacteria as well as algae and lichens can occur especially in high humidity and shading, as TMT does not contain any biocidal substances. Dirt deposits and inadequate cleaning can also promote growth. This usually does not lead

to wood destruction but often poses an aesthetic problem and is an indication of high ambient humidity. Under unfavourable conditions, the growth layer can also store moisture and hinder drying; this can increase the risk of subsequent infestation by wood-destroying fungi.

Quality assurance and certification of TMT

The properties of TMT depend largely on the type of wood, the raw material and the conditions of thermal modification. To ensure consistent product quality, controlled process control, factory production control and regular tests of selected product properties are therefore required.

There are several voluntary quality assurance and certification schemes for TMT in Europe:

- ThermoWood® Production and Product Quality Control – International ThermoWood Association (ITWA), Finland

- KOMO® product certificate „Timber modification“ – Stichting KOMO, Netherlands
- Quality Mark TMT – Entwicklungs- und Prüflabor Holztechnologie GmbH (EPH), Germany

These systems are used to monitor defined quality requirements for the manufacturing process and product properties. They differ in terms of their scope and their specific testing and monitoring requirements.

Recommendations for selection and application

When selecting TMT, the intended use class, the design conditions and the intended service life must be taken into account. For outdoor applications without contact with the ground (UC 3), a durability class DC 3 „moderately durable“ or better against wood-destroying basidiomycetes is usually recommended.

Biological durability should be proven for the respective TMT range by appropriate test methods. Information on treatment

temperature or modification intensity alone does not allow for reliable classification. Preferably, products with independent quality control should be used.

TMT is generally not recommended for applications with soil or water contact (UC 4 and 5). Use requires separate proof of suitability under the respective exposure conditions.

Bibliography

Standards

EN 84:2020, Durability of wood and wood-based products - Accelerated ageing of treated wood prior to biological testing - Leaching procedure

EN 113-2:2020, Durability of wood and wood-based products - Test method against wood destroying basidiomycetes - Part 2: Assessment of inherent or enhanced durability

EN 252:2014, Field test method for determining the relative protective effectiveness of a wood preservative in ground contact

EN 275:1992, Wood preservatives; determination of the protective effectiveness against marine borers

EN 335:2013, Durability of wood and wood-based products - Use classes: definitions, application to solid wood and wood-based products

EN 350:2016, Durability of wood and wood-based products - Testing and classification of the durability to biological agents of wood and wood-based materials

EN 460:2023, Durability of wood and wood-based products - Guidance on performance

EN 12037:2022, Wood preservatives - Field test method for determining the relative protective effectiveness of a wood preservative exposed out of ground contact - Horizontal lap-joint method

CEN/TS 15083-2:2005, Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 2: Soft rotting micro-fungi

CEN/TS 15679:2007, Thermal Modified Timber - Definitions and characteristics

Further reading

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International ThermoWood Association: ThermoWood®-Handbuch (www.thermowood.fi)

Jacobs, K.; Scheiding, W. (2023): Durability testing of thermally modified timber: methods and results. In: Proceedings of the 11th European TMT Workshop, Dresden, 2–3 March 2023. Institut für Holztechnologie Dresden gemeinnützige GmbH, p. 77–83.



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