

The timber revolution: ultra-resistant wooden homes

A scientific breakthrough has produced self-densified timber with nine times the strength, opening new possibilities for sustainable construction.

Why timber? The decision that defined PAPIK Group

When we built K-Llavaneres, our first Passivhaus project of 198 m², we had to choose a building system that would allow us to reach the levels of airtightness and insulation the standard demands. Timber was not an aesthetic decision: it was a technical one. The lightweight timber frame offers thermal performance, assembly precision and a build speed that conventional brick-and-concrete systems simply cannot match in the Passivhaus context.

After more than 15 years and 120 homes delivered, we are still building with timber. Not out of inertia, but because every project confirms that it is the material best suited to the demands of high-efficiency construction in the Mediterranean climate.

Lightweight frames: how the system works

The lightweight timber-frame system consists of a structure of studs and rails of solid or laminated timber, with cavities filled with insulation (wood fibre, mineral wool or blown cellulose). The result is a wall that combines structural and insulating functions in a single element, eliminating the need for separate layers.

At PAPIK Group we work with FSC-certified timber, as on the K-Alzina project in the Montseny (180 m²), where every structural element comes from sustainably managed forests. We mainly use European fir and pine, species with an excellent strength-to-weight ratio and a hygroscopic behaviour that regulates indoor humidity naturally.

Timber and the Mediterranean climate: a natural alliance

One of the most frequent questions we receive is whether timber works well in our climate, where hot summers are the main challenge. The answer is emphatically yes, for several reasons.

First, the low thermal inertia of timber allows the house to respond quickly to temperature changes: when the ventilation system or solar protection begin to act, the effect is almost immediate. Second, timber is a natural humidity regulator: it absorbs water vapour when the environment is humid and releases it when it is dry, contributing to stable indoor comfort without the need for dehumidifiers. Third, the intrinsic insulating capacity of timber ($0.13 \text{ W/m}^2\text{K}$ thermal conductivity) is between five and ten times higher than that of brick or concrete.

On the K-Valld'Or project (280 m^2), thermal simulations confirmed that timber-frame walls with 20 cm of wood-fibre insulation kept the indoor temperature stable even during summer heatwaves, with no need for active climate control for most of the year.

Build speed and precision

An advantage our clients particularly appreciate is the build time. A lightweight frame structure is assembled in a matter of weeks, not months. The panels arrive on site prefabricated with the insulation cavities already incorporated, the electrical services planned and the airtightness membranes integrated. This shortens timelines, minimises on-site waste and, above all, guarantees a millimetric precision that is essential to reach the Blower Door test results (our projects usually sit between 0.3 and 0.5 ACH, well below the 0.6 limit).

But... doesn't timber burn?

This is, without doubt, the question we are asked most. And the answer deserves an honest explanation. Yes, timber is combustible. But the fire behaviour of a timber structure is predictable, slow and calculable, which cannot be said of steel, which loses its load-bearing capacity suddenly at high temperatures.

A solid timber beam, in a fire, chars on the surface at a known rate (approximately 0.7 mm per minute) and maintains its structural integrity for a time that can be calculated precisely. Our structures meet the fire-resistance requirements of the CTE (R-60 or R-90 depending on the case) through oversizing of the sections and the use of plasterboard as passive protection.

In addition, in a Passivhaus the ventilation is mechanical and controlled: there are no air draughts to feed a fire, and the ventilation systems include automatic fire dampers.

The acoustic performance of timber

Another area where timber surprises is acoustic insulation. Lightweight frame walls, thanks to their multilayer composition (plasterboard, air cavity, insulation, structure, membrane, exterior finish), achieve acoustic attenuation values above 50 dB, comparable to or higher than those of a conventional brick wall of far greater thickness and weight. The key lies in the combination of materials of different densities, which prevents the transmission of sound waves.

The future: self-densified timber and new possibilities

Beyond the techniques we already apply, scientific research continues to expand the limits of what timber can do. A team of researchers from the University of Maryland and Chinese institutions has published in the **Journal of Bioresources and Bioproducts** a self-densification process that triples the density of timber and multiplies its tensile strength ninefold (up to 496 MPa), approaching the performance of certain metal alloys.

The process consists of partial delignification followed by an induced reorganisation of the cellulose fibres, which compact naturally during drying. The result is a material with exceptional mechanical properties that retains all of timber's environmental advantages: it is renewable, fixes CO₂ and its production generates a carbon footprint far lower than that of metals.

This research confirms what we already see on site every day: timber is a material with a potential we are only beginning to tap. Self-densification techniques are still in the laboratory, but the direction is clear. The day they reach commercial scale, the constructive possibilities will expand enormously.

Outstanding challenges and the road ahead

We must be honest: the current self-densification process uses substances such as lithium chloride and N,N-dimethylacetamide, which present toxicity and environmental persistence. Future research will have to find cleaner alternatives that maintain the same results. But the trajectory is unequivocal: materials science is moving towards an ever stronger, more versatile and more sustainable timber.

At PAPIK Group, we have been committed to timber construction for more than fifteen years. We have learned which species work best in our climate, how to manage humidity on site, how to guarantee long-term durability and how to get the most out of every structural element. When we see advances like self-densified timber, we are not surprised: they simply confirm that we chose well.

Science is advancing towards where we already work. Timber is not the material of the past: it is the material that the most cutting-edge research is rediscovering for the construction of the future.