← Cross-laminated timber is simply massive plywood that can be used to make entire walls, floor or roof panels in one piece.

Image: Hybrid Build Solutions, www.hybrid-build.co

Engineering timber for strength and sustainability

Timber is one of the oldest building materials known, and for many people it is the preferred choice for its visual appeal, ease of use and relatively low cost. However, not all timber is sustainably produced, and some is a downright environmental disaster.

Much of the timber used by the building industry is plantation sourced, most of that being pine. While pine plantations are regrown after harvesting, most plantations originally displaced native forest, so they have environmental baggage attached, along with the ecosystem disruption issues of monocultures. But even monoculture pine plantations provide some limited habitat for wildlife, which then brings with it its own issues of animal deaths caused during the tree harvesting.

Overall, plantation timber has both good and bad sides—it locks up carbon, at least until the timber reaches the end of its useful life (which could be more than 100 years with hardwood, if it is reused rather than dumped when the building is demolished), but it also displaces native forests. Then again, using plantation timber also reduces the need to harvest still-existing forests.

It can be difficult to find truly sustainable timber, but the Forest Stewardship Council's website lists retailers selling FSC-certified wood as well as a list of species that have received certification. See au.fsc.org for more information. The Australian Forestry Standards website (www.forestrystandard.org.au) has information on the AFS and PEFC certifications, which, while arguably less rigorous than FSC, cover a greater number of timber suppliers.

Traditionally timber has consisted of solid sections cut from logs and either air or kiln dried, but there are other forms that can be more suitable for particular building uses while reducing the amount of timber required.

Known as engineered timber, this covers any timber materials that have been manufactured to improve the qualities of the material. An example is plywood, which takes thin sheets of timber veneer and laminates them, with the grain orientation of each sheet at 90 degrees to the preceding layer. This results in a timber sheet with grain running in both directions, giving the finished sheet very high strength.

Plywood is a well-known example, but there are other forms of engineered timber that have been less well used in Australia due to the lack of availability or simply lack of awareness of their existence. Engineered timber beams, such as hyJoist from Carter Holt Harvey (www.chhwoodproducts.com.au/hyjoist), consist of laminated timber flanges bonded to a structural web (either plywood or oriented strand board) to form an I-joist with high strength yet light weight, ideal for domestic and commercial construction.

Other engineered timbers are available from Hyne Timber (www.hyne.com.au) and Wood Solutions (www.woodsolutions.com.au).

While plywood has been around for many decades, a newer form called cross-laminated timber (CLT) is gaining popularity. Effectively plywood on steroids, CLT is much more massive than even the thickest ply, and can be used in place of other load-bearing construction panels such as prefabricated concrete panels. One Australian supplier, Cross Laminated Timber in SA, supplies panels with each layer between 15 and 45 mm thick, resulting in panels up to 350 mm thick, 3.8 m wide and a huge 18 m long. An entire wall can be made in a single CLT panel, resulting in extremely fast construction times. The Forté apartment block in Melbourne (www.forteliving.com.au) is a recent example of CLT building.

While engineered timber is set to make huge inroads into building in Australia, any timber can gain improved properties with the right treatment. Treated timber has been common here for decades, but some forms of treatment, particularly CCA (chromated copper arsenate, also called copper chrome arsenic), is very toxic and has poor environmental credentials.

Less toxic treatments have been developed, but a new kid on the block that is not so well known is Accoya (www.accoya.com), an acetylated wood that has the properties of hardwood while being made from plantation softwoods. The acetylation process greatly reduces the wood's ability to absorb water by changing the free hydroxyls within the wood into acetyl groups. This is done by reacting the wood with acetic anhydride, from acetic acid. Because the ability of the wood to absorb water is greatly reduced it becomes more dimensionally stable and, because the digestion of wood by enzymes initiates at the free hydroxyl sites, it is no longer digestible and therefore extremely durable.

Framing the build: alternatives to timber and steel

By far the most popular framing material in Australia is timber, usually plantation softwood. However, wood may not always

Image: Doug Cooper

← Engineered timber, such as these Hyjoist beams, can provide high strength with much lower materials usage and weight.

be suitable, especially if you are in a termite-prone area.

Steel is a popular alternative material for both wall framing and roofing, and while it is light, strong and has a very long lifespan, it does have some downsides.

The main issue with steel in building is its thermal conductivity. In walls it acts as a thermal bridge, bypassing the insulation between the studs. This necessitates the need to insulate over the steel framing itself on the outside walls, adding to costs and construction time. The energy cost of steel manufacture is also an issue as it is one of the highest embodied energy materials per square metre of floor area other than concrete.

Another issue is condensation—steel-framed walls have a lower humidity buffering capacity and so can be more prone to condensation issues than wood-framed walls.

Lastly is the issue of fire resistance. Wood behaves in predictable ways in a fire and there are indicators that firefighters can look for to gauge the integrity of the structure. This is not the case for steel framing, which is prone to sudden collapse when a particular temperature is reached. As a result, experienced firefighters will often not enter a steel-framed home, instead fighting the fire from the outside. An interesting article on these and other issues related to steel framing can be found at www.bit.ly/GBABWSF.

If you can't or don't want to use wood or steel, what are your options?

One option is to not use framing as such at all. There are many prefabricated panels, such as CLT mentioned earlier, that eliminate the need for framing for the most part. Other options include SIPs (structural insulated panels, see Bricks, Blocks and Panels on p. 43).

Bamboo is not often thought of as a framing material but, used correctly, entire homes can be built from this amazingly strong and potentially sustainable material. Being a very fast-growing member of the grass family, bamboo can grow where trees (and many other plants) cannot, allowing the use of otherwise low-value land. Bamboo is light and as strong as steel per kilogram of material, making it versatile.

One drawback for building is its inconsistent size—each pole varies in diameter along its length, and may have slight curves or twists, making it not suitable for the average home design. But given that the developing world has been building amazing structures from bamboo for centuries, it's just a matter of adapting designs to suit the material.

Bamboo Living (www.bambooliving.com) in Hawaii has done just that and lays claim to supplying the only code-certified bamboo structures in the world. Almost the entire design is built of bamboo, including framing, flooring, roofing and wall cladding. Ibuku Designs (www.ibuku.com) makes amazing buildings from almost nothing but bamboo, and shows there are almost no limits to the size of building that can be built with this versatile material. (See *Sanctuary 28* for a longer discussion on the sustainability of bamboo for building purposes.)

While these styles of home are obviously not suitable everywhere, for the more tropical areas of Australia it could certainly work quite well, taking into account cyclone protection.

Another way of eliminating framing is with tensile structures. These are structures where the whole outer envelope is in tension, so that there are no elements undergoing compression or bending forces. The Sidney Myer Music Bowl in Melbourne is an example of a tensile structure.

Tensile structures often consist of one or more supporting structures or towers, from which are strung multiple cables in tension. The structure is covered in a membrane to complete the structure. This method of construction is only suitable to certain designs and locations, but can be used to provide strong, flexible roof structures for all manner of buildings. Examples include roofs on stadiums, museums and airports.

Image: Bamboo Living

↑ Bamboo can be used to build entire homes, such as this one from Bamboo Living in Hawaii.