Lightweight timber

Wooden structures have been used in all kinds of building types for many years. Lightweight timber construction has a long history in Australia where it is the most common house construction type. In a world living with the effects of global warming, timber provides a renewable building material that stores carbon in its production.

The lightweight timber house can be more cost effective and flexible in design than the massive solution and there are many situations where a lightweight building may result in the lowest lifecycle energy use (eg. hot, humid climates, sloping or shaded sites or sensitive landscapes).

Timber frames can support internal and external walls, floors and roofs. A variety of non-structural claddings, linings and finishes can be used such as weatherboards, timber fibre products, or non timber products such as brick veneer, fibre cement sheet or metal.

Lightweight timber houses may require less site disruption than their more massive counterparts. They can be open, filled with light and provide natural ventilation by careful window, door and ventilator placement.

One of the key advantages of timber is that it provides an adaptive material for use in all climatic zones. This fact sheet deals with lightweight timber constructions that are climatically appropriate for Australia.

PERFORMANCE SUMMARY

Appearance

Aesthetically, timber possesses a natural attractiveness that people readily relate to. Its range of colour, grain and texture make it a material with qualities that people generally find visually pleasing and enjoyable to touch.

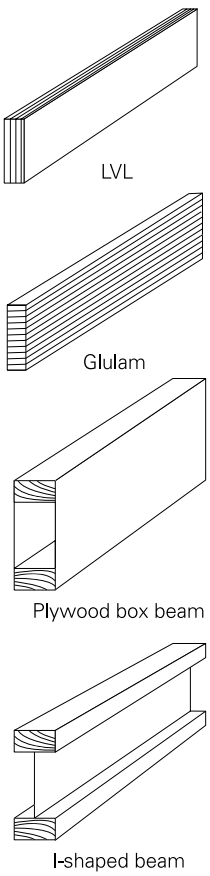
Timber houses can range in appearance from the ultra modern to the traditional weatherboard house. Depending on the cladding used, the appearance may express the timber construction or disguise it (most timber framed houses in Australia are finished in brick veneer).

Timber construction allows for a range of design solutions to achieve environmentally friendly housing in all climatic zones. Timber framed houses can be found in very cold climates such as Scandinavia and Canada through to the very hot tropical climates of South East Asia, and their appearance will vary according to the climate that they occupy.

Structural capability

Timber has good compressive strength but is strongest in tension. Structural design techniques exploit this characteristic that can be clearly seen in the design of roof trusses.

As well as solid timber there are many products that are composites or made of components that can be used in lightweight construction. These include plywood, particle board, fibreboard and engineered products such as glue laminated timber (Glulam) and Laminated Veneer Lumber (LVL). There is a timber product to meet most structural requirements, and engineered timber products can be manufactured to meet specified structural requirements.



Thermal mass

In general timber has low thermal mass. There are hardwoods that have similar densities to concrete - but these are not common building materials. Thermal mass can be built into lightweight timber constructions if a particular design requires it. This can be achieved with elements such as concrete slabs, masonry features or water tanks integrated into walls or floors.

Insulation

Timber is a natural insulator due to air pockets within its cellular structure. Most timbers are extremely low thermal conductors relative to other building materials - the conductivity of aluminium is typically about 1700 times as great, steel 400, concrete 10, brick and glass 6 times; but bulk insulation materials, such as mineral wool, may have as little as a third of the conductivity of wood.

As most timber buildings are 'stick' built, the spaces between noggings and joists can accept bulk insulation readily. Lightweight timber constructions can be designed to incorporate as much or as little insulation as the construction requires. Reflective materials can also be readily incorporated into lightweight timber constructions.

The low thermal conductivity of timber minimises the occurrence of thermal bridging that can reduce the overall R-value of a structure. [See: Insulation Installation]

Sound insulation

The sound insulation of walls is usually obtained by providing a barrier of sufficient mass to absorb the sound energy. In lightweight timber constructions the wall cavities provide a cushion of air that absorbs the sound energy, and as long as here are no rigid bridgings to transmit the energy this is an effective barrier. Acoustic barriers can be supplemented by placing insulation materials in the wall cavity.

Fire resistance

Where timber is used extensively in exterior application and around the house, Australian Standard AS 3959 must be consulted to ascertain if any special constructions are required. Each category of fire risk - from low to extreme - has a level of required construction that defines where timber can be used, and what detailing is required.

Vermin resistance

Termites are a main concern for lightweight timber constructions although a recent CSIRO study found that steel and masonry houses had virtually the same chances of attack as timber houses.

The two main methods of dealing with the threat of termites are chemical and physical. The emphasis of current building regulations is on managing termites through physical barrier systems and inspections rather than the environmentally harmful methods of the past.

Physical barriers prevent hidden entry. They are inspection systems rather than prevention systems. Termites attack from underground and the best risk management strategy is to design the house for easy inspection, ie. leave an accessible space to inspect for termite activity. Lightweight timber constructions, especially those with elevated floors or pole framing, lend themselves to easy inspection for termite activity.

Other vermin such as mice can be controlled by ensuring that all cavities are sealed.

Durability and moisture resistance

Timber is an organic material and deteriorates due to weathering. Moisture plays a role in the deterioration of all building materials with the possible exception of some synthetic polymers. The main way of preventing weathering is protection of the timber surface. This may be achieved by appropriate design detailing, so that the timber remains dry or sheds water quickly. It may be achieved by treatment with an appropriate surface coating of oil, varnish or paint. Such coatings on external timber components of buildings generally need replacing every 5 – 7 years.

Weathering can be reduced by the selection of durable timber species in the first instance. Over a forty year life a fully maintained timber clad building will require less embodied energy than common alternatives, see table below.

A lightweight timber construction can have a very long life, making the dwelling more valuable both from an economic and environmental perspective. This is easy to achieve using appropriate design, building practices and detailing.

Toxicity and breathability

Timber is generally non-toxic. Provided it is not sealed with material that is impervious to air it maintains its breathability. The durability of the timbers used in the lightweight construction can be improved by treatments. Very low VOC treatments are readily available nowadays and most are water rather than solvent based. [See: Indoor Air Quality]

	EMBODIED ENERGY PER UNIT AREA OF ASSEMBLY " MJ/M²	INITIAL EMBODIED ENERGY OF WALLS OF BUILDING MJ	EMBODIED ENERGY IN EXPANDED MAINTENANCE OVER 40 YEAR LIFE MJ	TOTAL EMBODIED ENERGY MJ
Timber frame, timber clad, painted	188	31,020	24,750	55,770
Timber frame, brick veneer, unpainted	561	92,565		92,565
Double brick, unpainted	860	141,900		141,900
AAC painted	464	76,560	24,750	101,310
Steel frame, fibre cement clad, painted	460	75,900	24,750	100,650

[See: Embodied Energy]

Sustainability (environmental impacts)

Timber is a renewable building resource that absorbs carbon it its production. A lightweight timber construction can be built for deconstruction, and timbers from the construction reused or recycled at the end of its use in the building. It has tremendous capacity to provide a sustainable construction option.
[See: Waste Minimisation]

Timber is completely biodegradable and can even be composted if no reuse application can be found. Timber building products offer an opportunity to sequester carbon in the built environment, complementing efforts to mitigate global warming with carbon abatement schemes using timber plantations (typically, pine) to absorb carbon from the atmosphere.


Environmental award winner for the 2004 Timber Design awards.

Although it is a low greenhouse emission product in principle, transport and manufacturing processes can add significantly to the overall emissions associated with typical modern timber construction. Fundamentally, timber construction has very low greenhouse gas emissions but the more highly engineered and processed it is the more there is potential for significant emissions. Nevertheless, lightweight timber construction is often a sustainable option for housing.

Buildability, availability and cost

Lightweight timber construction is relatively simple to build. Contractors are familiar with timber and comfortable using it. They find it easy to handle, easy to nail and easy to adjust. This contributes to affordable labour costs, and means that construction is quicker.

It is affordable to build in the short-term and with good design can provide a dwelling with low operational costs in the long run. The availability of plantation pine is increasing, ensuring that the financial cost stays down.

TYPICAL DOMESTIC CONSTRUCTION

Construction process

Typical lightweight timber construction consists of framed and braced structures with applied claddings. The type of framing can range from large, widely spaced timbers to the closely spaced light timbers commonly seen in stud frame construction. The process of construction may begin with a concrete slab onto which continuous frames are fixed, or placement of piers or pad footings to carry posts or bearers.

Timber components may be fabricated off or on-site. Modern construction techniques in Australia generally favour off-site fabrication of items like trusses with the extent of on-site fabrication of elements like stud frames being dependent on individual designs.

Typical details

Typical details of lightweight timber construction are regulated by the Building Code of Australia. All structural design should be prepared by a competent person and may require preparation or checking by a qualified engineer. Qualified professionals, architects and designers provide years of experience and access to intellectual property that has the potential to save house builders time and money as well as help ensure environmental performance.

Footings

A sub structure of piers, piles, stumps, posts, dwarf brick walls or perimeter masonry walls support the building frame.

The sub structure carries the load to the footings, which depending on local practice may be sole plates of durable or treated timber or commonly, a concrete pad or a rectangular section reinforced concrete-filled trench.

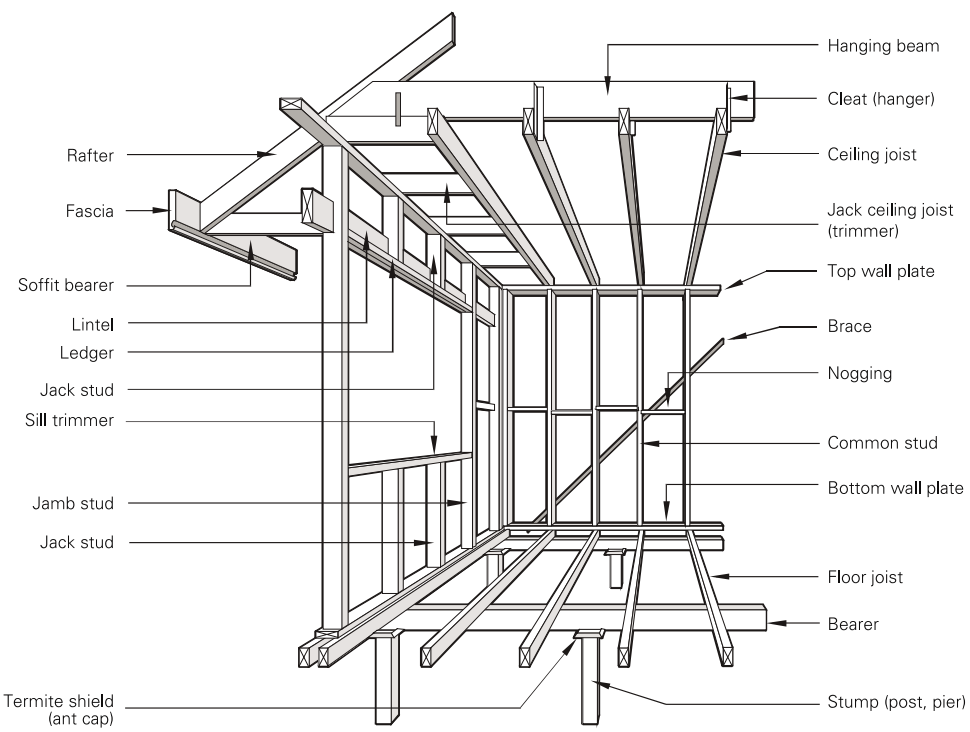
The use of piers and posts can greatly reduce the need for cut-and-fill on sloping blocks.
[See: Site Issues Introduction]

Frames

For a conventional house, a timber frame can be described as a skeleton of timber components to which is attached exterior wall claddings, internal linings, flooring, roofing, windows and doors.

If designed and built to the Australian Standard AS1684 “Code of Practice for Construction in Timber Framing” (known as the Timber Framing Code) a conventional timber framed house will usually be deemed to comply with structural requirements of the Australian Building Code.

For unconventional timber framed housing the approving authority will accept that Australian Standard AS1720 “The Timber Structures Code” can be utilised in design but will need some professional expertise to verify that the proposed design meets statutory requirements.



Some terms that apply to timber framing.

Joints and connections

There are many types of traditional joints and a professional joiner or carpenter will use the most appropriate for a specific construction.

Timber frames and trusses can also be purchased ready fabricated. A common joining system is a nail plate that is a metal plate with integral nail shapes, or holes for nails, designed to join the timbers together.

Finishes

Finishes can be applied to increase timber's resilience: to make it more durable in external applications, to protect it from the elements, or to increase wear resistance for internal applications (such as varnish on floors). There are a wide range of finishing products on the market with a number of environmentally friendly water based finishes emerging that make timber more durable whilst complementing its aesthetic beauty.

Things to watch out for

Builders, consumers and designers should be alert to the emergence of new systems, new building codes or regulations and innovation such as the engineered timber products incorporated in the NSW Timber Development Association's 'Timber House of the Future' which set out to "redefine the way people think about timber and timber products and the way they may be used".

The picture above shows engineered timber products including I beams, plywood, LVL and plantation pine in the structure of the Timber House of the Future.

ADDITIONAL KEY REFERENCES

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TIMBER DEVELOPMENT ASSOCIATION www.timber.net.au