Built in days, last for century …

TECHNICAL PROPERTIES

Rapid Building System™

KRIVAJA® TMK

AUSET PACIFIC PTY LTD

Contents of Technical Properties

Summary

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. When it comes from genuinely sustainable sources, timber has the potential to provide a renewable building material that stores carbon in its production.

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.

The lightweight timber house can provide cost effective and flexible design options. Just as the high mass construction materials are most effectively employed when used as part of appropriate design strategies, so there are many situations where a lightweight building may result in a low lifecycle energy use (e.g. hot, humid climates, sloping or shaded sites).

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 are well suited to stilt construction and similar design approaches intended to minimize site disruption. Framed structures lend themselves to making houses with diverse openings that provide light and natural ventilation by careful window, door and ventilator placement. Timber provides an adaptive material for use in all climatic zones.

Appearance

Rapid Building System™ can range in appearance from the ultra-modern to the traditional houses. Depending on the cladding used, the appearance may express the timber construction or disguise it by applying fiber-cement or render finishes.

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.

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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.

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 using elements such as:

- *Concrete slabs.*
- *Masonry features.*
- *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.

The low thermal conductivity of timber minimises the occurrence of thermal bridging that can reduce the overall R-value of a structure.

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 some of the sound energy, and as long as here are no rigid bridging's to transmit the energy this can be a reasonably effective barrier. Acoustic barriers can be supplemented by placing insulation materials in the wall cavity and this also helps to reduce the drumming effect of large sheets of lining material.

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.

Never the less, when exposed to higher fire load wooden structure has better performance than reinforced concrete or steel. Burning surface forms thin carbonized layer which prevents wood from further burning.

Vermin Resistance

Termites are a main concern for lightweight timber constructions. The two main methods of dealing with the threat of termites are chemical and physical. Current building regulations *emphasise managing termites through physical barrier systems and inspections rather than the environmentally harmful methods of the past.*

Physical barriers prevent hidden entry. This is inspection systems rather than prevention systems. Termites attack from underground and the best risk management strategy is to design the house for easy inspection, 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. 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.

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

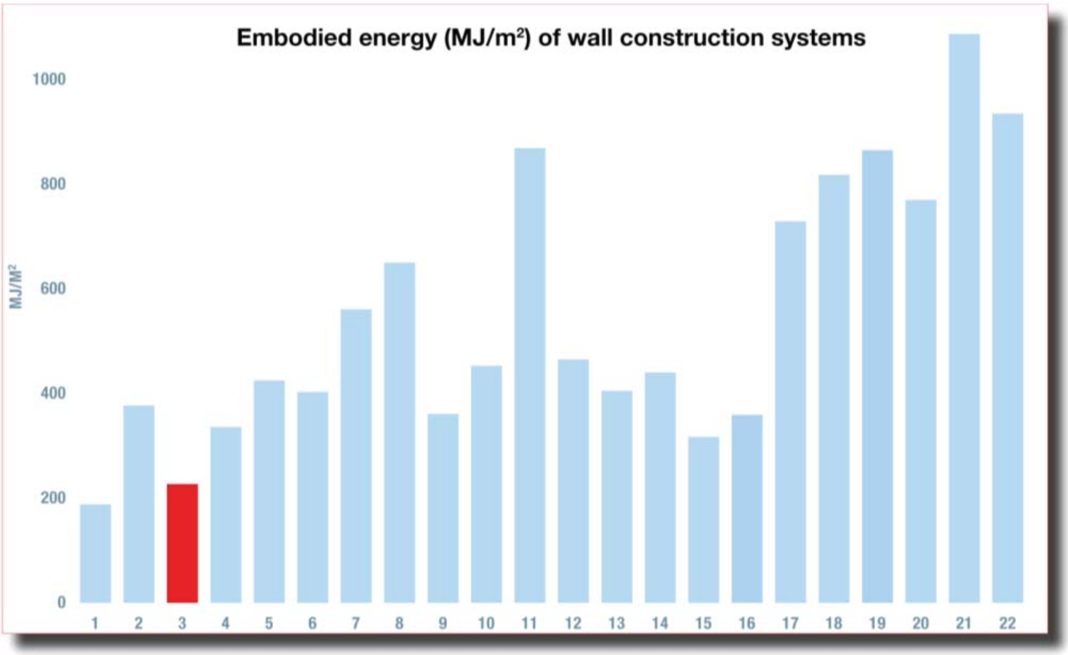
Toxicity and Breathability

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.

Environmental Benefits

The environmental effects of building huge houses that use vast amounts of energy are measurable and alarming.

Embodied energy is the energy consumed by all of the processes associated with the production of a product. CO2 emissions are highly correlated with the energy consumed in manufacturing building materials. The embodied energy of a fiber cement clad timber-framed wall systems can be up to 60% lower than a clay brick veneer wall, it is illustrated below:



		MJm²
1	Timber Frame, Timber Weatherboard Wall	188
2	Timber Frame, Reconstituted Timber Weatherboard Wall	377
3	**Timber Frame, Fibre Cement Weatherboard Wall**	**227**
4	Timber Frame, Steel Clad Wall	336
5	Steel Frame, Steel Clad Wall	425
6	Timber Frame, Aluminium Weatherboard Wall	403
7	Timber Frame, Clay Brick Veneer Wall	561
8	Steel Frame, Clay Brick Veneer Wall	650
9	Timber Frame, Concrete Block Veneer Wall	361
10	Steel Frame, Concrete Block Veneer Wall	453
11	Cavity Clay Brick Wall	869
12	Cavity Concrete Block Wall	465
13	Single Skin Stabilised Rammed Earth Wall	405
14	Single Skin Autoclaved Aerated Concrete Block (AAC) Wall	440
15	Single Skin Cored Concrete Block Wall	317
16	Steel Frame, Compressed Fibre Cement Clad Wall	359
17	Hollow Core Precast Concrete Wall	729
18	Tilt-up Precast Concrete Wall	818
19	Porcelain-Enamelled Steel Curtain Wall	865
20	Glass Curtain Wall	770
21	Steel Faced Sandwich Panel Wall	1087
22	Aluminium Curtain Wall	935

Source: Building Materials Energy and the Environment, Towards Ecologically Sustainable Development, (James Hardie "The Smarter Construction Book" 2008, Table 6.2, p59; Appendix B), Dr Bill Lawson, 1996.
The figures for fibre cement have been updated with approval of the author on the basis of the LCA study conducted by James Hardie.

Figure 1: Embodied energy

Cradle-to-gate is an assessment of a partial product life cycle from resource extraction('cradle') to the factory gate (i.e., before it is transported to the consumer). The use phase and disposal phase of the product are omitted in this case.

Cradle-to-gate assessments are sometimes the basis for environmental product declarations (EPD) termed business-to-business EDPs.

Material	**Energy MJ/kg**	**Carbon kg CO_2/kg**	**Density kg /m^3**
Timber general	10.00	0.72	480
OSB	15.00	0.96	640
Glue laminated timber	12.00	0.87	
Rockwool (slab)	16.80	1.05	24
Plasterboard	6.75	0.38	800

DOORS & WINDOWS	**MJ per window**	**kg CO_2**	
Timber laminated frame, 2x glazed	230-490	12-25	

PAINT	**Energy MJ/m^2**	**Carbon kg CO_2/m^2**	
Water-borne paint	59.0	2.12	

Embodied energy in expanded maintenance over 40 year life 24,000 MJ

Figure 2: 'Cradle-to-Gate' analysis

Environmental Impacts

Timber is a renewable building resource that absorbs carbon it its production. A lightweight timber construction can be built for deconstruction or easy dismantling, and timbers from the construction re-used or recycled at the end of its use in the building.

Timber is completely biodegradable and can even be composted if no re-use 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.

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.

Becoming Carbon Neutral

The first step in becoming carbon neutral is to reduce the demand for energy and the amount of CO_2 being emitted. After reductions have been made offset credits can be purchased equivalent to the remaining emissions.

Yearly Energy Usage Calculation

Coefficient of thermal conductivity is expressed in W/m^2K.
Coefficient means ability to conduct energy between inside and outside of certain element.
Lower the coefficient, the energy loses are less.

External walls	*0,11 W/m^2K*
Ceiling	*0,13 W/m^2K*
Floor	*0,20 W/m^2K*
External window	*0,90 W/m^2K*
External door	*1,70 W/m^2K*
Thermal bridges for windows	*a=0,3 $3\sqrt{Pa^2}$*
Thermal bridges for doors	*a=1,0 $3\sqrt{Pa^2}$*

Calculation of energy loses for $91m^2$ sample house with air temperature of 20^0C inside and projected outside temperature of $-18\,^0C$

External walls	*85,0 m^2 x 0,11 x 38 =*	*360 W*
Ceiling	*91,0 m^2 x 0,13 x 35 =*	*420 W*
Floor	*91,0 m^2 x 0,20 x 15 =*	*271 W*
External window	*14,0 m^2 x 0,90 x 38 =*	*480 W*
External door	*1,8 m^2 x 1,70 x 38 =*	*120 W*

Subtotal ***1651 W***

Qp = a x L x H x r x Δ
Qp = 0,3 x 45 x 0,72 x 0, 9 x 38 = (External window) *362 W*
Qp = 1,0 x 6 x 0,72 x 0,9 x 38= (External door) *190 W*

Total ***2203 W***

Qn = 2203 $W/91m^2$ = 25 W/m^2

Calculation of yearly energy used for family house heating:

Qa = bv x Qn

Qa - assumption of yearly energy usage in KWh/year according to European Standard DIN 2007
bv- hours of usage
Note: for Germany, hours of energy usage for residential users is 1553 hours

Qa = 1553 x 2203 / 1000 = 3350 KWh/year
or
3350 KWh/year/$91m^2$ = ***37 KWh/m^2 yearly***

House built with Rapid Building System™ requires energy for heating/cooling below 40 kWh/m2 per year or 3 liters of diesel per m2 per year.

A Low-Energy house is any type of house that from design, technologies, and building products and uses less energy, from any source, than a traditional or average contemporary house. They are the practice of Sustainable design, Sustainable architecture, Low energy building, Energy-efficient landscaping. They often use Active solar and Passive solar building design techniques and components to reduce their energy expenditure.

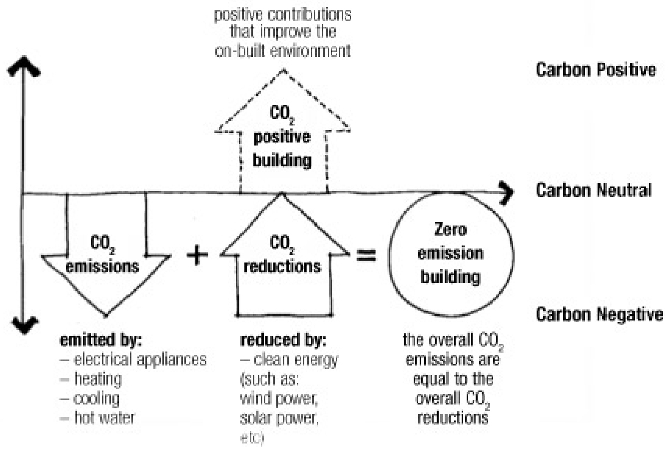


Figure 3: Low energy house

Energy Efficient Building

Energy savings requirements in construction of family homes have grown significantly in recent years.

Accordingly, our building components satisfy the following criteria:

- *External Wall Insulation Rating (R value) = **6.75 R***
- *Ceiling And Roof Insulation Rating (R value) = **7.51 R***
- *Windows and Doors Insulation Rating (R value) = **1.1 R***

*The **R-value** is a measure of thermal resistance used in the building and construction industry.*

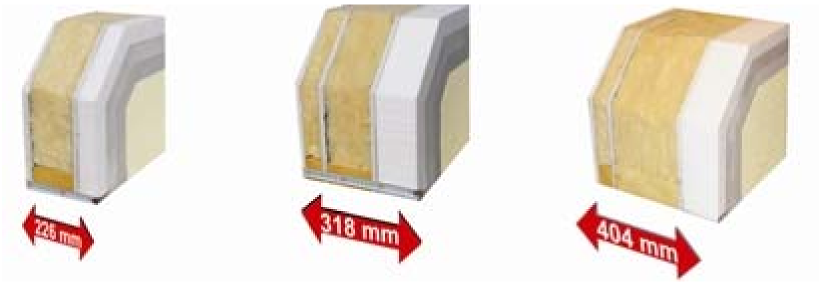


Figure 4:

Low-energy external wall panel	Passive external wall panel	Close to Zero energy external wall panel
U = 0.195 W/m2K	U = 0.135 W/m2K	U = 0.104 W/m2K

*The **U value** is the number of watts that will pass through 1 square meter of a material. The U-value (or U-factor), more correctly called the overall heat transfer coefficient, describes how well a building element conducts heat. It measures the rate of heat transfer through a building element over a given area, under standardized conditions.*
The usual standard is at a temperature gradient of 24 °C at 50% humidity with no wind (a smaller U-value is better).

Energy Efficiency Classification

- *Standard house in Australia, 55.5 kWh/m^2 per year for space heating and cooling*
- *Low energy house, less than 40 kWh/m^2 per year for space heating and cooling*
- *Passive house, less than 15 kWh/m^2 per year for space heating and cooling*
- *Zero houses achieve full energy coverage, and in some cases can produce excess energy*

Energy Efficiency as calculated – Rapid Building System™ 37 KWh/m2 per year

Low-Energy House

Low-Energy house is an icon of sustainable building implementation throughout its whole life cycle, starting from careful selection of building materials, whose production does not damage the environment, through their energy efficiency and rational energy spending over the lifetime, to the rational waste management. In addition, low energy houses, including the passive house provide a high living comfort with a pleasant climate all year round with a very low heating/cooling associated cost.

Passive House

Passive house refers to standard for energy efficiency in a building reducing its ecological footprint. It results in ultra-low energy buildings that require little energy for space heating and cooling. All of this is achieved by using super-insulation materials, advanced window *technology, air barriers and careful sealing of all construction joints, good ventilation, various mobile and fixed shades, outdoor shatters and awnings.*

Passive house is 90% heated and cooled passively, thanks to the energy emitted by other household equipment and by occupants, as well as solar energy.

Zero House

Zero-energy house refers to building that over a year does not use more energy than it generates.

Acoustic Performance

Weighted Sound Reduction Index value, rw *related to Acoustic properties for the Rapid Building System™:*

- *External Wall Acoustic Insulation Rating (Rw value) =* ***52 dB****, as per European Standard HRN EN ISO 717-1:1998*

- *Internal Wall Acoustic Insulation Rating (Rw value) =* ***46 dB****, as per European Standard HRN EN ISO 717-1:1998*

The Rw Value - Weighted Sound Reduction Index *is a single number used to rate the effectiveness of the System as a noise insulator.*

Rw describes the airborne sound insulating power of a building element. It is a laboratory measured value. It can apply to walls, ceiling/floors, ceiling/roofs, doors, or windows. The higher the number, the greater the sound insulating power of the building element.

Rw	Rw + Ctr	EFFECT OF DIFFERENT VALUES OF Rw AND Rw + Ctr ON SOUND INSULATION PERFORMANCE
25	22	Normal speech can be heard easily
30	25	Loud speech can be heard easily
35	28	Loud speech can be heard but not understood
42	35	Loud speech heard as murmur
45	38	Must strain to hear loud speech
48	40	Loud speech can be barely heard
53	44	Loud speech can not be heard
63	55	Music heard faintly, bass notes 'thump'
70	60	Loud music still heard very faintly

Figure 5:
Effect of various walls on sound insulation performance

	AIRBORNE SOUND INSULATION	IMPACT SOUND INSULATION
BUILDING CLASS 1 - NSW, VIC, QLD, TAS, WA, SA and ACT		
Walls separating a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw + Ctr ≥ 50	√ Discontinuous
Walls separating SOUs in all other cases.	Rw + Ctr ≥ 50	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a habitable room.	Rw + Ctr ≥ 40	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a kitchen, bathroom or other non-habitable room.	Rw + Ctr ≥ 25	
BUILDING CLASS 2 AND 3 - NSW, VIC, QLD, TAS, WA, SA and ACT		
Walls separating habitable rooms in adjoining SOUs.	Rw + Ctr ≥ 50	
Walls separating kitchens, toilets, bathrooms and laundries in adjoining SOUs.	Rw + Ctr ≥ 50	
Walls between a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw + Ctr ≥ 50	√ Discontinuous
Walls between a SOU and a public corridor, public lobby, stairway or the like or parts of a different classification.	Rw ≥ 50	
Walls between a SOU and a plant room or lift shaft.	Rw ≥ 50	√ Discontinuous
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a habitable room.	Rw + Ctr ≥ 40	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a kitchen or other non-habitable room.	Rw + Ctr ≥ 25	
Floors between SOUs and between a SOU and a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.	Rw + Ctr ≥ 50	Lnw Ci ≤ 62
BUILDING CLASS 1, 2 AND 3 - NORTHERN TERRITORY		
Walls separating a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw ≥ 50	√
Walls separating SOUs in all other cases.	Rw ≥ 45	
Walls or ceilings separating a soil or waste pipe from a habitable room.	Rw ≥ 45	
Walls or ceilings separating a soil or waste pipe from a kitchen, bathroom or other non-habitable room.	Rw ≥ 30	
Floors between SOUs.	Rw ≥ 45	
BUILDING CLASS 9C - ALL AUSTRALIAN STATES AND TERRITORIES		
Walls separating SOUs from a kitchen or laundry.	Rw ≥ 45	√ Discontinuous
Walls and floors separating SOUs and walls separating SOUs from a bathroom, toilet, plant room or utilities room.	Rw ≥ 45	

Table 2 lists some of the more common requirements but is not intended as a substitute for the BCA, and does not include Building Classes other than 1, 2, 3 and 9c [REFER TO THE BCA FOR THE FULL DETAILS OF ACOUSTIC REQUIREMENTS].

Figure 6:
BCA Acoustic Requirements for Sole Occupancy Units