

Ollabunda
a village for life

Materials & Construction Systems



Material Selection Criteria

- Strong contribution to thermal comfort in considered system
- Inherent beauty & reflective of Illabunda
- Long life span with minimal maintenance
- Low embodied energy
- Renewable resources
- Recycled/able where possible
- Low Volatile Organic Compounds
- Price
- Compliance BCA
- Replicable by others



Green House Gas Emissions BHP Research & Uni Newcastle

To ascertain the energy efficiency of a small sized project home typical of Sydney's climate, a Life Cycle Analysis was carried out by BHP Research in collaboration with The Centre for Sustainable Technology at The University of Newcastle. The study considered a housing life of 60 years. It looked at all stages of production of building materials, transportation to the site, and construction including fit-out and appliances. It included the energy costs of cooking, lighting, heating and cooling, repairs and maintenance and building decommissioning (including credits for recycled building materials).

Construction

Utilisation (excluding heating & cooling)

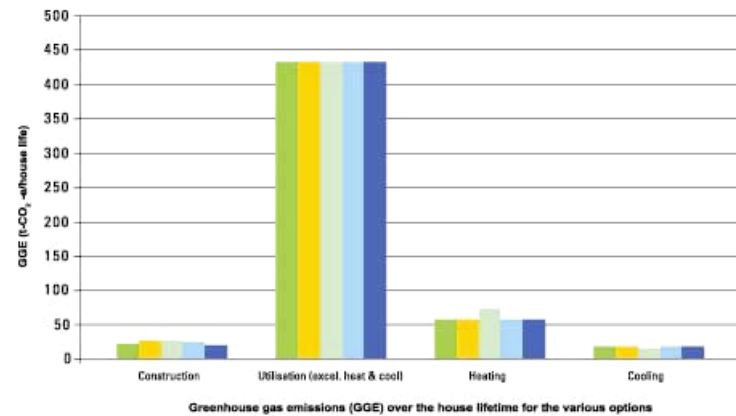
Heating

Cooling

Source: <http://www.greenhouse.gov.au/yourhome/technical/fs34g.htm>

- ▼ **Option 1**
Brick veneer/timber frame/concrete slab
- ▼ **Option 2**
Brick veneer/steel frame/concrete slab
- ▼ **Option 3**
Double brick/concrete slab
- ▼ **Option 4**
Timber clad/steel frame/concrete slab
- ▼ **Option 5**
Timber clad/timber frame/concrete slab

The results are summarised in the following chart.



Greenhouse gas emissions over life cycle of a house

Embodied Energy - some figures

MATERIAL	PER EMBODIED ENERGY MJ/KG
Kiln dried sawn softwood	3.4
Kiln dried sawn hardwood	2.0
Air dried sawn hardwood	0.5
Hardboard	24.2
Particleboard	8.0
MDF	11.3
Plywood	10.4
Glue-laminated timber	11.0
Laminated veneer lumber	11.0
Plastics - general	90
PVC	80.0
Synthetic rubber	110.0
Acrylic paint	61.5
Stabilised earth	0.7
Imported dimension granite	13.9
Local dimension granite	5.9
Gypsum plaster	2.9
Plasterboard	4.4
Fibre cement	4.8*
Cement	5.6
In situ Concrete	1.9
Precast steam-cured concrete	2.0
Precast tilt-up concrete	1.9
Clay bricks	2.5
Concrete blocks	1.5
AAC	3.6
Glass	12.7
Aluminium	170
Copper	100
Galvanised steel	38

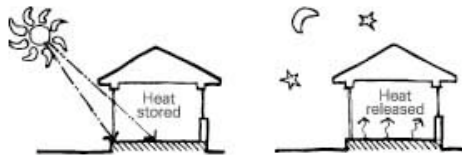
ASSEMBLY	PER EMBODIED ENERGY MJ/M ²
WALLS	
Timber frame, timber weatherboard, plasterboard lining	188
Timber frame, clay brick veneer, plasterboard lining	561
Timber frame, aluminium weatherboard, plasterboard lining	403
Steel frame, clay brick veneer, plasterboard lining	604
Double clay brick, plasterboard lined	906
Cement stabilised rammed earth	376
FLOORS	
Elevated timber floor	293
110 mm concrete slab on ground	645
200 mm precast concrete T beam/infill	644
ROOFS	
Timber frame, concrete tile, plasterboard ceiling	251
Timber frame, terracotta tile, plasterboard ceiling	271
Timber frame, steel sheet, plasterboard ceiling	330

Embodied Energy - some cautions

- Different calculation methods[for embodied energy] produce vastly different results (by a factor of up to 10). For best results, compare figures produced by a single source using consistent methodology and base data.
- There are many situations where a lightweight building is the most appropriate and may result in the lowest lifecycle energy use (eg. hot, humid climates, sloping or shaded sites or sensitive landscapes). [Note - this is not the majority of Illabunda]
- In climates with greater heating and cooling requirements and significant day/night temperature variations, embodied energy in a high level of well insulated thermal mass can significantly offset the energy used for heating and cooling.
- There is little benefit in building a house with high embodied energy in the thermal mass or other elements of the envelope in areas where heating and cooling requirements are minimal or where other passive design principles are not applied.
- Each design should select the best combination for its application based on climate, transport distances, availability of materials and budget, balanced against known embodied energy content.

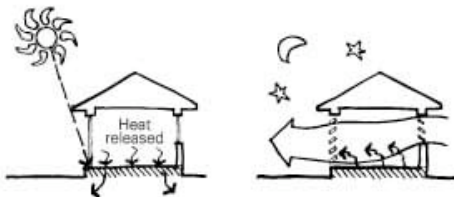
Thermal Mass - introduction

- Thermal mass is the ability of a material to absorb heat energy. A lot of heat energy is required to change the temperature of high density materials like concrete, bricks and tiles. They are therefore said to have high thermal mass. Lightweight materials such as timber have low thermal mass.



Winter

Allow thermal mass to absorb heat during the day from direct sunlight or from radiant heaters. It will re-radiate this warmth back into the home throughout the night.



Summer

Allow cool night breezes and/or convection currents to pass over the thermal mass, drawing out all the stored energy. During the day protect thermal mass from excess summer sun with shading and insulation if required.

Thermal Mass - where to locate

The location of thermal mass within the building will have an enormous impact on its year round effectiveness and performance.

As a rule of thumb the best place for thermal mass is inside the insulated building envelope. Insulation levels required will depend on the climate. A better insulated envelope will mean more effective thermal mass.

Thermal mass must be left exposed internally to allow it to interact with the house interior. It must not be covered with thermally insulating materials such as carpet. To determine the best location for thermal mass you need to know if your greatest energy consumption is the result of summer cooling or winter heating.

Heating Application: Locate thermal mass in areas that receive direct sunlight or radiant heat from heaters.

Heating and cooling: Locate thermal mass inside the building on the ground floor for ideal summer and winter efficiency. The floor is usually the most economical place to locate heavy materials and earth coupling can provide additional thermal stabilisation. Locate thermal mass in north facing rooms which have: good solar access; exposure to cooling night breezes in summer and additional sources of heating or cooling (heaters or evaporative coolers). Locate additional thermal mass near the centre of the building, particularly if a heater or cooler is positioned there. Feature brick walls, slabs, large earth or water filled pots and water features can provide this.

Cooling Application - Protect thermal mass from summer sun with shading and insulation if required. Allow cool night breezes and air currents to pass over the thermal mass, drawing out all the stored energy.

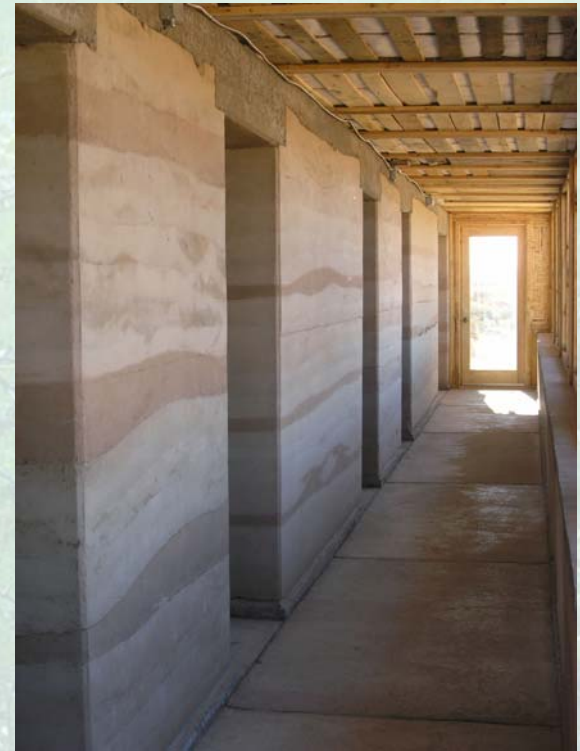
Proposed Materials for Illabunda Concrete Floor Slab

- High thermal mass moderates extreme climatic conditions
- Floor slab connected to dry earth (earth coupling) most beneficial condition (Sydney)
- 15.5% of overall floor area with north facing window to heat (winter)
- High durability
- Many finishing options
- Fly ash concrete
(in lieu of Portland cement)
as recycled material



Proposed Materials for Illabunda Rammed Earth (Stabilised)

- Signature Material
- High thermal mass
- Monolithic system (ground movement)
- Poor thermal insulation qualities
- High sound insulation qualities
- High fire rating qualities
- Durability - careful detailing required
- Low embodied energy



Illabunda

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Proposed Materials for Illabunda Straw Bale

Architect's note: I am yet to build with Straw Bale and hence am a bit nervous about this. I also have a belief that SB is best in colder climates - but I am open to being convinced this is ill-founded. I am also a little concerned about the physical footprint size of SB on small lots - again, can be convinced.

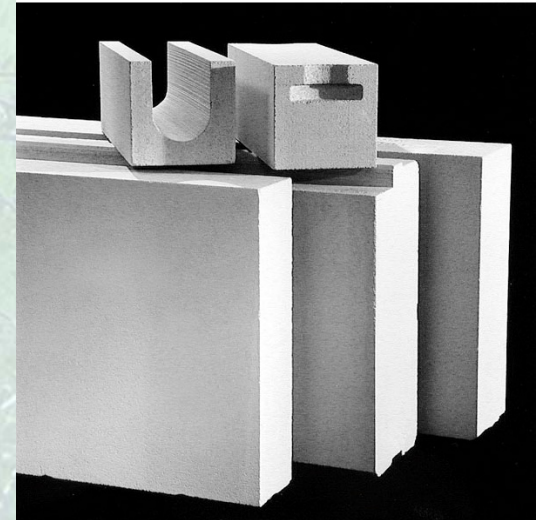
Finished straw bale walls are invariably rendered with cement or earth so that the straw is not visible. The final appearance of rendered straw bale can be very smooth and almost indistinguishable from rendered blockwork, or it can be more expressive and textural.

Straw bales themselves have very low thermal mass, being composed, by volume, mostly of air. However, the cement and earth renders typically used on straw bales results in finished walls having some appreciable thermal mass in the thin masonry 'skins' either side of the insulated straw core. With the use of earthen renders a thick render skin of up to 75mm can be achieved, providing significant thermal mass.



Proposed Materials for Illabunda Autoclaved Aerated Concrete (AAC)

- High levels of thermal insulation (200mm block = apx 1.8 R Value)
- AAC products or building solutions may have lower embodied energy per m² than a concrete alternative. Its much higher insulation value reduces heating and cooling energy consumption. AAC has some significant environmental advantages over conventional construction materials addressing longevity, insulation and structural demands in one material. As an energy and material investment it can often be justified for buildings intended to have a long life. (Source: <http://www.greenhouse.gov.au/yourhome/technical/fs34b.htm>)
- Requires external sealing or cladding for weather proofing
- Off-cuts can be recycled
- Requires careful detailing for window & door fixing



The Building Envelope System

- Concrete slab where winter solar gain achievable (to north facing rooms with glazing)
- Where thermal mass used - shade from solar gain in summer
- Insulated walls (like AAC) where minimal or no thermal gain can be achieved.
- Cavity 'Chimney Wall' to high heat load East & West facing facades
- Lightweight profiled (eg corrugated) metal roof sheeting with reflective foil insulation below (to address radiant heat gain in summer)
- Insulate ceiling with bulk insulation (say r2.0-3.0) to address winter
- Use openable windows and 'roof vents' to ventilate stale & warm summer air as well as cross ventilation

