Guide 5
Building Materials and Insulation for Townsville Homes

In Townsville's climate it is essential to choose building materials that perform well in our local conditions.

Choosing the correct materials and insulation will improve the overall thermal performance of your home, making it more comfortable and consequently less energy dependant.

Introduction

In our local climate, building materials should:

- release unwanted heat quickly once the sun has gone and it has begun to cool down e.g. lightweight walls;
- keep out the heat during the day e.g. appropriate insulation and colour choice; and
- not store heat and release it inside the home long into the night e.g. a block wall.

This guide outlines the problem of heat transfer and how it can be minimized by choosing the right building materials and installing insulation in Townsville.

Heat transfer and the principles used to reduce it will be discussed in the following sections:

1. Heat Transfer;
2. Roofs;
3. Walls; and
4. Floors and windows.

1. Heat Transfer

There are three main ways that heat can be transferred into the home:

- **Radiation** is heat that travels from a heat source to warm a surface (Figure 1). An example is the sun shining through a window directly heating the floor and furniture.

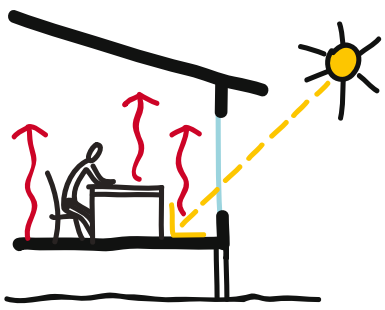

Figure 1 *Example of radiation.*

- **Conduction** is heat that transfers through solid objects. An example of this is heat being transferred from the outside surface of a block (the outside of the home), to the inside surface of a block (the inside of the home) (Figure 2).

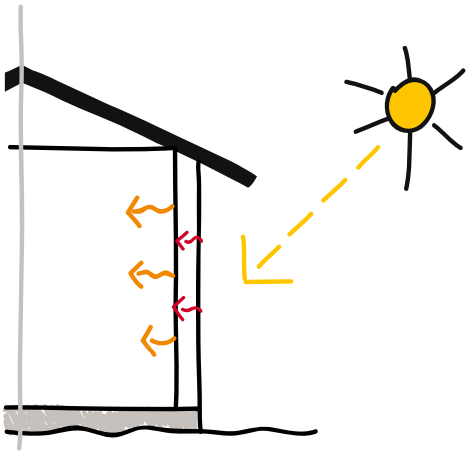

Figure 2 *Example of conduction.*

- **Convection** is heat that is carried by the circulation of liquids or gases (Figure 3). The circulation continues until the temperature evens out. An example of this is when hot air in a room rises, drawing cooler air from below.

Figure 3 *Example of convection.*

The following sections will discuss the principles of reducing heat gain in roofs, walls, floors and windows.

2. Roofs

The roof is the largest surface area of the home and is exposed to the sun all day. As a result, choosing the right building materials and insulation for your roof is essential for achieving the desired climatic performance.

Choose Light Colours

Light colours reflect heat, preventing surfaces from becoming excessively hot. Dark-coloured roofs absorb heat which is then transferred into the home. Thus, choosing light colours for the roof is vital for reducing heat gain and therefore the need for air conditioning (Figure 4 and 5).

Figure 4 *A light-coloured roof reflects heat and stays cooler (Photo:TCC).*

Figure 5 *A dark-coloured roof absorbs and re-radiates heat (Photo: TCC).*

Choosing white for your roof colour or other light colours such as cream, light beige and light greys, is one of the cheapest and easiest ways to reduce the amount of heat entering the home. For existing homes, the roof can simply be painted with a reflective light colour for an instant result.

FACT 1

Recent studies have shown that a light-coloured roof can have approximately 30% lower heat gain than a dark roof. Results from a case study in Townsville showed that after the roof was painted with a reflective light-coloured paint there was a significant reduction in the roof surface temperature and consequent ceiling space temperature. In turn this reduced room temperatures which increased human comfort and decreased the need for air-conditioning (Suehrcke, Peterson and Selby, 2008).

Roof colours to avoid include: black, dark blues, dark greens, dark greys, reds and weathered or rusting galvanised surfaces which can get nearly as hot as a black roof.

Steel and Tile Roofs

Steel roof sheeting such as corrugated iron, will lose heat quickly as soon as the sun stops shining on it. Its physical properties allow it to respond quickly to any change in temperature which is beneficial, particularly at night, for instant relief from the heat.

Roof tiles, because of their physical properties, will slowly absorb heat during the day and then slowly re-radiate it into the home at night. This can prevent the home from cooling down quickly and in many cases the inside will remain hotter than the outdoor ambient temperature (Figure 6).

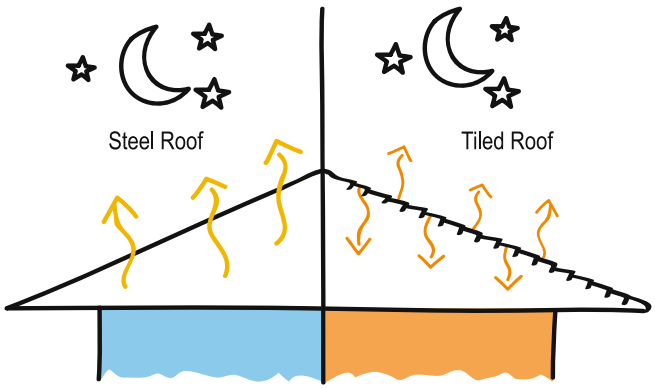

Figure 6 *Steel roofs cool off quickly whereas tiled roofs continue to radiate heat.*

If using tiles the inclusion of reflective foil (refer to the Reflective Foil section later in this guide) is essential to help improve the thermal performance of the home.

Ventilate Your Roof-Space

Poorly ventilated roof-spaces get hot. Heat coming through the roof superheats the air in the roof-space which in turn conducts heat through the ceiling into the room below.

FACT 2

The temperature of trapped air in the roof-space can exceed 70°C.

In homes with a ventilated roof-space, the temperature of the air in the roof will be similar to the outside air temperature. This simple renewing of air reduces excess heat transfer down through the ceiling and into the home.

Therefore, in Townsville, which has approximately 300 sunny days per year, ventilating a roof-space is incredibly important. Ventilating the roof-space is easy and is done by installing: rotating roof vents, solar powered roof ventilators, roof vents, gabled vents and unsealed eaves, to name a few.

Insulate Your Roof Effectively

Insulation is an essential component of roofs for both climate-responsive and air-conditioned homes. Insulation can significantly reduce the amount of heat entering the home. It can also help seal in the cool air created by air-conditioning. Air-conditioning is not considered sustainable but with insulation, can be used more effectively to reduce its impact.

The building stage is the most convenient and hence cost-effective opportunity to insulate, therefore, plan ahead to get the best performance out of your building.

A well designed insulation system will often pay for itself in electricity savings in as little as two to three years.

There are two main types of insulation:

- Reflective (Figure 7), and
- Bulk (Figure 8).

Figure 7 *Example of reflective insulation (Photo: TCC).*

Figure 8 *Example of bulk insulation (Photo: TCC).*

These are discussed in more detail below.

Reflective Insulation

Reflective insulation reflects heat away from a surface preventing 95% of infrared “radiant” heat from entering the space below. It is therefore highly effective at preventing the penetration of a large percentage of radiant heat that would otherwise enter a home through the roof.

There are several types of reflective insulation: reflective foil sheeting (sarking), multi-cell sheeting (like bubble-wrap) and expandable concertina sheeting, amongst others. Commonly these products are known as reflective foil laminates or ‘RFL’.

RFLs should be installed directly underneath the roof sheeting with the shiny side down and a minimum 25mm air gap between the roof sheeting and the foil or the heat will conduct straight through (Figure 9). This will reflect the heat away before it has a chance to heat up the roof-space. An RFL placed on top of the ceiling also works and is applicable when retro-fitting insulation. However, it is not as effective at keeping the heat out as it does not prevent the roof-space from heating up.

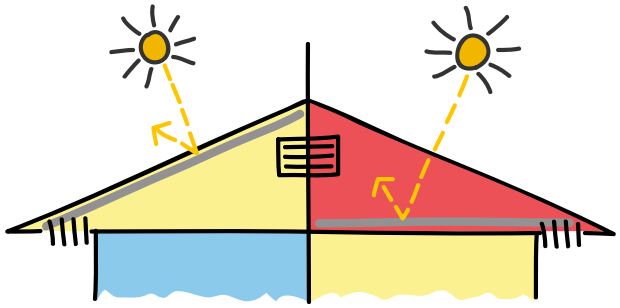

Figure 9 *Reflective foil under the roof sheeting keeps the roof-space cooler than if placed on the ceiling.*

Bulk Insulation

Bulk insulation reduces the amount of heat being transferred into the home. It works by resisting the amount of "conducted" and "convected" heat flow between the hotter air in the roof-space and the cooler air inside the home.

There are several types of bulk insulation: polyester, wool, bubble wrap, fibreglass (glass wool), rock wool (spun fibres of basalt – like glass wool), cellulose fibre (paper) and polystyrene. Depending on the type of insulation, these materials may be supplied as a blanket, batts or blown loosely onto the ceiling to form a layer.

FACT 3

The level of insulation a product is able to supply is given as an R-value. An R-value is a measurement of the products resistance to heat flow either 'UP' or 'DOWN'.

In Townsville, 'DOWN' R-values (also called 'summer' R-values) are very important, particularly for roof and ceiling spaces. Together, all of the components of a roof must achieve a minimum total R-value of 2.7 to comply with the building code of Australia.

Insulation with high 'DOWN' and low 'UP' R-values are particularly important for homes in Townsville.

There is little or no heating required in the Townsville region. The provision of insulation in the building fabric must therefore be designed to minimise heat flow from the outside to the inside.

For a home with only occasional or no air-conditioner use, bulk insulation is best installed under the roof sheeting as this will keep the roof-space cool and prevent hot air being transferred through the ceiling into the rooms below (Figure 10). Bulk insulation under the roof is easier to install during building construction however, it should never be compressed as it loses its effectiveness.

For homes that use more air-conditioning, the best place to install bulk insulation is on top of the ceiling (Figure 10). Placing insulation on the ceiling helps keep the cool air where it is needed so you are not inadvertently trying to cool down the room and the entire roof-space.

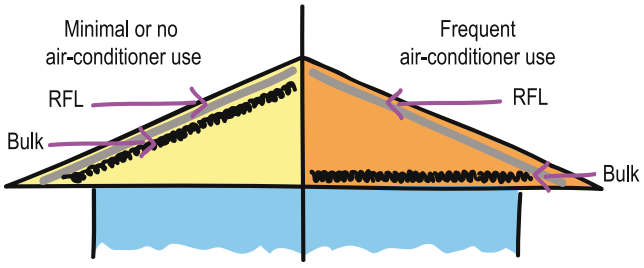

Figure 10 *The best location for the installation of bulk insulation depends on how often the house will be air-conditioned.*

In a hot humid climate such as Townsville, the provision of bulk insulation on the ceiling sheet combined with good ventilation of the roof-space is a good combination. It has the added benefit in that it can be easily retro-fitted in existing homes.

3. Walls

Insulate All Walls Exposed to Sun

If external walls in Townsville cannot be adequately shaded then it is important that they are insulated. However, if there are budget restrictions and not all the walls can be insulated, then west-facing walls, which are subject to the hot afternoon sun, should be the highest priority. *For more information on the importance of shading refer to Guide 3 - Shading Out the Heat.*

Reflective foil insulation on its own will provide a significant improvement, when installed correctly, compared to an uninsulated, unshaded wall. Reflective foil in walls must also have a 25mm air gap to be effective. However, bulk and reflective insulation together can also be an effective option for air-conditioned rooms.

Use Lightweight Walls

In Townsville, the temperature drop that comes with sunset is a relief. A home and its component materials should respond quickly to the cooling outside temperature. The materials should release heat rapidly rather than storing it and re-radiating it back inside the home.

Lightweight walls generally consist of either a timber or steel frame structure with cladding fixed to the frame on the outside and the inside. Externally, they can take on a variety of looks depending on the type of cladding used. Some choices include: corrugated steel sheeting, fibre cement sheets, timber weatherboard, manufactured boards and plywood sheets (Figure 11). Plasterboard is the most commonly selected inside lining, although others are available.

(a) During Construction

(b) After Construction

Figure 11 *A lightweight wall, with a layer of reflective insulation and a rendered finish (Photo: ecoSAVVY).*

Lightweight walls are constructed using a combination of materials. They are easier and cheaper to insulate because there is a cavity (Figure 12) between the external and the internal cladding into which insulation can be fitted without the need for additional construction methods.

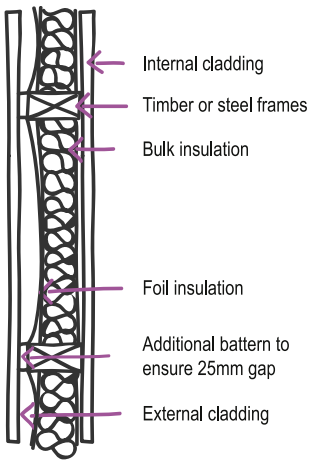

Figure 12 *A section of a lightweight wall with both bulk and foil insulation in-between the framing.*

Homes do not have to be constructed exclusively from lightweight walls. In some cases, a combination of lightweight and masonry walls can be very successful. A good example of this is where the internal walls of a home have been constructed from concrete blocks whilst the external walls are constructed from lightweight materials.

FACT 4

Australian Standards specify minimum strengths for cyclone resistance. Did you know that homes with lightweight walls are just as cyclone resistant as homes with concrete block walls?

Use Masonry with Care

Masonry is the term given to building materials such as bricks, concrete blocks, concrete, rammed earth walls, clay roof tiles, and similar building materials.

FACT 5

'Thermal Mass' is a material or element in the home that absorbs, stores and later releases heat to great effect. Thermal mass has two main properties; the ability to absorb and release heat, known as 'Thermal Lag' and its capacity to store heat, known as 'Volumetric Heat Capacity'.

Masonry that is exposed to a hot environment absorbs heat and then slowly releases it over many hours at night. This results in homes that are slightly cooler in the middle of the day, but consistently warmer in the late afternoons and evening when many of us are at home. As a result, masonry homes generally need air-conditioning to remain comfortable during those times.

For homes in the tropics, masonry must be used with care. If masonry is to be used as a building material it must be either shaded, or alternatively, insulated (Figure 13 and 14).

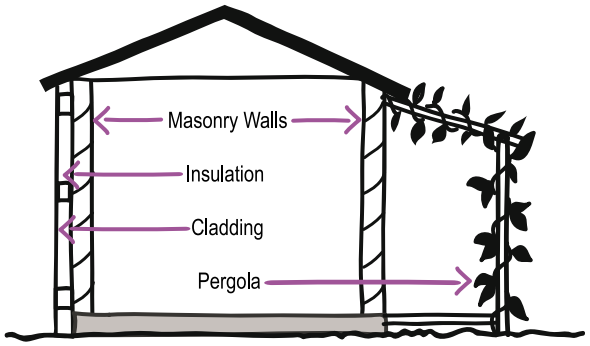

Figure 13 *Masonry walls can be prevented from heating up by insulation (left) or shading (right). An example of which is a pergola with landscaping over it.*

FACT 6

In Townsville, concrete block walls have become the preferred building method. Reasons for this include availability, cost, speed of erection and building covenants but do not include climatic performance.

However, this may change over time as new building regulations are introduced that require our homes to perform better in our climate.

To insulate a concrete block wall, a frame is attached to either the outside or the inside of the wall thereby providing a space for the insulation. Cladding can then be fixed to the frame to cover and protect the insulation (Figure 14). Insulating the outside is generally preferred as this prevents the block wall from heating up and re-radiating heat. Insulating the inside of a block wall may be limited to bulk insulation for any kind of thermal improvement. Installing foil in-between a masonry block wall and an internal wall lining will not improve performance.

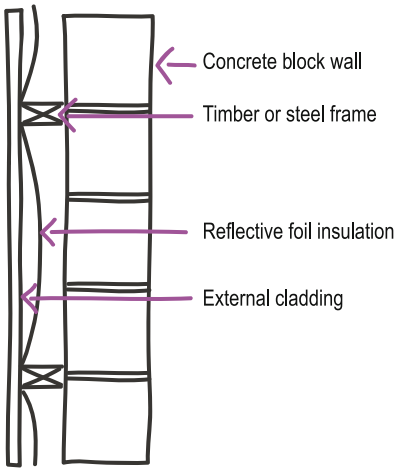

Figure 14 *Wall cross-section showing insulation on the outside of the block wall.*

There are many alternatives to traditional concrete blocks. One building alternative is Autoclaved Aerated Concrete (AAC). This product is lighter and more energy-efficient compared to regular concrete blocks.

FACT 7

One night, go out and put your hand on any concrete surface that has been in the sun; if it is still warm it is still radiating heat. This makes your home, and the area around it, hotter.

4. Floors and Windows

Masonry Floors

Masonry or concrete slab floors can be beneficial in Townsville when they are kept out of the sun. They are slow to respond to temperature change, which is advantageous because they keep their cool longer.

Because masonry materials keep a fairly constant temperature when in the shade, or in contact with the ground, they will often provide a positive cooling effect; particularly compared to the midday air temperature. These materials will be comparatively cool to the touch, allowing you to benefit by feeling cooler in the heat.

This can also be applied to fully shaded, masonry or stone internal walls.

Raised Timber

Naturally ventilated homes with raised timber floors can benefit from not having any insulation under the floor to enhance their ability to cool the home all year round. This cooling is especially beneficial in the summer.

However, once residents are used to the higher temperatures of Townsville, the weeks during mid-winter can feel quite cold. In this case, insulation underneath a raised timber floor may be desired. However, this will reduce the effects of ventilated cooling during summer.

FACT 8

If you are planning on air-conditioning your home it is recommended that both concrete and timber suspended floors in tropical regions are insulated with a minimum R1.0 insulation.

Tinted Glass

Using tinted glass can help reduce glare and heat transfer through windows (Figure 15).

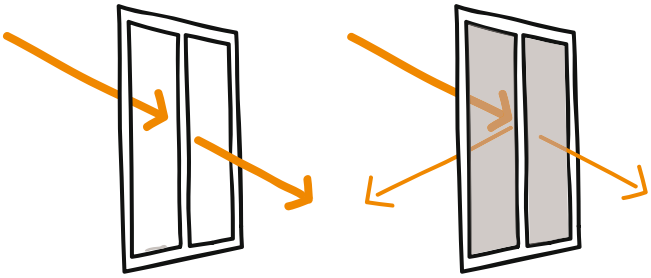

Figure 15 *Less heat passes through tinted glass.*

There are several products on the market based either on reflectivity films applied to the glass surface or a special inter-layer applied to laminated glass.

Shading is still the most effective means of reducing heat gain into a home regardless of glass type. However, tinted and high performance types of glass can be particularly beneficial for windows on the east or west of the house or windows that might otherwise be difficult to shade.

FACT 9

Double glazed windows will stop the outside heat from coming into a cool or air-conditioned room. However, they must be completely shaded to prevent the suns rays penetrating through and heating the room.

What your home is made of will have a direct effect on how well it performs in Townsville's tropical climate. Lightweight and light-coloured materials will achieve the best overall thermal performance for your home.

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