Module 29: Home insulation

Module Objectives

By the end of this session, participants will understand:

1. The new regulations regarding energy saving for South African houses
2. The three different types of heat transfer which occur in houses
3. Insulating ceilings and roofs
4. Insulating walls
5. Insulating floors

Module at a glance:

Topic	You will learn
National Building Regulations and home insulation	- About the different climatic zones in South Africa - What R-value means
Heat transfer	- About the three different kinds of heat transfer
Insulating a house	- About ceiling and roof insulation - About wall insulation - About floor insulation

Energy saving regulations

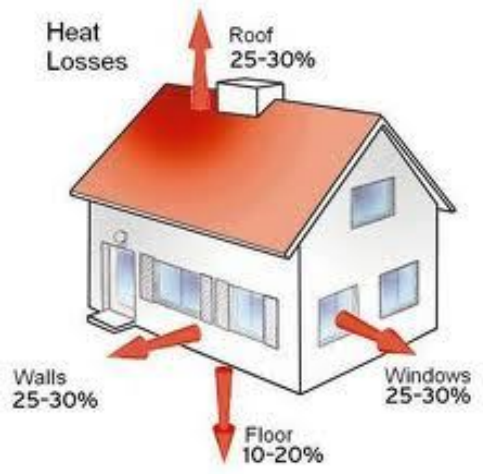
As a response to the energy crisis, all new homes built in South Africa are now subject to thermal insulation regulations. These regulations are now part of the National Building Regulations (Part X). Properly applied thermal insulation techniques and materials make it possible to save nearly 80 per cent of a building's energy consumption for space heating, cooling and hot water systems.

The National Building Regulations were updated in 2011 to include Part X which addresses environmental sustainability, and Part XA, which regulates energy efficiency in new buildings.

The new standard is intended to save about 4 500MW of electricity per year. This is almost twice the electricity currently produced by South Africa's only nuclear power plant, Koeberg (1800 MW).

Impending electricity price increases of between 25 per cent and 30 per cent p.a. up to 2015, will also have a significant influence on the design of new buildings and the use of insulation products. Therefore the home inspector needs to be familiar with the basics of the new energy saving regulations, and also the mechanics of home insulation.

Changing the temperature of the air in a house requires a lot of energy. Any gains through heating in winter, or cooling in summer, can be quickly lost if the house is not well insulated. Heat exchange with the outside occurs through the walls, windows, ceilings and floor. A well-insulated home will save a lot of power that would otherwise have been necessary to maintain a comfortable temperature inside.



Correctly insulating the building envelope, in combination with energy saving techniques, can control energy losses and reduce energy consumption by up to 78%

Food for thought...
Many existing homes in South Africa are poorly insulated because, due to our very temperate climate, most homes are only really uncomfortable for one or two months in the year. Our historically cheap electricity prices, have also allowed many people to afford the large amounts of electricity needed for heating/cooling. With Eskom prices rocketing this is no longer the case.

Previously, building codes and builders have also not emphasised insulation in domestic homes.

R-value

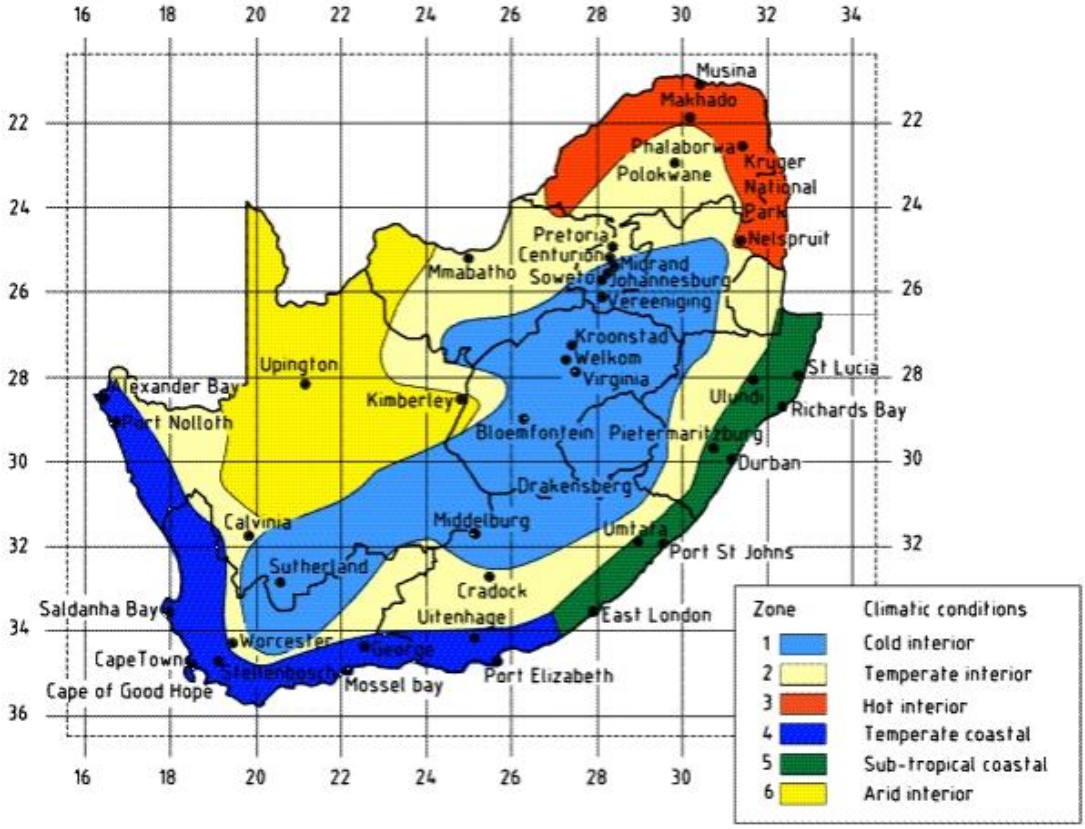
The new minimum specifications stipulate a total R-value for roofs and ceilings, depending on pitch and roof construction, which can be achieved by installing either a single layer of ceiling insulation, 60mm to 160mm thick or multi-layered ceiling insulation. Minimum requirements also apply to walls and windows.

"R" stands for resistance to heat flow, or Thermal Resistance Value.

Note...
The higher the R-value, the greater the insulating effectiveness of the product.

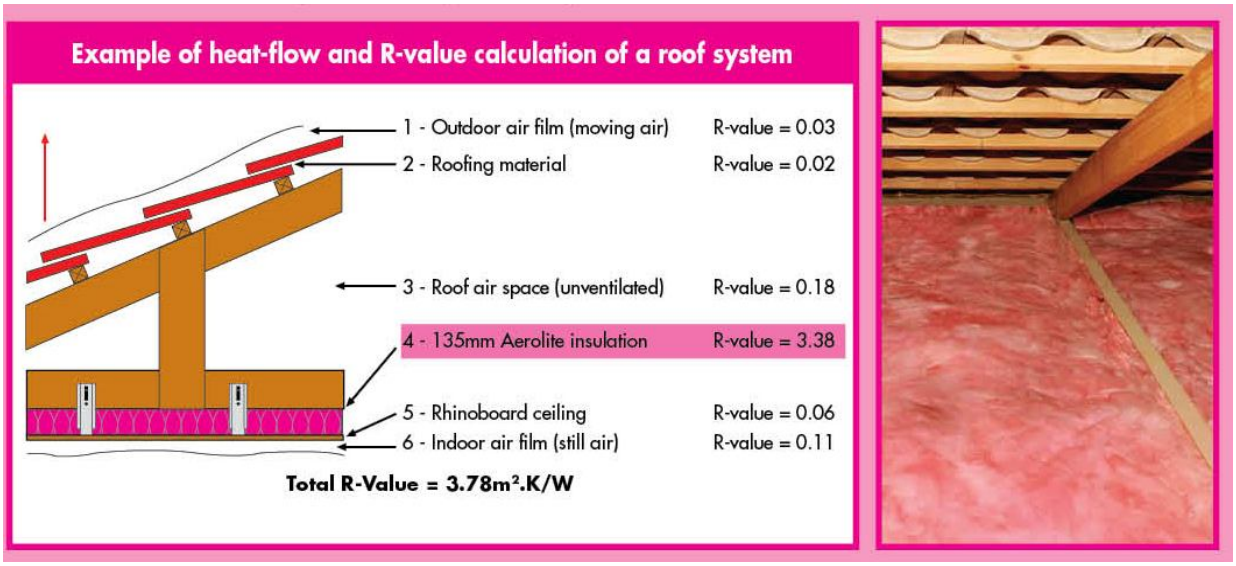
Manufacturers of insulation products, print the R-value of their products on the facings of bats and rolls of thermal insulating material.

Expressed as a formula: R Value = thickness of insulating material ÷ thermal conductivity of material.



An important consideration when building is to determine the relevant climatic zone. Each of the zones shown on the above map has a different R-value requirement for outside walls and ceilings. These R-Value requirements appear in the table below.

Zone	R. Value	Ceiling insulation thickness
Zone 1	R3.38	135mm
Zone 2	R2.88	115mm
Zone 3	R2.5	100mm
Zone 4	R3.38	135mm
Zone 5	R2.5	100mm
Zone 6	R3.38	135mm



An example of heat flow and R-value calculation in a roof system. (Graphic by Aerolite)

Heat transfer

There are three forms of heat transfer:

Radiation heat transfer

This is the type of heat generated by a fireplace or heater – or by the sun. Radiant heat is often the most effective because the heat is felt immediately. Radiation, however, requires direct line of site between the heater and what is being heated.

Insulation against radiant heat transfer from the sun and outside, air is achieved by using a highly reflective surface (e.g. shiny aluminum foil) – often referred to by the trade name "Sisalation".

Radiant heat absorption is maximized by painting the surface matt black (i.e. make it completely unreflective).

Convection heat transfer

This is the transfer of heat via the circulation of a fluid or gas.

Blowing hot air down a duct, or piping hot water through pipes, is an example of convective heat transfer. There is some delay between the start of the heater and when the heat is felt in different parts of the house or room.

Convection also works against you, when there are air gaps where hot air can flow out of the home and/or cold air flow in. Convection heat transfer is minimised by preventing gases or fluids from circulating (many materials used for insulation do this by trapping air into many tiny bubbles, which prevents any convective heat transfer between them).

Conduction heat transfer

This occurs between things that physically touch each other. Insulation against conduction is important with regard to reducing heat lost through solid barriers, such as the ceiling or walls. Good insulators against conduction are polystyrene foam sheeting, glass fibre blankets or polyurethane foam.

All insulation is designed to reduce one or more of these heat transfer mechanisms. Understanding how and when they are occurring, helps select the most appropriate solution. The building regulations specify which types of insulation are acceptable; particularly with respect to their fire hazard ratings (some older types of insulation are flammable).

Ceiling and roof insulation

There are two main forms of heat transfer occurring in the roof cavity. Firstly the ceiling panels allow heat to be conducted out of the house in winter, when the inside is warmer than the outside and the reverse occurs in summer.
Secondly the roof tiles or corrugated iron roof sheeting heat up from the sun during the day and then transfer that heat to the ceiling boards by radiation.

Some form of insulation designed to reduce conduction such as glass fibre blanket, cellulose, polystyrene sheet or foam, should be laid on top of the ceiling boards to reduce conduction through the ceiling.

Pumped in loose recycled paper (Eco-insulation) in a roof cavity, together with tile underlay.

To reduce radiation from the roof tiles, some form of aluminium foil sheeting (sisalation) is often laid directly underneath the tiles, with the shiny side facing upwards. Ideally this should be done during construction, but it can be retro fitted by attaching it to the underside of the roof brandering.

Both these types of insulation can be installed relatively easily into most homes, provided one has access to the roof space.

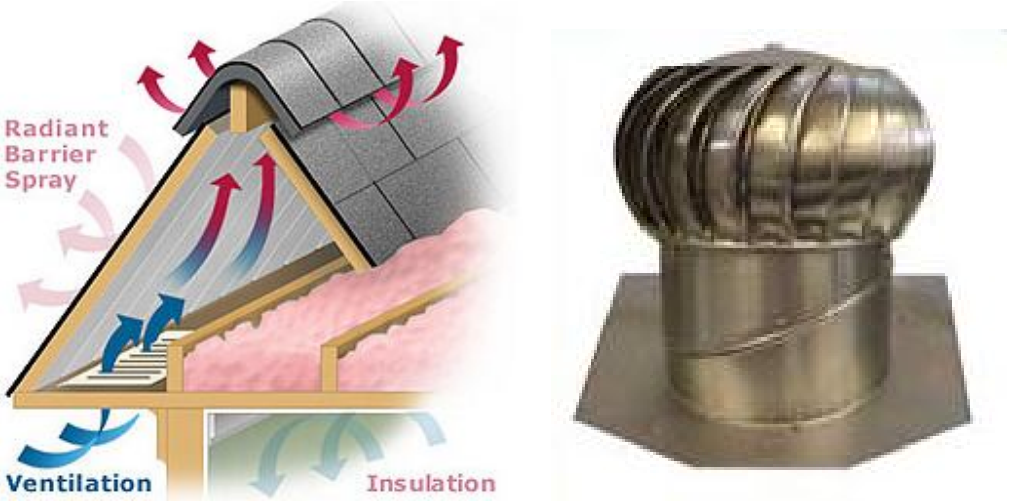
Roof ventilation

Most pitched roofs in South Africa lack a ventilation system in the roof cavity, with the result that hot air trapped in this space becomes like an “oven”, with resultant heat transfer to the rooms below. Insulation laid on top of the ceiling helps reduce the heat transfer, but a more obvious solution is to provide effective ventilation within the roof cavity, thereby allowing the hot air to escape and to be replaced by cooler air.

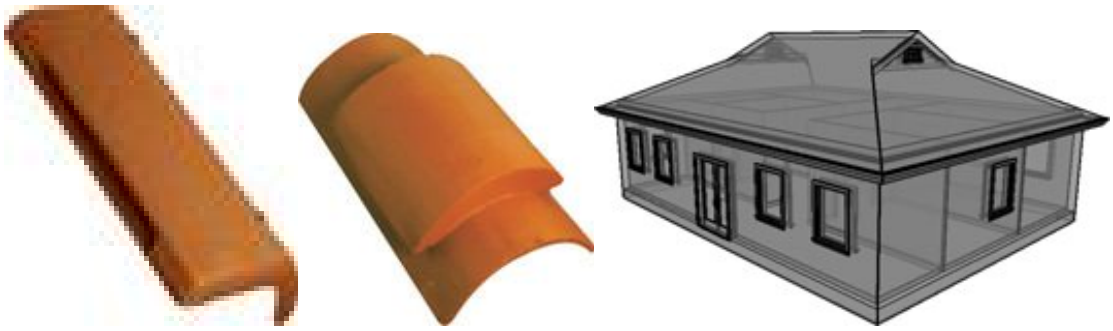
Roof vent pipes with electric fans or wind driven extractors (called “turbo vents” or “whirly birds”) are one solution. Louvered vents (Dutch gables) in gambrel-type roofs are another.

Ridge vents

However, ridge venting combined with grids in the eave soffits is easily the most efficient and cost effective.



Left: An illustration of an efficient roof venting system. Right: A whirlybird or turbo vent



Left: Two examples of vented concrete ridging capping tiles available in South Africa.
Right: An example of roof venting via "Dutch gables"

Wall insulation

The older building codes used to include cavity walls as the standard way of building the external walls of a house. Cavity walls have an air gap between the inner and outer course of bricks. The air gap stops heat being transferred via conduction through the two brick courses. The air gap acts as a partial insulator, because heat can only flow via convection across the gap. Convection is far less effective as a heat transfer mechanism. If necessary, one can even minimise convection by injecting polyurethane foam (as a retro fit) into the air gap, or alternatively polystyrene sheeting can be inserted into the gap during construction.

Many older houses still have cavity walls. Unfortunately, cavity walls have long since been discontinued by many local builders as standard practice. No form of insulation is currently added to the walls of modern homes, unless specifically requested by the architect or owner. One should consider this if one is currently building a home.

Adding insulation to your existing walls if your home does not have cavity walls, may require virtually rebuilding them or panelling the walls with thermal insulation boards such as thermocoustix.

Window insulation

Heat flows through a single pane of glass in the following ways:

- Radiant heat is both entering and leaving the room via the window. During the day sunshine passing through the window will heat up all surfaces it lands on. During the evening warmer surfaces inside the house will radiate their heat outside if the curtains are not drawn.
- Heat will be lost via conduction through the glass pane to the air on the outside at night and the reverse will occur during the day.

To reduce radiant heat lost via windows, one should keep the curtains closed at night. Failing that, one can apply specialised films to the glass which lowers its transparency and/or emissivity to the wave lengths of radiation that transfer heat.

In colder regions such as Europe and the US, one can purchase glass that has these characteristics, but unfortunately it doesn't seem to be available here in SA.

Double glazing (two panes of glass with an air gap between them) reduces heat lost via conduction quite effectively. Thick, heavy curtains that seal off the window from the rest of the room will do the same thing, but to a considerably lesser extent. Double glazed windows usually need to be installed during construction. Retrofitting them is usually quite costly and can require breaking into the wall to remove the previous frames.

Floor insulation

The earth can be considered to be a giant heat sink. Heat is constantly being lost by conduction, down into the earth through the floor. Anyone who has spent a night sleeping on the floor or camping will tell you that it's more important to place insulation beneath one than above.

In colder regions of the world, it is standard practice to place a layer of insulation beneath the floor slab to reduce heat loss through the floor, but not unfortunately in South Africa. Clearly this can only be done during the construction phase.

Tiled floors are especially good conductors of heat away from a room. Carpets are the most practical option in South African homes of insulting the floor of a home. Laminated wooden flooring is also usually installed with a layer of insulation beneath it.

Some insulation products found in SA homes

Roof insulation

Sisalation (aluminium foil) installed shiny side up, under the purlins and battens under the roof sheeting or tiles. Insulating board such as **Celenit Eco** cement bonded wood fibre boards can be fixed to the top or underside of roof rafters. Also used for thermal and acoustic insulation of walls, floors and ceilings.

Ceiling insulation

Various roll-on products such as **Isotherm** (recycled polymer batting) and **Aerolite "Think Pink"** (recycled glass); pumped in loose cellulose fibre (recycled paper) such as **Eco-insulation** (this product can be pumped into ceilings or into cavity walls), thermal ceiling panels such as **IsoBoard** (polystyrene) or **Thermocoustex** board (recycled polyester fibres).

Wall insulation

Panelling with insulating board such as **Thermocoustex** or filling wall cavities with pumped in cellulose **Eco-insulation** fibre are two solutions.

Floor insulation

InnoFilla is a vermiculite based product which traps air in millions of minute pores, which results in exceptional thermal and acoustic values. InnoFilla can also be used in normal aggregate for floor applications, resulting in an excess of 10% in energy savings. InnoFilla is also used in conjunction with the mortar mix to add thermal properties to concrete bricks and blocks, and to plaster mixes. Wood and laminate flooring and fitted carpets also provide insulating properties to floor slabs.

It should be noted that most products which improve thermal insulation of a home, also improve the acoustic insulation values of the structure – i.e. they tend to also reduce noise transference.

Fire resistance

All insulation products used in South African homes have to satisfy the SABS that the product will not burn or promote fire spreading. Most of these products are either inherently inert, or have been impregnated with flame retardants.

Before you take the online test, please.....

Make sure that you are thoroughly familiar with the material in this module before completing the online test. The more familiar you make yourself with the information presented in this Module the better you will be as a professional home inspector. Review thoroughly all areas of this module before and during the open book online test.