Avoiding unseen heat loss

The importance of slab-edge insulation

Insulating under slabs has become commonplace, but slab-edge insulation can be just as important. But how do you do it and still provide good termite protection? Dick Clarke explains the physics and a simple design solution.

IT'S not so long ago that Australian homes were built without any insulation. Anywhere. Extraordinary thought, isn't it? What's more extraordinary is that I am talking 2003 here, not 1960. The introduction of Section J of the Building Code of Australia in 2003 has made it impossible for houses to be legally built or renovated without some form of insulation in walls and roofs. But floors have so far been a low priority for the government regulators.

Insulating beneath concrete slabs has become widely accepted practice in Australia and some structural systems like waffle pods provide it as a matter of course. But adding insulation to the edge of concrete slabs is still an unusual feature.

One issue is that the available thermal performance software cannot model the performance of slab-edge insulation adequately, although both NSW's BASIX and the National Construction Code (formerly BCA) mandate slab-edge insulation if any form of heating is to be installed in the slab.

Why do we need it?

Under-slab and slab-edge insulation benefits come from moderating the temperatures at and just below ground level. Ground-level surface temperatures move through a large range in most populated parts of Australia.

Surface temperatures are linked to the deep temperature of the site, perhaps at 50 m down, which may be a consistent year-round 21 °C or so (assuming no tectonic activity).

However, this 'push' of stable temperature suffers a 'pull' of variable temperature in changing seasons and weather at the surface. An extreme example might be Alice Springs, where the air temperature consistently varies between sub-zero in winter to 40-plus in summer. These extremes work their way into the soil (or rock) at the surface, such that the first half a metre or so might vary between 5 °C and 35 °C seasonally, with the range narrowing the deeper you go. Alpine regions and the south island of New Zealand have surface temperatures which are consistently too cool for comfort.

Under-slab temperatures

Most house-sized slabs will attract earth temperatures from about three metres deep up to the surface of the slab. In some climate zones this is a lovely annual average, and no under-slab insulation is required. But in most of southern Australia and pretty much all of New Zealand we see a net annual benefit from under-slab insulation (see box for more).

Slab-edge temperatures

Most concrete floor slabs have a floor level 100 mm or more above ground and this exposed edge is subject to these surface temperature fluctuations, even if there is under-slab insulation. Putting aside the relatively few houses built in truly benign sub-tropical climate zones, this means 98% of the Australian and New Zealand population live in buildings with uncontrolled heat flows right around the perimeter.

This also applies to apartments, even those well above ground level. Any slab that has heating installed (hydronic or resistive) exaggerates the temperature differences, and it becomes not just beneficial but critical that the edge is insulated.

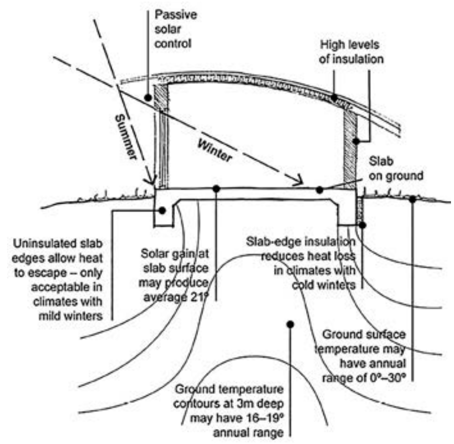


Image: Your Home, www.yourhome.gov.au/materials/concrete-slab-floors

↑ Soil temperatures vary depending on depth, with surface temperatures varying considerably throughout the year. Slab-edge insulation can reduce thermal losses in winter.

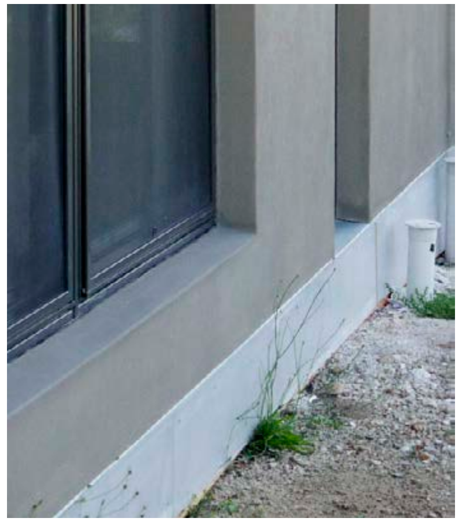
What happens in colder climates

In seriously cold climates like Germany, Switzerland, Canada and the mid-west of the USA, the benefits have been obvious for decades, and these jurisdictions have regulations requiring floor-edge insulation, and they have tradies, products and systems that are well adapted to dealing with the issue. For instance, there is a German product that allows a concrete slab to be cantilevered from the main structure with a complete thermal break (insulation) at the point of cantilever. This product has a distributor in Australia and New Zealand, but I am unaware of any building using it yet.

Beating termites

Of course, what mainland Australia has is a persistent little critter whose sole purpose is to clean up all the dead and rotting timber

↑ Waffle pod slab before (left) and just after the concrete pour. Note the termite barrier under the waffle pods, as per the ISEG.2 approach.



↑ Newly completed slab edge including insulation and termite barrier using the ISEG.2 approach.

on the face of the continent. This delightfully diligent creature is the termite. A decade ago Minimum Termite Risk construction techniques were adopted in Australia, which principally relied upon an exposed slab edge if no other mechanical barriers (such as Granitgard or Termimesh) were used—and none of these termite solutions solved the slab-edge insulation issue. And so we have a dichotomy: a non-hazardous non-chemical physical termite barrier causing poor thermal performance. Or to put it the other way around, excellent thermal performance being hampered by safe termite barriers.

A first generation approach

However, as persistent as the termite is, the human is more inventive. So the following strategy was born in my design practice—let's call it Insulated Slab Edge Gen 1 (or ISEG.1):

- concrete slab on ground (with or without under-slab insulation as dictated by the location) and foundations to AS2870 Masonry Code (to resist cracking), with a minimum 100 mm of slab edge exposed above the finished ground level
- closed cell high density foam insulation (typically R1.5) from bottom of slab edge beam to ground level, permanently in place
- a removable strip of foam between ground and bottom of insulated wall cladding, which enables any termite tunnels ('leads') to be easily seen during a twice annual inspection (the Australian Standard!)
- a strip of cladding material that covers and protects the foam from UV and physical damage (from line trimmers etc), held in place with a robust clip or other device.

Under-slab insulation

Ground coupling in mild climate zones such as Perth, Brisbane or coastal NSW allows the floor slab of a well-insulated house to achieve the stable temperature of the earth: cooler in summer, warmer in winter. In winter, added solar gain boosts the surface temperature of the slab to a very comfortable level.

In areas with low winter temperatures such as southern Victoria and Tasmania, the deep ground temperature is too low to allow passive solar heating to be effective, increasing the energy use required for comfortable room temperatures.

In areas with milder temperatures and higher ground temperatures, under-slab insulation is often not required, and not insulating the slab will often result in more stable indoor temperatures. One interesting study of a building with no under-slab insulation, yet which still performs very well, is the Greeny Flat (www.greenyflat.com.au and profiled in *ReNew 130*) in Mittagong, NSW, around 100 km south-west of Sydney and 30 km from the coast.

To decouple the slab from the ground, under-slab insulation is often used. This usually takes the form of polystyrene or polyisocyanurate foam insulation or polystyrene concrete forms (used to reduce the amount of concrete used), such as waffle pods. Alternatively, arrays of linked polypropylene domes such as the Cupolex Building System may be used.

Under-slab insulation also works well in warm zones with higher soil temperatures. If a home is to be air conditioned then under-slab and slab-edge insulation will reduce the amount of air conditioning required by reducing heat ingress through the slab, and should be used.

If in-slab heating (or cooling) is to be used, then the slab should be fully insulated, both underneath and along the edge, to reduce the energy losses from (or gains to) the slab.

Note that different soil conditions can affect the way the slab interacts with the ground temperature. Also, reactive soils prone to movement may not be suitable for particular slab construction and insulating techniques and this should be addressed at the design stage.

www.yourhome.gov.au/materials/concrete-slab-floors

Image: Chris Norman Architecture, www.chrisnorman.co.nz

↑ Regular slabs can be fully insulated as well, and there's a range of foam products designed specifically for under-slab use.

The main problem with ISEG.1 is the removable strip for inspections—it is hard to find a good robust system. It also relies on inspections, although any physical barrier system is the same: at least with a physical barrier, if you inspect you know all is well. With chemical barriers, because you are relying on unseen elements, all you can do is assume, and hope; and worry about what to do when it runs out of potency.

A better approach—ISEG.2

A number of designers toyed with ISEG.1's shortcomings and trialled different solutions that didn't require a removable part for inspections. We were able to do this when a termite barrier came on the market (Homeguard TMB or Rentokil product) that embeds the termiticide into poly sheets and plastic fittings at the molecular level. This means that the active agent doesn't leach out and is safe in the environment, while it also remains potent: termites are repelled on contact. Our new detail, let's call it ISEG.2, looks a bit like ISEG.1 except that:

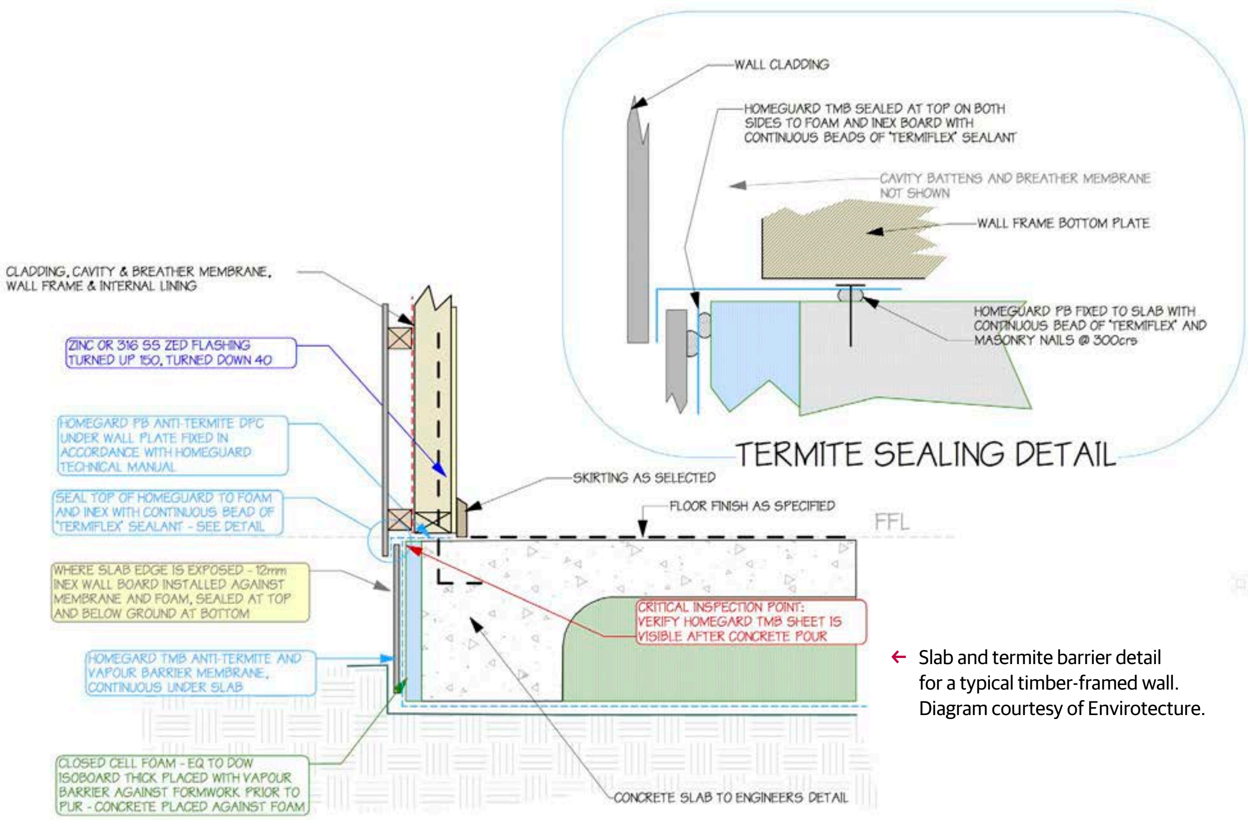
- the termite barrier is the slab's vapour barrier sheet (such as Homeguard TMB), which wraps up the slab edge, and is exposed at the top for the 'critical stage' certification inspection
- R2.0 (typical) high density closed cell foam is placed against the inside of the vapour/termite barrier, which is held against the edge formwork and sealed at the top with a continuous bead of Homeguard Termiflex, before the concrete is poured
- 24+ hours after pouring, the formwork is stripped and the barrier sheet checked for integrity. Then, a sheet of magnesium oxide cement (MgO) is permanently fixed to the outside, for UV and physical protection during the remainder of the works and ever after (MgO can be left in ground contact, and saturated), sealed at the top with a continuous bead of Homeguard Termiflex
- alternatively, the MgO sheet can be installed before the pour, tight against the formwork, sealed to the Homeguard TMB sheet with a continuous bead of Termiflex
- when cladding or wall finishes are installed, a stainless steel 'Z' flashing is added to cover the top of the MgO and foam, or the wall cladding is extended down 40 mm; usually all wall finishes are flush, but that is an architectural detail which can be varied to taste.

Note that the base of the wall structure must be protected by flashings in accordance with Australian Standards, but this can be integrated into ISEG.2.

It is frustrating that the NatHERS house energy rating software has not in the past been able to model the benefit from slab-edge insulation and successive governments have failed to ramp up the stringency of the building regulations sufficiently. That is now changing, and it is the leaders of industry at the forefront, with CSIRO and others also making big strides. Cleverer people than this writer have calculated the physics of slab-edge insulation's benefits from first principles, finding that, in Sydney or Melbourne for instance, it can reduce heating bills by hundreds of dollars per year.

ISEG.2 is quick to install and the materials are inexpensive, so the payback in dollars can be quite short. The payback in comfort and lifestyle is so good it's hard to put a price on. ✱

Dick Clarke is a Sydney-based building designer and regular contributor to *Sanctuary* and *ReNew* magazines.



← Slab and termite barrier detail for a typical timber-framed wall. Diagram courtesy of Envirotecture.