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Perimeter insulation

To help improve our homes, the recently released BRANZ *House Insulation Guide* now includes thermal performance values for more insulated slab-on-ground flooring options and waffle pod systems.

Perimeter insulation was built into this floor slab.

THERMAL RESISTANCE (or R-value) is used to measure the effectiveness of insulation - the higher the figure, the better the resistance to heat flow.

Perimeter insulation advantages

Perimeter insulation is defined in the BRANZ *House Insulation Guide* as a rigid foam insulation (typically expanded polystyrene (EPS) or extruded polystyrene (XPS)) placed vertically against the outside face (the perimeter) of a concrete floor slab or foundation wall. Although not currently standard practice, perimeter insulation is sometimes the only practical way to significantly increase the R-value of a floor slab.

Perimeter insulation will also increase the R-value of a slab-on-ground floor that has insulation under the slab. It can be retrofitted, but ideally it should be incorporated into the detailing of the wall cladding and foundation or the floor system.

BRANZ thermal modelling has shown R1.0 perimeter insulation to be optimal - higher levels have minimal benefits as edge losses have been largely eliminated and most of the heat loss is then from under the slab.

Two big areas for heat loss

Since most heat loss is at the perimeter of a slab, the primary influence on the overall R-value is the length of the slab perimeter compared to its area - the area-to-perimeter ratio. A small slab will have a smaller area-to-perimeter ratio and consequently a lower R-value. A large slab will have a higher area-to-perimeter ratio and therefore a higher R-value.

A secondary influence on the R-value is the depth of the building walls above the slab. In buildings with deeper walls, the heat escaping through the perimeter of the slab has a greater distance to travel, and hence the edge of the floor slab has a higher R-value.

Waffle pod systems

The *House Insulation Guide* defines waffle pod systems as any concrete flooring system that uses 200-250 mm thick expanded polystyrene blocks in a grid pattern with 100 mm gaps between. Concrete fills both the gaps and a 300 mm wide perimeter band to give the floor system structural strength.

Unfortunately, the concrete thermally bridges the expanded polystyrene. The result of BRANZ thermal modelling has shown that there is a minimal overall increase in R-value for these systems above a plain slab-on-ground floor.

Looking at some examples

As an example, Table 1 summarises R-values for a variety of flooring systems from the 5th edition of the *House Insulation Guide*.

Table 1

R-VALUES FOR A VARIETY OF FLOORING SYSTEMS FROM BRANZ MODELLING

		AREA-TO-PERIMETER RATIO						
		1.3	1.9	2.2	2.5	2.8	3.1	4.0
		TOTAL CONSTRUCTION R-VALUE						
WITHOUT PERIMETER INSULATION								
SLAB ON GROUND	90 mm deep wall frame	0.8	1.0	1.1	1.2	1.4	1.5	1.8
	140 mm wall frame or 150 mm masonry	0.8	1.1	1.2	1.3	1.5	1.6	1.9
	200 mm masonry	0.9	1.2	1.3	1.4	1.5	1.7	2.1
	250 mm masonry	1.0	1.2	1.4	1.5	1.5	1.8	2.2
WAFFLE POD	90 mm deep wall frame	1.0	1.2	1.3	1.5	1.6	1.7	2.1
	140 mm wall frame or 150 mm masonry	1.0	1.3	1.4	1.5	1.7	1.8	2.2
	200 mm masonry	1.1	1.4	1.6	1.7	1.9	2.0	2.4
	250 mm masonry	1.3	1.6	1.8	1.9	2.1	2.2	2.6
R1.0 PERIMETER INSULATION								
SLAB ON GROUND	90 mm deep wall frame	1.2	1.5	1.7	1.9	2.0	2.2	2.7
	140 mm wall frame or 150 mm masonry	1.3	1.6	1.8	1.9	2.1	2.3	2.8
	200 mm masonry	1.3	1.6	1.8	2.0	2.1	2.3	2.8
	250 mm masonry	1.3	1.7	1.9	2.0	2.2	2.4	2.9
WAFFLE POD	90 mm deep wall frame	1.4	1.8	1.9	2.1	2.3	2.4	2.9
	140 mm wall frame or 150 mm masonry	1.5	1.8	2.0	2.1	2.3	2.5	3.0
	200 mm masonry	1.6	1.9	2.1	2.3	2.5	2.6	3.1
	250 mm masonry	1.7	2.1	2.2	2.4	2.6	2.8	3.3
R1.0 PERIMETER AND R1.2 UNDER-SLAB INSULATION								
SLAB ON GROUND	90 mm deep wall frame	1.7	2.1	2.3	2.5	2.7	2.9	3.5
	140 mm wall frame or 150 mm masonry	1.8	2.2	2.4	2.7	2.9	3.1	3.7
	200 mm masonry	1.9	2.4	2.6	2.8	3.0	3.2	3.8
	250 mm masonry	2.0	2.5	2.7	2.9	3.2	3.4	4.0

The green shaded areas are systems that meet the R1.9 minimum requirement for embedded heated flooring specified in H1/AS1 Replacement Table 2.

Small increase for waffle pod

The increase in overall R-value for a waffle pod system relative to a plain slab without EPS under the slab is only R0.2 (for a building with 90 mm deep wall frames) and up to R0.4 (for 250 mm thick masonry walls).

Perimeter insulation impact clear

The impact of adding R1.0 perimeter insulation is equally effective for both plain concrete slabs and the waffle pod type, with an increase in R-value of 30–50% (see Table 1).

Without perimeter insulation, only the large slabs (greater than 150 m²) will have R-values more than the R1.9 required for embedded heating flooring. However, by adding perimeter insulation, all but the smallest waffle pod floors will be thermally sufficient.

Under-slab insulation increase R-value

Plain concrete floor slabs with perimeter insulation also have the option of including R1.2 under-slab insulation to increase the R-value further and enable the smaller slabs (30 m²) to achieve R1.9 overall. Those plain slabs with area-to-perimeter ratios above 2.5 (minimum of a 100 m² square slab) will also meet the R1.9 minimum.

The combined effect of perimeter and under-slab insulation is an almost doubling of the R-value, which equates to halving of the heat loss.

Widely used overseas

Perimeter insulation of floor slabs is common practice internationally where products are commercially available. In New Zealand, however, perimeter insulation has been much more ad hoc, with strips of rigid foam insulation material (usually EPS) cut and assembled on site, then covered with a protection material.

One product available in North America is made from a glass-reinforced plastic protection layer bonded to high-density expanded polystyrene. Using a higher-performance but more expensive foam means the overall thickness, and therefore the visual impact, can be reduced.

Products on the horizon

There is at least one perimeter insulation product currently being developed locally. This is designed to be incorporated into the boxing when a waffle pod floor is being poured. The EPS foam has a protective plaster coating preapplied, and the product is installed so it sits flush with the cladding rather than protruding out.

There is also at least one New Zealand-based fully enclosed basin-style fully insulated system. This uses high-density EPS to have a continuous (unbroken) insulation layer between the concrete and the perimeter as well as the underside of the concrete.

A current Building Research Levy-funded project is helping industry to develop perimeter insulation products. The initial results of the research will be available at the end of this winter.