

INFORMATION SHEET

THERMAL



The information provided below has been taken from the New Zealand Timber Design Guide 2007, published by the Timber Industry Federation and edited by Professor A H Buchanan. To purchase a copy of the Timber Design Guide, visit www.nztif.co.nz

The R-value is a measure of the total thermal resistance of a building element to heat flow when the internal and external environments are constant.

DETERMINING R-VALUE

The BRANZ House Insulation Guide provides R-values for a range of timber wall, roof and floor constructions. Methods for determining the R-value of constructions that fall outside the scope of the BRANZ Guide are given in NZS 4214: 2006 *Methods of Determining the Total Thermal Resistance of Parts of Building*.

The simple analytical method in NZS 4214:2006 is based on one-dimensional conduction and determines the R-value, R_T , of walls, roofs and suspended floors by:

$$R_T = R_{se} + R_{sy} + R_{si} \quad (\text{m}^2\text{K/W})$$

where R_{se} and R_{si} are the prescribed thermal resistances of the external and internal surfaces respectively and R_{sy} is the thermal resistance of the construction between the external and internal faces. R_{sy} is determined by summing the resistances of the layers of material perpendicular to the heat flow:

$$R_{sy} = R_1 + R_2 + \dots + R_n \quad (\text{m}^2\text{K/W})$$

where $R_1, R_2 \dots$ is the thermal resistance of each layer.

Conduction is two or three-dimensional at the intersection of building elements (eg. at the wall-floor intersection) and in building elements with thermal bridges (eg. timber frame walls). Treating conduction as one-dimensional may significantly overestimate the R-value of these building elements. While the New Zealand Building Code may allow this, a safer approach (in terms of meeting a building thermal performance target) is to account for multi-dimensional conduction by using a computational or experimental method to determine R-value.

THERMAL CONDUCTIVITY OF WOOD

The thermal resistance of a homogenous layer of timber or composite wood, R , is directly related to its thickness, L (m), and inversely related to its thermal conductivity, k (W/mK).

$$R = \frac{L}{k} \quad (\text{m}^2\text{K/W})$$

The thermal conductivity of timber and composite wood is much less than the conductivity of concrete or steel and two to four times that of common insulating materials. The thermal conductivity of timber and composite wood varies with:

- Density. Conductivity increases approximately 100% with a 100% increase in density.
- Moisture content. Conductivity increases 10-20% with an increase in wood moisture content from 12% to 18%.
- Temperature. The effect of temperature is typically minor, with a 2-4% increase in conductivity for a 10°C rise in temperature.
- Heat flow direction with respect to the grain. Conductivity with heat flow parallel to the grain is 50-200% greater than conductivity with perpendicular heat flow.

The thermal conductivity of Radiata Pine at 12% moisture content varies in literature from 0.10-0.14 W/mK. The value for pine in NZS 4214: 2006 is 0.12 W/mK. NZS 4214: 2006 also provides values for other types of timber and composite wood. Thermal conductivity may be determined experimentally for materials not listed in NZS4214: 2006.