BRANZ FACTS
ROOF VENTILATION #3

Air permeability of common New Zealand ceilings and ceiling penetrations

BRANZ has tested the air permeability of a range of common ceiling types and fixtures. The findings can help address the problem of moisture being transported into airtight roof spaces.

Air permeability of ceiling types

Various ceiling types were installed in a facility designed to measure air permeability. A fan pressurised the room below. Air movement was measured in cubic metres per second per area of ceiling [$m^3/s/m^2$] for sheet material and in cubic metres per second per unit length [$m^3/s/m$] for linear elements such as scotia trimmings or expansion control joints. The results are shown in Table 1.

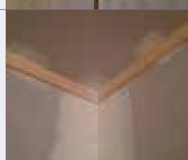
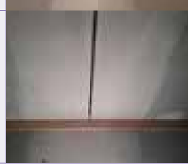
While the data given here is primarily envisaged as input parameters to various hygrothermal numerical simulations, it is nevertheless useful to simply compare different ceiling types and penetrations. Designers should always aim for an airtight ceiling level if there is the risk of condensation in the space above the ceiling.

Acoustic tiles were by far the leakiest type of ceiling. A 10 m^2 ceiling area with a constant pressure difference of 1.2 Pascals across it would result in an airflow of 6.6 litres/second.

The tiles were followed by a tongue and groove timber system and then plywood. Air permeability can vary significantly depending on installation – a gap of just 5 mm between plywood sheets increased the flow coefficient by roughly a factor of 5.

Installing timber scotias to plasterboard instead of square stopping introduces an air leakage path. The timber scotia and the plasterboard control joint have similar leakage properties on a per length basis.

Table 1. Air permeability of different types of ceilings (from SR401 *Airtightness of roof cavities*).

	Ceiling type		Airflow formula	Flow coefficient *c*	Exponent *n*
Airflow per unit installed	Acoustic ceiling tiles - suspended 900 x 1200 mm each		$Q\,[l/(s\,m^2)] = c\,\Delta p^n$	0.56	0.89
	T&G timber ceiling 80 mm width			0.07	0.77
	Plywood tight fit 1200 x 2400 x 12 mm each			0.01	0.81
	Plywood 5 mm gap 1200 x 2400 x 12 mm each			0.05	0.71
Airflow per length of installed product	Scotia on plasterboard		$Q\,[l/(s\,m)] = c\,\Delta p^n$	0.02	0.84
	Plasterboard control joint			0.02	0.88

Notes
1. In the air flow (leakage) formula:
- Q is the volumetric airflow rate
- *c* is the flow coefficient characteristic for the ceiling or fixture [$m^3/(s\,Pa^n)$]
- Δp is the pressure difference across the ceiling (in Pascals)
- *n* is the pressure exponent, describing the nature of the flow (laminar or turbulent).

2. The maximum pressure across the tested ceilings was chosen to be 15–20 Pascals.
3. Typical pressure drops across the ceiling of a dwelling are between 1 and 4 Pascals. Most of the time, the gradient is such that air is moved from the living spaces into the roof space.

Air permeability of ceiling fixtures

Fixtures that penetrate ceilings were tested using a small airtight enclosure. The results are shown in Table 2.

Old-style incandescent downlights allowed by far the largest amount of air leakage into the roof space. At the other end of the scale (with a flow coefficient around a hundred times lower) are the new generation of tightly fitted LED recessed downlights. A traditional roof space access hatch also allowed a significant amount of air to pass to the roof space. Although not tested in this report, more airtight and insulated roof access hatches are commercially available.

More information

Fact sheet 1 *Roof space ventilation in New Zealand houses*

Fact sheet 2 *Testing the airtightness of residential roof spaces in three dwellings*

Fact sheet 4 *Moisture and ventilation in skillion roofs*

Rupp, S., Plagmann, M. & Cox-Smith, I. (2018). *Airtightness of roof cavities*. BRANZ Study Report SR401. Judgeford, New Zealand: BRANZ Ltd.

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Table 2. Air permeability data for different types of ceiling fixtures (from SR401 *Airtightness of roof cavities*).

	Ceiling type		Airflow formula	Flow coefficient *c*	Exponent *n*
Airflow per area of installed product	Classic roof space access hatch		Q [l / s)] = c Δp^n	0.87	0.58
	Downlight, incandescent old style			1.60	0.46
	Downlight, incandescent new style			0.40	0.59
	Downlight, halogen bulb			0.06	0.69
	Downlight, LED tight fit			0.02	0.71

Notes

1. In the air flow (leakage) formula:
   - Q is the volumetric airflow rate (here: litres per second per unit)
   - *c* is the flow coefficient characteristic for the ceiling or fixture $[m^3/(s\,Pa^n)]$
   - Δp is the pressure difference across the ceiling (in Pascals)
   - *n* is the pressure exponent, describing the nature of the flow.