BRANZ

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BULLETIN

EXCESSIVE MOISTURE IN ENCLOSED SUBFLOOR SPACES

February 2016

- This bulletin describes the causes and effects of excessive subfloor moisture in buildings.
- It outlines ways of avoiding and/or detecting the problem and gives potential remedies.
- This bulletin updates and replaces Bulletin 457 *Ventilation of enclosed subfloor spaces*.

1.0 INTRODUCTION

1.0.1 Around 1.2 million New Zealand houses have suspended timber ground floors, and one in 12 new homes are built this way. Insufficient ventilation under the house can lead to high subfloor moisture levels. This, in turn, can lead to problems such as rot, corrosion, borer infestation, loss of insulation performance and reduced durability in building materials. It can also lead to health problems for the occupant from the subsequent dampness, resulting in internal mould and fungi growth.

1.0.2 The New Zealand Building Code and building standards contain specific subfloor ventilation requirements.

1.0.3 BRANZ house condition surveys have regularly found houses with suspended timber floors that do not meet the current requirements for ventilation. Also, subfloors have a consistent moisture source (soils) and, typically, a limited volume, which requires a relatively high ventilation rate to remove moisture.

1.0.4 This bulletin outlines ways to avoid the build-up of moisture levels in subfloor spaces and how to manage the moisture that does occur. It updates and replaces Bulletin 457 *Ventilation of enclosed subfloor spaces*.

2.0 BUILDING CODE AND STANDARDS REQUIREMENTS

2.0.1 New Zealand Building Code clause B2 *Durability* requires that building elements that provide structural stability to a building (including subfloor framing) have a durability of not less than 50 years.

2.0.2 Clause E2 *External moisture* has the objective "to safeguard people from illness or injury that could result from external moisture entering the building".

It has the functional requirement that "buildings must be constructed to provide adequate resistance to penetration by, and the accumulation of, moisture from the outside". Following this are performance requirements that include the following:

- "Walls, floors and structural elements in contact with, or in close proximity to, the ground must not absorb or transmit moisture in quantities that could cause undue dampness, damage to building elements, or both."
- "Building elements susceptible to damage must be protected from the adverse effects of moisture entering the space below suspended floors."

2.0.3 NZS 3602:2003 *Timber and wood-based products for use in building* Table 1C gives requirements for subfloor timbers and interior flooring to achieve 50-year durability. It requires an in-service moisture range of 20% or less for solid timber subfloor framing and 18% or less for LVL framing and interior flooring above suspended ground floors.

2.0.4 NZS 3604:2011 *Timber-framed buildings* requires subfloor ventilation openings over the whole of the subfloor area. The specific requirement is openings at least 3500 mm^2 per m^2 of floor area, evenly spread around the house perimeter. (See 2.1 in this bulletin for guidance should this not be possible.) NZS 3604:2011 also specifies minimum dimensions for clearances between the ground and the framing and flooring.

2.0.5 Acceptable ventilation options given in NZS 3604:2011 include:

- baseboards with 20 mm wide gaps between them (Figure 1)
- regularly spaced ventilators, starting 750 mm from each corner and no more than 1.8 m apart
- a 50 mm gap between the wall plates and a boundary joist at the ends of cantilevered floor joists and the wall plate and joist where the bearer is cantilevered (Figure 2).

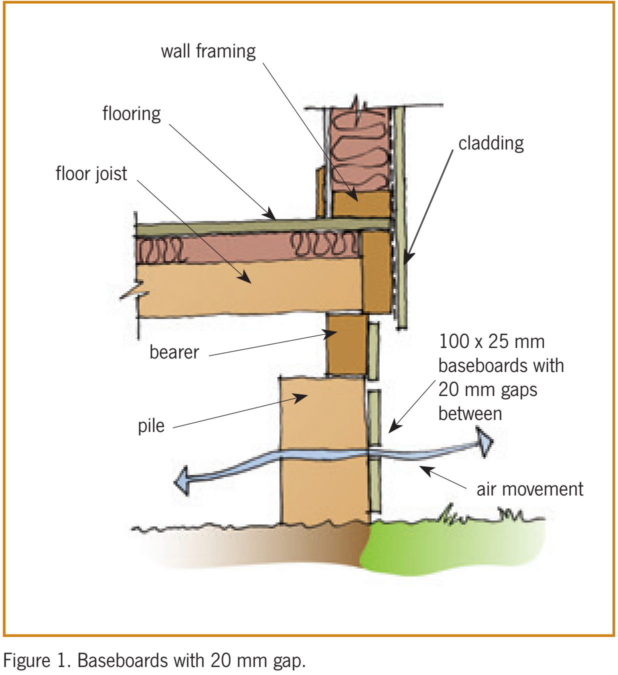

Figure 1. Baseboards with 20 mm gap.

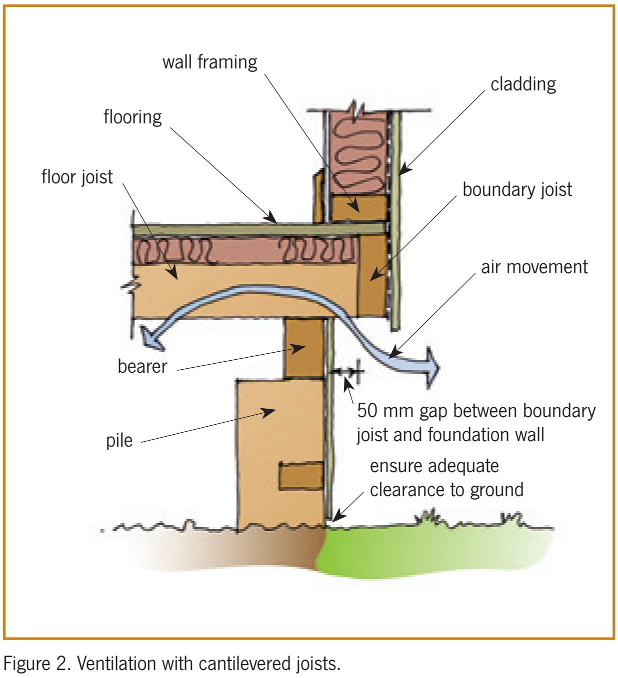

Figure 2. Ventilation with cantilevered joists.

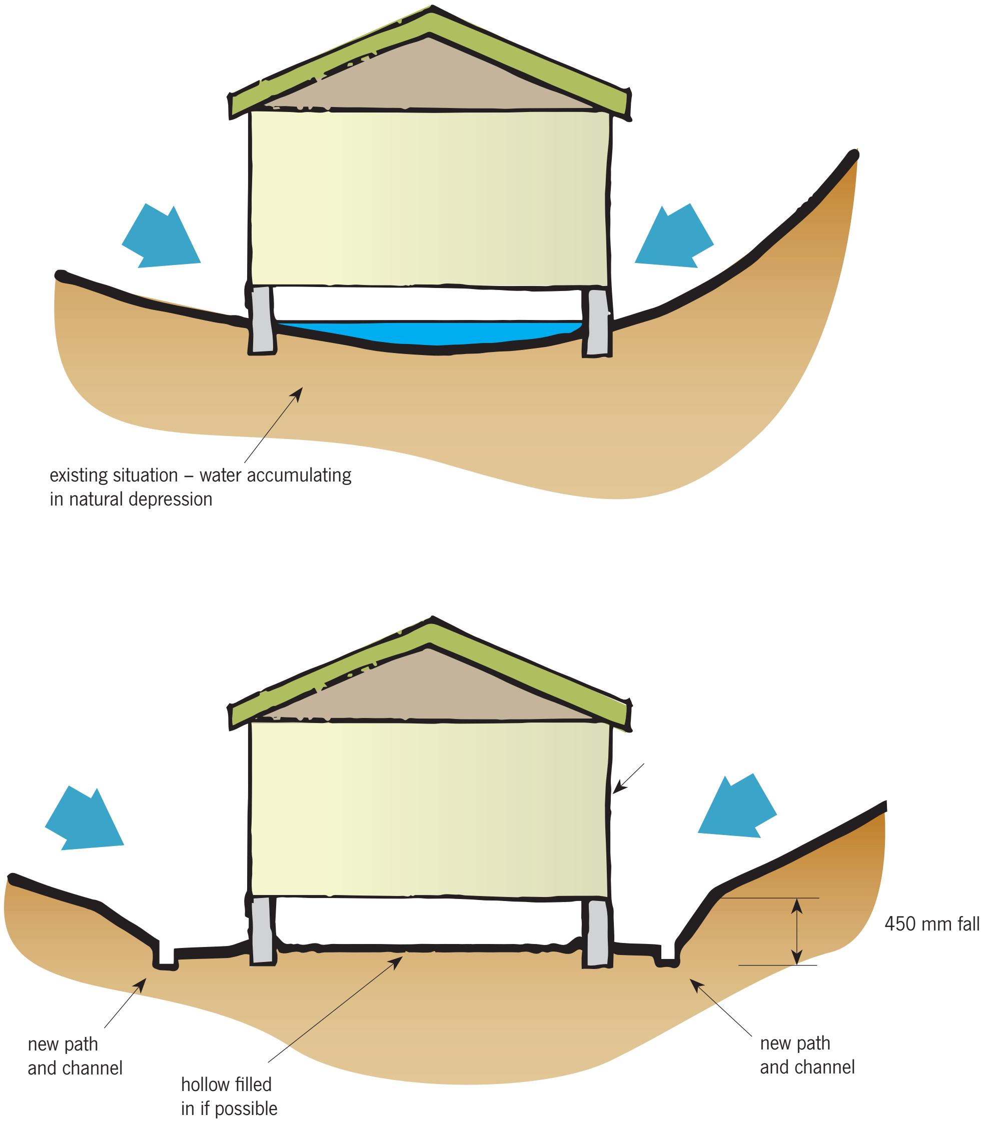

Figure 3. Water must not be allowed to pond under a house. Land or paving immediately around a house should be graded so rainwater runs away from the building. Ensure adequate drainage to a stormwater disposal system.

2.0.6 NZS 3604:2011 also states that water must not be allowed to accumulate in a building's subfloor (Figure 3).

2.0.7 As one means of reducing the risk of water flow under a building, the standard requires a clear horizontal separation of not less than 450 mm between the outside of any wall cladding and any adjacent rising ground, with suitable drainage.

2.1 GROUND COVER

2.1.1 NZS 3604:2011 requires a damp-proof ground cover over the whole subfloor area where:

- ventilation openings of 3500 mm^2/m^2 of floor area are not possible, or
- airflow is obstructed, or
- any part of the space is more than 7.5 m from an opening.

2.1.2 Polythene sheet that is 0.25 mm thick and lapped 75 mm at the joints meets the ground cover requirement of vapour flow resistance of not less than 50 MN s/g. It must be butted against foundation walls and piles and weighed down with bricks or rocks to stay in place. The ground under should be no lower than that outside the building and preferably be shaped so that water drains to the outside and does not allow water to pond on the ground cover.

2.1.3 With the ground cover in place, there must still be ventilation openings, at least 700 mm^2 for each m^2 of floor, located to provide a cross-flow. (Even with a ground cover, aiming for ventilation of 3500 mm^2/m^2 wherever possible is recommended.)

2.1.4 A ground cover should always be installed on wet sites.

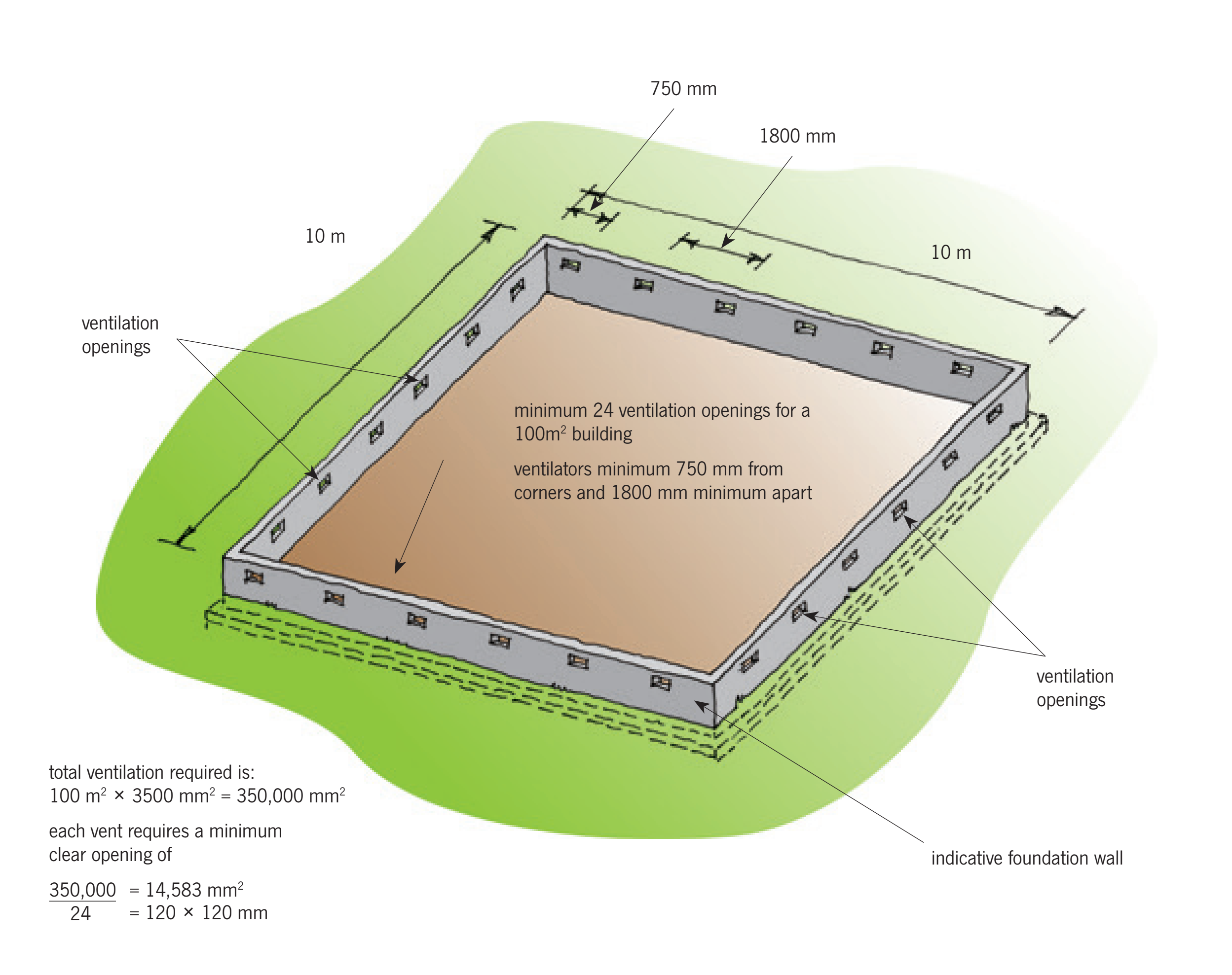

Figure 4. Acceptable ventilation in NZS 3604:2011 *Timber-framed buildings*.

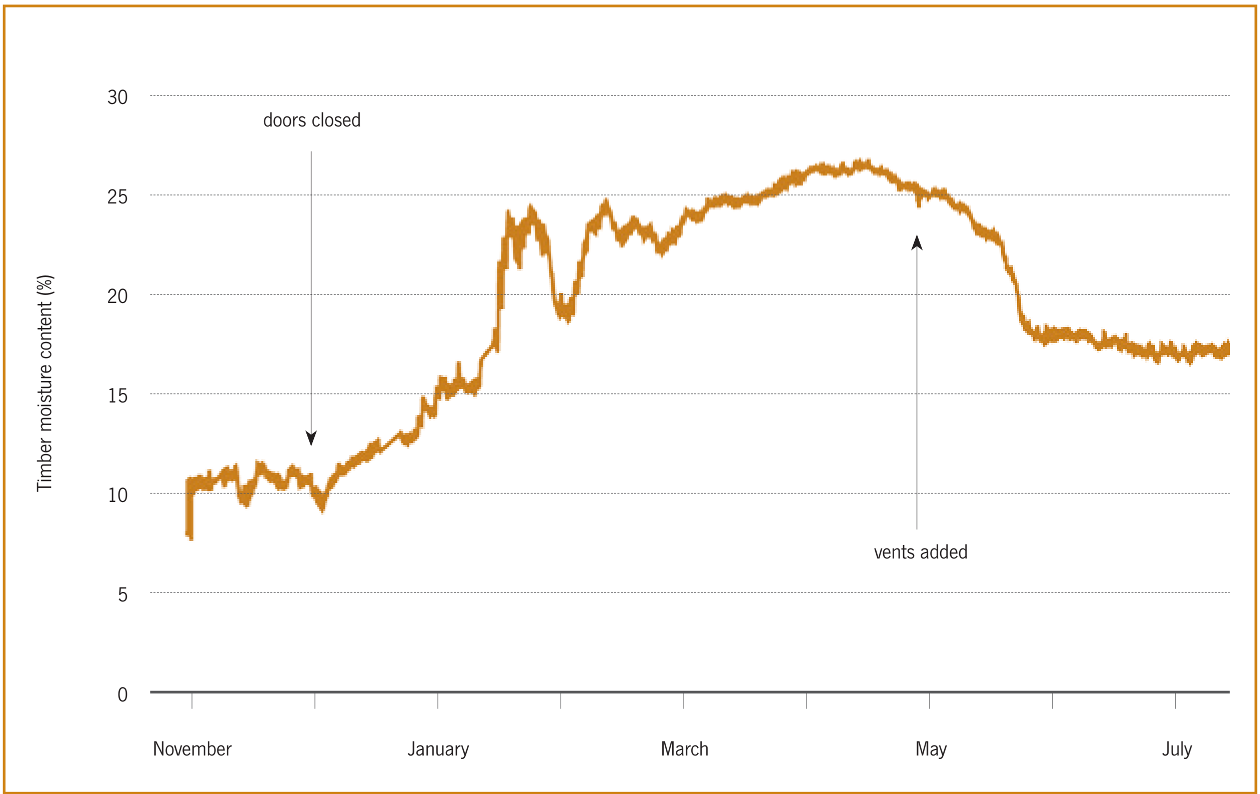

Figure 5. The moisture content of a floor joist on the south side of a BRANZ test house fell after subfloor vents were added.

2.1.5 Under NZS 3602:2003 clause 108.3, a ground cover must be maintained in an effective condition for the life of the building.

3.0 SIZING AND POSITIONING OF VENTS

3.0.1 When selecting air vents, the net opening area – the area through which air can move – is the crucial measurement, not the size of the ventilator itself. For example, a precast concrete vent with a net open area of 3600 mm^2 may measure around 230 × 80 mm – a total area of 18,400 mm^2.

3.0.2 When calculating the amount of ventilation to be provided, the distribution of vents as well as the total amount of opening must be considered. Even if the minimum total ventilation is achieved, if vent positions exceed the maximum permissible centres, extra vents must be added to meet the minimum requirement for spacing (Figure 4).

3.0.3 Baseboards with gaps between are an effective way of providing ventilation. They are often used in buildings that are totally supported on piles.

3.0.4 Ready-made ventilator grilles in pressed metal or plastic or precast concrete are available for different foundation wall materials.

3.0.5 Position vents high in perimeter foundation walls but below the level of joists or bearers to achieve maximum cross-ventilation and avoid still air pockets of damp air forming around timberwork.

3.0.6 A recent BRANZ project provides strong evidence of the effectiveness of ventilation. The moisture content of a floor joist fell significantly and relatively quickly once vents were added to the subfloor of a test house (Figure 5).

4.0 SOURCES OF SUBFLOOR MOISTURE

4.0.1 All ground continuously emits water vapour, even when it appears mostly dry on the surface. On average, 0.4 litres of water can evaporate from 1 m^2 of ground in 24 hours – that is 60 litres per day on average for the ground under a 150 m^2 house.

4.0.2 Some sites have high groundwater or a high water table or springs.

4.0.3 Moisture naturally occurring in the ground beneath a floor may be added to by:
- leaking water pipes or gully traps or defective waste pipes
- downpipe discharge draining under the floor
- leaks from wet areas inside the house
- surface water from surrounding ground flowing under the building
- water wicking up through brick or concrete masonry foundations.

4.0.4 Unless the subfloor is adequately ventilated, air within it and subfloor materials will absorb moisture until they become saturated.

4.0.5 When air temperatures are lower, water will condense from moisture-laden air and will form on cold surfaces. Condensation can be absorbed by material such as timber.

5.0 EFFECTS OF SUBFLOOR MOISTURE

5.0.1 Excess moisture can affect timber by:
- causing it to swell
- supporting fungal growth that can lead to decay of the timber – NZS 3602:2003 notes that any timber framing (treated or untreated) that becomes damp and remains damp will be susceptible to decay
- supporting borer infestation of susceptible timber
- corroding metal fasteners and fixings
- allowing absorption and transmission through the timber into the interior space.

5.0.2 Excess moisture can affect concrete by:
- corroding permanent steel formwork
- corroding embedded reinforcing with inadequate concrete cover
- gradual absorption and transmission through the concrete into the interior space
- supporting fungal growth on concrete surfaces.

5.0.3 Moisture can lead to condensation forming under foil insulation, which can reduce its effectiveness.

5.0.4 Moisture from excessively damp subfloors can penetrate to the interior spaces through gaps in the building construction or by absorption through building materials. This moisture can cause:
- health risks to occupants, especially children, the elderly or sufferers of asthma, allergies and respiratory problems
- odours in poorly ventilated rooms
- high levels of condensation on internal surfaces
- deterioration of particleboard flooring
- deterioration of surface coatings and finishes
- mould growth on internal surfaces
- rotting and swelling of internal timbers
- borer infestation of susceptible internal timber.

5.0.5 For masonry veneer construction (pre-1970s typically) where the veneer cavity is open to both the subfloor and the roof space, subfloor moisture can be carried into the roof space. (This should not be the case in modern construction as this breaches Building Code clause E2.)

6.0 SIGNS OF EXCESSIVE SUBFLOOR MOISTURE

6.0.1 The most common indication of subfloor moisture is a musty smell inside a building. Other signs are:
- cupping of timber strip flooring
- patchy stains under clear floor coatings
- dampness in carpet and under rubber underlay

- blistering of sheet vinyl on floors
- persistent mould growth
- excessive condensation, especially on windows.

6.0.2 Where possible, crawl under the house with a powerful torch to examine the ground, piles, fixings, bearers and joists, vents, water and wastepipes. Try to determine the scale of the problem and potential causes. Look for these signs:
- Leaks.
- Water ponding or flowing under the house from outside.
- Blocked vents.
- Potential damage such as corroded fixings or rotten timber. Check for rot in timber piles or other timber with a screwdriver. Try to push it into the timber – with timber piles, do this just below the ground surface. If the screwdriver easily enters the timber, the timber is rotten.
- If possible, determine whether dampness from the subfloor is getting into rooms through gaps in the flooring or service holes cut in framing.

6.0.3 Excessive dampness under the floor can often be detected by observing:
- soil stains remaining on the surface of the skin after rubbing a sample of subfloor soil between the fingers
- the presence of mould or condensation on subfloor framing, the underside of flooring or insulation
- white fungi growing on soil under the house.

6.0.4 Moisture may be a problem even where the ground appears dry. A BRANZ research project on subfloors used a test house with very little ventilation (Figure 5). The moisture content of a floor joist doubled within 3 months, and heavy condensation formed on the underside of insulation. However, the ground under this was dry to the touch and but was very damp just 50 mm below the dry surface.

7.0 STEPS TO REMEDY EXCESSIVE SUBFLOOR MOISTURE

7.0.1 When excessive levels of subfloor moisture are found or suspected:
- Deal first with any obvious causes of moisture under the house itself, for example, by fixing leaky pipes.
- If water is flowing under the house from outside or ponding under the house, consider the options for modifying the ground surface. The ground immediately around the house should be graded so rainwater runs away from the building. If hard paving around the house is causing run-off under the house, replace it or modify it.
- In some cases, new channels or subsurface drains that discharge to an approved stormwater drain or soakpit may be required, especially if surrounding land slopes down to the house and existing drainage is insufficient.
- Clear ventilators that have become blocked through soil or vegetation build-up outside the house or items stored inappropriately under the house.
- Remove any thick paint or other coating build-up on vents that may be reducing airflow.
- Remove baseboards that do not have sufficient ventilation gaps, and refix with 20 mm spacing between boards.
- Assess whether new vents are required and where they should go:
  - Where there are concrete foundation walls, this may mean drilling through concrete, which is a specialised task. Locate reinforcing before drilling, and ensure holes avoid the reinforcing.
  - Where the foundation wall is sheet lining or weatherboards, installing additional vents is usually straightforward.
  - With weatherboard subfloor claddings, another option is to replace the bottom one or two boards with H3.2 treated baseboards with a 20 mm gap between them and to the lowest cladding board.
- Install a damp-proof ground cover.

7.0.2 If a large amount of material is stored under the house and blocking effective cross-ventilation, another storage location should be found for it.

7.0.3 In the case of many pre-1930 houses, the house itself or some part of it may be very low to the ground, or bearers may even be sitting on the ground. Improving ventilation can be extremely difficult or impossible in such cases. Lifting and repiling the house may be the only effective long-term option.

8.0 MOISTURE ENTRY THROUGH A RETAINING FOUNDATION WALL

8.0.1 Ground moisture may move through a retaining foundation wall into a subfloor space when poorly waterproofed or constructed without drainage behind the wall. If there is a drainage pipe, the pipe or the drainage gravel around it may have become blocked with silt and no longer be working effectively.

8.0.2 The best solution, where possible, is to dig out and expose the basement wall. Flush out the existing drainage pipe or install a new pipe. Place gravel around the pipe and lay a geotextile filter fabric over the gravel. Seal the exposed wall with a damp-proof membrane or specialised coating, carefully following the manufacturer's instructions. Protect the membrane with a sheet material such as polystyrene, then backfill with free-draining granular fill.

8.0.3 Some treatments of leaking basement walls are not always effective. Consult the BRANZ Good Repair Guide *Leaking Basement Walls* for more detailed guidance.

8.0.4 Ordinary paints or coatings are likely to fail in a short time and should not be used under these conditions.

9.0 MORE INFORMATION

Ministry of Business, Innovation and Employment
New Zealand Building Code clauses B2 *Durability* and E2 *External moisture*.

Standards New Zealand
NZS 3602:2003 *Timber and wood-based products for use in building* (as modified by B2/AS1)
NZS 3604:2011 *Timber-framed buildings*

BRANZ
Good Repair Guide *Damp Subfloors*
Good Repair Guide *Dealing with Mould*
Good Repair Guide *Leaking Basement Walls*
Good Repair Guide *Subfloor Timber*

Bulletin 585 *Measuring moisture in timber and concrete*
Bulletin 570 *Ground clearances*
Bulletin 560 *Pile foundations*

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