BRANZ

ISSUE 645 BULLETIN

INSTALLING TIMBER STRIP FLOORING OVER TIMBER JOISTS

December 2019

Concrete floors are the most commonly installed flooring system but there is still a demand for timber strip flooring laid directly over floor joists.

Poorly installed timber strip flooring can result in problems such as cupping, warping, buckling and squeaking of boards. The main causes of problems are installing flooring before the building is fully enclosed, high moisture levels, boards of insufficient thickness and joists too far apart.

This bulletin describes the requirements for installing timber strip flooring over timber suspended floor framing and outlines finishing options and maintenance requirements. This bulletin replaces Bulletin 390 *Laying timber strip flooring over timber joists.*

1 INTRODUCTION

1.0.1 In the past, timber floorboards installed over timber subfloor framing was the main option for flooring. Despite a wide range of other flooring options now being available, timber strip flooring is still a popular choice in both domestic and commercial situations.

1.0.2 Timber strip flooring is now more commonly installed over a concrete slab, but the traditional method of fixing floorboards over timber joists remains in use. A particular benefit is the level of resilience it gives to floors in spaces such as gymnasiums, squash courts and dance floors that cannot be achieved when timber flooring is laid over a concrete slab.

1.0.3 Despite the benefits, timber floors can have problems such as cupping, buckling and boards lifting if:

- the flooring is laid before the building is fully weathertight
- the moisture content for the flooring timber or the floor joists or both is incompatible at the time of laying
- the subfloor is damp.

1.0.4 To achieve a timber floor that is well laid with tight joints between boards, a range of factors must be considered including:

- expected in-service moisture content of the flooring and subfloor framing
- internal building temperatures and relative humidities
- timber species
- board size and span
- method of fixing
- applied coating system.

1.0.5 This bulletin describes the recommendations for installing, finishing and maintaining a solid timber floor laid over timber subfloor framing. It replaces Bulletin 390 *Laying timber strip flooring over timber joists*.

2 SUBFLOOR FRAMING

2.0.1 Clause 2.1.7 of NZS 3602:2003 *Timber and wood-based products for use in building* requires that all subfloor framing protected from the weather but exposed to ground atmosphere (joists, subfloor braces, bearers, wall plates and blocking) must have a moisture content of 20% or less before attaching any finishing timbers. NZS 3602:2003 Table 4 sets out allowable moisture content levels for timber flooring at the time of installation (see section 3.2 below).

2.0.2 Subfloor framing must be designed in accordance with NZS 3604:2011 *Timber-framed buildings*, which sets out maximum permitted sizes and spans for bearers and joists.

2.1 VENTILATION

2.1.1 Ventilation must be provided to the subfloor space to prevent dampness in accordance with NZS 3604:2011 (3500 mm^2 of ventilation for every square metre of floor area).

2.1.2 Where adequate ventilation cannot be provided or subfloor ground conditions are damp, a damp-proof ground cover should be laid over the whole subfloor area to restrict moisture moving from the ground to the underside of the flooring. A 0.25 mm thick polythene sheet lapped 75 mm at joints and held in place by rocks or bricks will meet NZS 3604:2011 requirements. It should be installed to avoid ponding of water and sloped to drain any water to the exterior of the building (Figure 1).

2.1.3 A minimum ventilation of 3500 mm^2 net open area for every square metre of floor area must also be provided to give cross-flow underfloor ventilation. Note that, where 3500 mm^2 per square metre cannot be provided, a minimum of 700 mm^2 per square metre can be used in conjunction with a damp-proof ground cover and ventilation as per the requirements of NZS 3604:2011 clause 6.14.3.

2.2 UNDERFLOOR INSULATION

2.2.1 Under New Zealand Building Code clause *H1 Energy efficiency*, buildings must be constructed to provide adequate energy efficiency. Acceptable Solution H1/AS1 references NZS 4218:2009 *Thermal insulation – Housing*

Figure 1. Damp-proof ground cover.

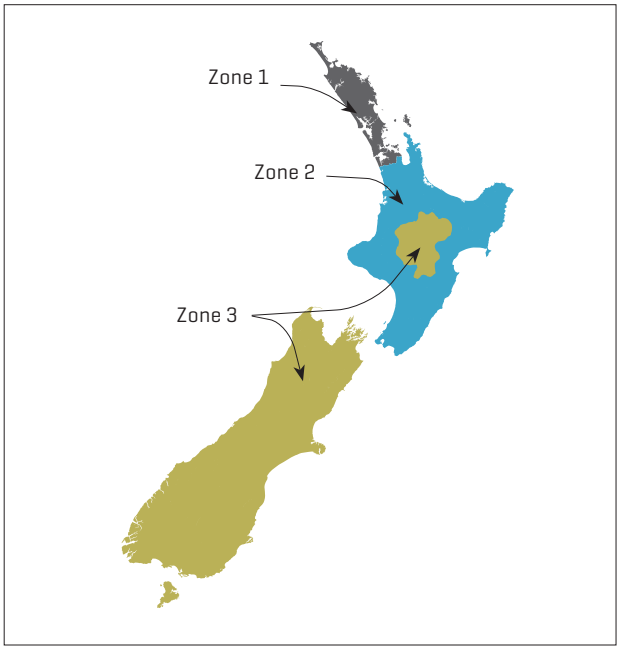

Figure 2. New Zealand climate zones.

and small buildings, which includes three methods of demonstrating compliance – the schedule method, the calculation method and the modelling method.

2.2.2 Under the schedule method, climate zones 1, 2 and 3 all require a minimum construction R-value of R1.3 for underfloor insulation (Figure 2). Where the floor is heated, the minimum R-value is required to be R1.9. For both the calculation and modelling methods, the minimum R-values for underfloor insulation must be calculated.

2.2.3 When installing underfloor insulation under a suspended timber floor, options include:

- bulk insulation – glass wool (fibreglass), sheep's wool, polyester or wool/polyester blends
- polystyrene.

2.2.4 Bulk insulation is supplied as blankets or rolls that are installed between floor joists. Polystyrene is supplied as a rigid board insulation that must be fitted snuggly between floor joists. All underfloor insulation must be fitted directly to the underside of the flooring.

3 TIMBER FLOORING

3.1 TIMBER SPECIES

3.1.1 Timber selected for flooring should be stable and hardwearing. Suitable species include matai, rimu, tawa, silver beech, red beech, hard beech, American and European oak, American white maple, kwila, merbau, cypress, jarrah, Tasmanian oak, blackbutt, spotted gum and other eucalyptus species.

3.2 MOISTURE CONTENT OF FLOORING

3.2.1 One of the main properties of timber is that it is hygroscopic – it absorbs and releases moisture in response to changes in the humidity of the air. The timber swells as moisture is absorbed and shrinks again as moisture is released.

3.2.2 NZS 3602:2003 Table 4 sets out allowable moisture content levels for timber flooring at the time of installation. For flooring exposed to ground atmosphere at the time of installation, the allowable moisture contents are:

- for air-conditioned or centrally heated buildings – 10–14%
- for intermittently heated buildings – 12–16%
- for unheated buildings – 14–18%.

3.2.3 Where the flooring is not exposed to the ground such as on upper floor levels, Table 4 requires the moisture content levels at the time of installation to be:

- for air-conditioned or centrally heated buildings – 8–12%
- for intermittently heated buildings – 10–14%
- for unheated buildings – 12–16%.

3.2.4 Timber for flooring is most commonly supplied kiln dried and supplied at a moisture content of 9–14%. Species such as oak and maple manufactured in the USA and imported are often near or a little below the lower end of this range.

3.3 TIMBER FLOORBOARDS

3.3.1 Timber strip flooring generally consists of tongue and groove boards 13–21 mm thick and 65–150 mm wide. (Note that NZS 3604:2011 provides requirements for boards up to 100 mm in width). Boards installed over timber subfloor framing are typically a minimum of 19 mm thick and may be either a standard profile (face nailed) or secret nail profile (face nailed or secretly fixed) (Figure 3).

3.3.2 With flooring, we refer to the exposed width as the cover width and also to the tongue thickness and groove width (Figure 4).

3.3.3 Note that narrower boards (65–85 mm wide)

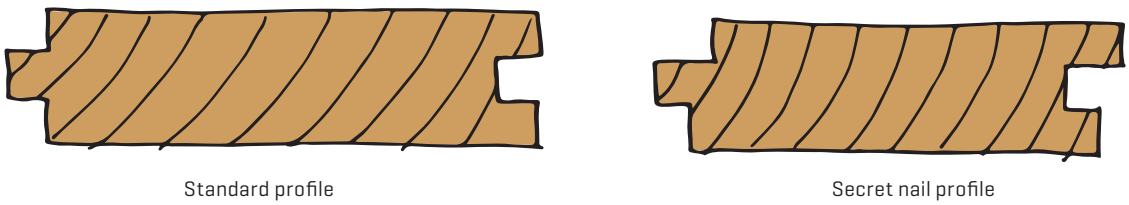

Figure 3. Standard and secret nail profile.

allow movement to be distributed over a greater number of joints and can improve floor stability. The cutting pattern also influences board stability. Quartersawn boards (grain at right angles to the face of the board – only available in some species) experience less in-service movement.

3.3.4 The tongues and grooves must be accurately machined to provide a firm fit. Tongues and grooves that are too loose can result in a floor that squeaks and can cause coating delamination at board edges. Grooves are profiled to be slightly wider than the tongue thickness for easier fitting. The underside of the boards will also be grooved.

3.3.5 Where the flooring is to be butt joined over joists, ends are cut clean and square (Figures 5 and 6). Flooring with an end-matched joint (tongue and groove ends) allows boards to be joined between joists.

3.3.6 Note that past practices allowed joints to be splayed, allowing each nail to provide fixing to both boards (Figure 7). Some floors may also have had undercut joints (Figure 8).

3.3.7 NZS 3604:2011 provides minimum thicknesses and maximum spans for floorboards of various timber species (Table 1).

3.4 CONDITIONING (OR ACCLIMATISING) TIMBER FLOORING

3.4.1 When a timber floor is laid, it is beneficial that the average moisture content of the flooring is within a few percent of the expected in-service moisture content to reduce the amount of swelling or shrinkage after installation.

3.4.2 Equilibrium moisture content relates to humidity and temperature – for example, at 65% relative humidity and 20°C, timber will approach 12.0% moisture content.

3.4.3 If the flooring moisture content is significantly lower than the expected average in-service moisture content it will attain, the timber needs to be acclimatised before laying or additional expansion allowed for. If the internal environment is to remain very dry (such as in a controlled environment), acclimatisation may be used to lower board moisture content, shrinking the boards prior to laying.

3.4.4 Acclimatisation is achieved by storing the timber in the space where it is to be installed prior to installation and monitoring the moisture content and cover width of the boards. The timber flooring should be stored stacked and filleted to enable air to circulate around the timber. It may take 3–14 days for the timber flooring to adjust. Note that putting timber to acclimatise on a site that is still being built may not achieve the required in-service moisture content as the site may be too damp from construction moisture.

3.4.5 With flooring supplied at a lower moisture content than the expected in-service moisture content, monitoring should indicate an increase in moisture content and cover width of the boards. The opposite applies to flooring at a higher moisture content.

4 INSTALLING TIMBER STRIP FLOORING

4.0.1 Before installing timber strip flooring, ensure that:

- the building is completely weathertight
- the ground beneath the building does not allow water to accumulate (NZS 3604:2011 clause 3.6)
- polythene has been installed over the ground below the floor if required

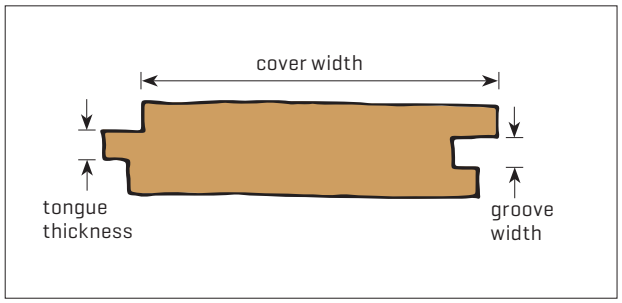

Figure 4. Board terminology.

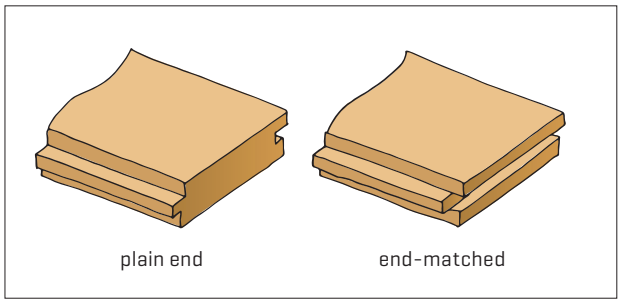

Figure 5. Plain end and end-matched flooring.

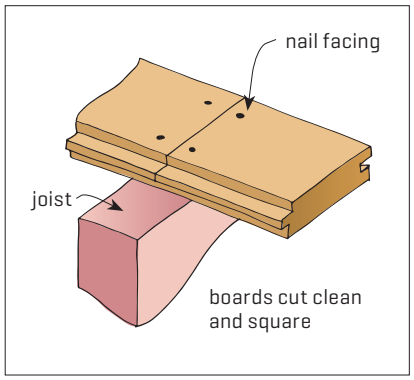

Figure 6. Current practice – boards cut clean and square.

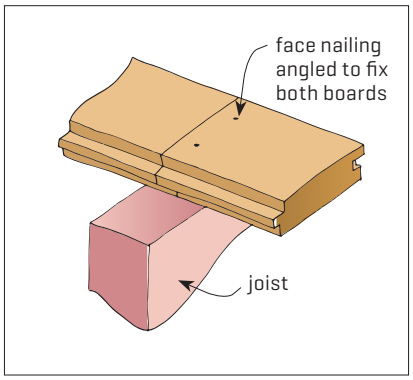

Figure 7. Splayed end joint.

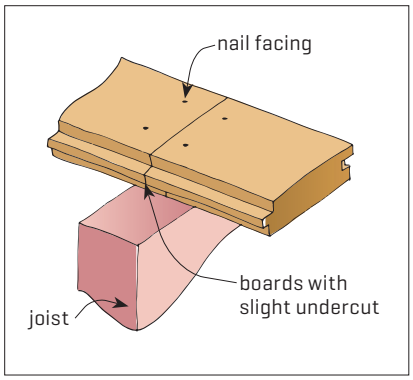

Figure 8. Undercut plain end joint.

- the moisture contents of the subfloor framing and the flooring are at the required level – note that subfloor framing in existing buildings is often a few percent higher than what the floor will be and may be used as a guide to the expected in-service moisture content of the flooring
- the upper surfaces of the floor joists are level and joist spacing is appropriate for the thickness of the boards (see Table 1).

4.0.2 NZS 3604:2011 requirements for timber strip flooring:
- Sufficient room (6–10 mm) is left around the exterior edge of the flooring to allow for movement from moisture content changes.
- Flooring must be laid in straight, parallel lines at right angles to joists, with tongues fitted into grooves and cramped tightly together.
- Where not end-matched, boards are cut square and end joints tightly butted together over joists and with end joints in adjacent boards staggered (Figure 9).
- Where end-matched, end joints are tightly butted together but need not be over joists provided each unjointed length is supported by two or more joists and there are two or more unjointed adjacent boards between end-jointed boards.
- When fixed through the face of the board to each joist, nails are punched to facilitate stopping and sanding.
- When secretly fixed, the fixing is skew driven through the tongue and seated to ensure board edges fit tightly.

4.0.3 The layout of the space generally determines the laying sequence. Laying may start in the middle of a room with boards laid consecutively to the outside walls, or laying may begin on one side of the space with boards laid consecutively across the floor area. An 8–10 mm gap, which will be covered by skirting, should be allowed around the perimeter and to vertical surfaces of the floor to accommodate movement (swelling and shrinkage).

4.0.4 Boards need to be fitted around loadbearing partitions but may be laid under non-loadbearing partitions that are installed after the flooring.

4.0.5 When installing the floor:
- before laying, check that boards are straight and parallel and free of damage
- handle boards carefully to prevent damage to the tongues and grooves and to edges – long boards should be brought into the space with the tongues and grooves positioned the correct way for laying the floor
- flooring offcuts may be used to protect the edge of the boards from damage when tightening and cramping.

4.0.6 If the floor area is more than 6 m in either direction, movement control joints should be incorporated. These are formed by leaving a larger (10–12 mm) joint and filling with cork or a sealant appropriate for use with the timber, or smaller joints may be incorporated at closer spacings. A combination of larger and smaller joints can provide movement control over a large floor area.

4.1 FIXING OPTIONS

4.1.1 Floorboards should be fixed in accordance with the nailing schedule in NZS 3604:2011 Table 7.5. The two options are face nailing and secret nailing. An adhesive is recommended in conjunction with double nailing.

4.1.2 Using adhesive:
- Use a polyurethane or polymer timber flooring adhesive.
- Apply adhesive in accordance with the manufacturer's instructions for application temperatures and open times.
- Ensure the adhesive meets the 15-year durability requirement of the Building Code.
- Apply a 6–10 mm bead of adhesive to the joists.
- Press the flooring firmly into the adhesive to make the glue bond to both the timber and the joist.
- Contact must be made before the adhesive has begun to go off or skin over. Any adhesive that has begun to cure must be removed and replaced.

4.1.3 Face nailing for board widths up to 100 mm:
- Cramp a maximum of six boards at a time using floor cramps.
- Do not fix the board immediately adjacent to the cramps to enable the tongues of the next group of boards to be easily fitted.
- Keep the floor weighted while fixing to allow the boards to be nailed tightly onto the joist.
- Use one nail fixed 10–15 mm from the tongue edge of the board at each joist for boards 75 mm or narrower and two nails per board for boards wider than 75 mm (Figure 10).

Table 1. Spans for timber board flooring from NZS 3604:2011.

Maximum joist spacing (mm)	Minimum thickness (mm)[1]	
	red beech, silver beech, rimu, matai, radiata pine, Douglas fir, larch[2]	karri, blackbutt, tawa, hard beech, jarrah, tallowwood eucalyptus[2]
400	16[3]	16[3]
450	19	16[3]
600	22	19

Notes:

(1) Flooring timbers thinner than the figures given must be fully supported by the subfloor (e.g. plywood or particleboard).

(2) Timbers other than those provided in the table may be used. With timbers below a published density of 720 kg/m^3, the first column is applicable.

(3) Some timber suppliers recommend a minimum thickness of 19 mm rather than 16 mm allowed by NZS 3604:2011. Imported timbers often have a nominal thickness of 19 mm.

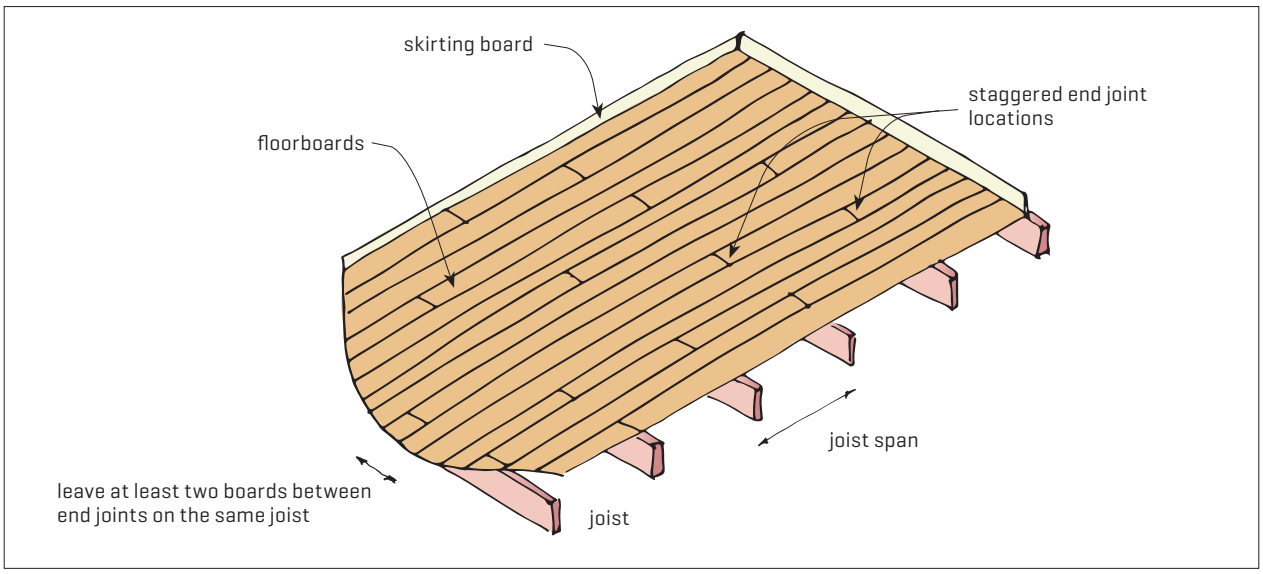

Figure 9. Staggered end joints over joists.

- If hand fixing, use annular-grooved jolthead nails with length of 2.5 times the finished board thickness.
- Nail in straight lines.
- When the whole floor has been laid, punch nails 3 mm below the timber surface in preparation for filling and sanding.

4.1.4 Secret nailing for board widths 85 mm or narrower:

- Fit each board individually.
- Fix boards with a 50 mm long staple or cleat through the top of each tongue or predrill nail holes to prevent tongues from splitting.
- Skew nail the board through the top of the tongue once it is tightly fitted (Figure 10).
- Cramp each board individually as necessary.
- Ensure boards are tight to the joist.

4.1.5 Secret nailing for wider boards (up to 128–130 mm maximum):

- as for 4.1.4 above, but nail off at 400 mm centres maximum and apply adhesive full width across the board at each joist.

4.1.6 Protect the flooring (if necessary) from damage. Softboard sheets or similar may be laid over the floor to protect it from foot traffic before and after sanding and coating.

5 FLOOR FINISHES, CLEANING AND MAINTENANCE

5.1 FLOOR FINISHES

5.1.1 Timber flooring is susceptible to moisture penetration at the end grains and joints so they must be sealed with a waterproof coating, especially when used in areas exposed to watersplash.

5.1.2 Once a face-nailed floor has been installed, fill nail holes and sand the timber, ensuring that joints are level and machine marks are removed.

5.1.3 Finishing options for timber floorboards include applying:

- polyurethane (solventborne or waterborne)
- an oil-modified urethane
- a penetrating oil or hard wax.

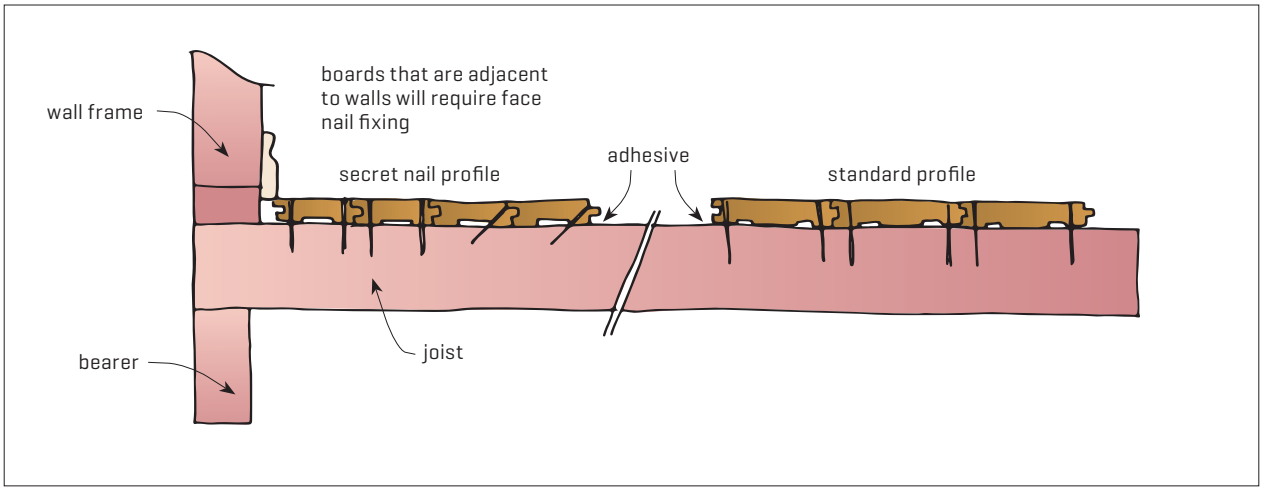

Figure 10. Face nailing and secret fixing.

5.1.4 Polyurethanes may be moisture cure solventborne or evaporative cure waterborne. They provide a hardwearing, water-resistant and easy-to-clean finish. Solventborne polyurethanes are highly durable but are also high in volatile organic compounds (VOCs) with significant odour until cured. Timber that has been coated with polyurethane, particularly if it is solventborne, tends to darken over time when exposed to UV light. Waterborne polyurethane is less affected by light, although a bleached appearance can occur in direct sunlight. They can be less hardwearing and the coating is more permeable to moisture, requiring spills to be attended to more quickly. Solventborne polyurethane can provide a very hardwearing higher-gloss finish.

5.1.5 Oil-modified urethane consists of a mixture of oil and urethane. It may be either solventborne or waterborne. Both are high in VOCs, reasonably hardwearing and will darken with exposure to light.

5.1.6 Oils soak into the timber, and hard wax oils can be buffed to a sheen. They require a specific and regular maintenance regime that periodically adds oil back into the floor as part of the cleaning process. Some can be susceptible to spillage damage. They are much lower in VOCs than oil-modified urethane or polyurethane finishes. They are also much easier to repair than a polyurethane-coated floor.

5.2 CLEANING, MAINTENANCE AND PROTECTION

5.2.1 Timber flooring should be cleaned by soft-bristle vacuuming (ensure brushes are not worn) or using a microfibre mop. Marks and spills should be cleaned as quickly as possible as the length of time a substance is on a floor can affect the degree of possible damage.

5.2.2 Use water sparingly to clean as moisture may cause swelling and discolouration at the joints between boards.

5.2.3 Avoid using harsh cleaning products such as detergents, scouring cleaners, steam mops and waxes and polishes. Follow the coating manufacturer's recommendations. Generally, neutral pH cleaning products should be used.

5.2.4 Solar heat gain through north-facing windows or internal heat build-up can affect the in-service moisture content of a timber floor, particularly in an intermittently heated building. Areas of floor near glass doors or large windows should be protected by screening or tinted windows to reduce shrinkage effects and bleaching effects with some coatings.

5.2.5 To repair damage to a polyurethane or oil-modified urethane timber floor, most floors will require resanding to remove scratches and marks. As the floor colour will change with time, the whole floor may need to be sanded and recoated.

5.2.6 Worn coatings can be rejuvenated through cutting back and recoating but only if the coating has not worn through to bare timber. In newly coated floors, a patch repair to individual boards may be possible. Floors with hard wax oil can be repaired much more easily as the oil and wax can be buffed back in.

5.2.7 To protect timber floors:

- use door mats on both sides of exterior doors
- remove sand or other abrasive materials as soon as possible
- fit the feet of furniture with felt pads or use rubber or cork coasters or cups
- place furniture legs or castors on pads or cups to distribute the weight.

6 FURTHER READING

NEW ZEALAND STANDARDS

- NZS 3602:2003 *Timber and wood-based products for use in building*
- NZS 3604:2011 *Timber-framed buildings*
- NZS 3617:1979 *Specification for profiles of weatherboards, fascia boards, and flooring*
- NZS 4218:2009 *Thermal insulation – Housing and small buildings*

BRANZ BULLETINS

- BU585 *Measuring moisture in timber and concrete*
- BU587 *Dealing with construction moisture in new buildings*
- BU594 *Excessive moisture in enclosed subfloor spaces*

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