

ISSUE 626 **BULLETIN**



SLIP RESISTANCE OF FLOORS

August 2018

- Falls on slippery floors claim the lives of several New Zealanders every year, and many more suffer non-fatal injuries from slipping or skidding.
- Under Building Code clause D1 *Access routes*, defined access routes, floors and paths must have sufficient friction to minimise the risk of people slipping and being injured.
- This bulletin covers how to ensure floors are slip resistant. It updates and replaces Bulletin 370 of the same name.

1 INTRODUCTION

1.0.1 On average, falls on slippery floors claimed the lives of 35 New Zealanders every year between 2012 and 2016, with 44 fatalities in 2016. Over this period, more than 150,000 people each year suffered non-fatal injuries from slipping or skidding, with more than half of the injuries occurring in the home. In 2016, ACC paid over \$230,000 for slipping and skidding injury claims.

1.0.2 These figures highlight the need to specify, at design stage, floor surfaces with sufficient slip resistance under normal use to allow occupants to move about the building safely. This is equally important for domestic buildings and for public buildings.

1.0.3 This bulletin looks at:

- the limited statutory slip resistance requirements for floors and other walking surfaces
- the issues that should be considered to ensure floors are slip resistant.

1.0.4 This bulletin updates and replaces Bulletin 370 of the same name.

2 BUILDING CODE REQUIREMENTS

2.0.1 Slip resistance of floors must meet the performance criteria of New Zealand Building Code clause D1 *Access routes* for access routes and stairs. There is no statutory requirement for providing slip-resistant surfaces to other floor areas.

2.0.2 The performance requirement D1.3.3[d] states that access routes and stairs shall have adequate slip-resistant walking surfaces under all conditions of normal use.

2.0.3 An access route is defined in Acceptable Solution D1/AS1 as “a continuous or direct route that permits people and goods to move between the apron or construction edge of the building to spaces within a building, and between spaces within a building”. For a dwelling, this means the direct route from the street to the primary entry point into the building – typically, the front door.

2.0.4 The means of compliance to meet the slip resistance requirements of clause D1 are contained in:

- D1/AS1 section 2.1 and Table 2
- AS 4586-2013 *Slip resistance classification of new pedestrian surface materials*, which is cited in D1/AS1.

2.0.5 D1/AS1 paragraph 2.1.2 states that, for level access routes, walking surfaces must have:

- a slip resistance value [SRV] of not less than 39 in accordance with AS 4586-2013, or
- use the materials listed in D1/AS1 Table 2 as ‘acceptable wet slip’.

2.0.6 There are some exceptions to this:

- Where safety matting is provided at an entrance [D1/AS1 paragraph 2.1.6b].
- For housing, except the path to the main entrance and stairs, which must meet slip resistance requirements. [Note that secondary approaches and internal access routes for housing are not required by D1/AS1 to meet acceptable wet slip resistance criteria.]
- Areas that are primarily used barefoot such as around swimming pools or in communal shower areas using slip resistance data derived from the ramp test method. Selection of finishes that provide a degree of slip resistance while not harsh on feet is considered prudent.



A mat provides slip resistance for tiles in wet conditions.

2.0.7 For sloping access routes, including stairs and landings, the SRV must be 39 or greater depending on the slope of the surface. D1/AS1 Table 2 lists surfaces that are acceptable for stairs as well as for a range of sloping surfaces. Note that:

- D1/AS1 paragraphs 3.1.4 and 4.1.4 reference Table 2 for ramps and stair surfaces but also permit testing to AS 4586-2013 Appendix A or B
- note 3 to D1/AS 1 Table 2 provides for stair materials to be tested to AS 4586-2013 on the basis of a 1:10 slope.

2.1 HYGIENIC AND WET FLOOR SURFACES

2.1.1 Building Code clauses E3 *Internal moisture* and G3 *Food preparation and prevention of contamination* both require floor surfaces in wet areas and food preparation areas to be impervious and easily cleaned. Although there is no statutory requirement for slip resistance in these areas [apart from access routes having adequate slip resistance under all conditions of use], providing a degree of slip resistance is considered prudent.

2.1.2 The requirement to provide smooth, easy-to-clean floors, which present a greater slip hazard, must be balanced with providing [for safety] sufficient slip resistance while meeting the hygiene and cleaning requirements. Generally, the more slip resistant a floor is, the harder it will be to keep clean.

2.1.3 Acceptable Solution G3/AS1 lists acceptable hygienic flooring materials including:

- PVC sheet lining
- ceramic tiles [6% maximum water absorption] with waterproofed grouted joints
- concrete with a steel-trowelled finish.

2.2 BUILDING CONSENT REQUIREMENTS

2.2.1 For areas where slip resistance is mandatory, building consent documents must clearly identify:

- the floor finishes/materials being installed
- the slip resistance of that finish/material.

3 DEFINING SLIP RESISTANCE

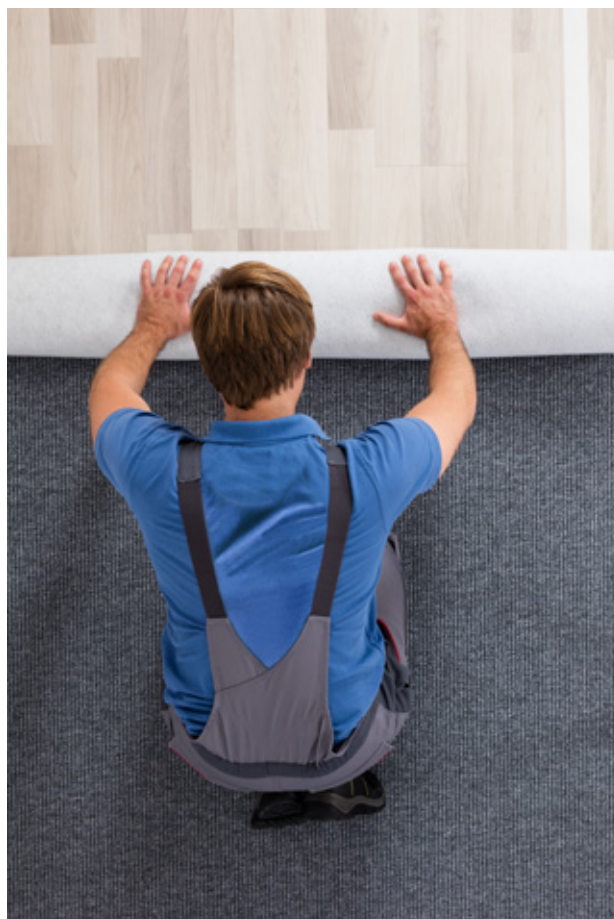
3.0.1 Slip resistance is provided by surfaces that are walked on, such as floors and paths, having sufficient friction to minimise the risk of slipping. The amount of friction a walking surface has is defined as slip resistance.

3.0.2 A dry floor surface will generally provide better slip resistance than a wet floor. For surfaces that are highly polished, even in dry conditions, the slip resistance may not be enough to provide a safe walking surface.

4 MEASURING SLIP RESISTANCE

4.0.1 Slip resistance is expressed as a slip resistance value [SRV] in accordance with AS 4586-2013.

4.0.2 The minimum SRV permitted in accordance with AS 4586-2013 for a level surface is 39. This is deemed equivalent to a slip resistance of not less than 0.4 when tested under AS/NZS 3661.1:1993 *Slip resistance of pedestrian surfaces – Requirements*. [Although now superseded, this standard remains referenced in D1/AS1.]



Carpet provides good slip resistance in all conditions.

4.1 ACCEPTABLE SLIP-RESISTANT SURFACES

4.1.1 Acceptable Solution D1/AS1 gives different slip resistance solutions depending on location and whether the surface is level or sloped, wet or dry.

4.1.2 Level access routes that are likely to become wet must:

- have a minimum SRV classification of 39 from AS 4586-2013 Appendix A, or
- be a material listed in Acceptable Solution D1/AS1 Table 2.

4.1.3 Level access routes expected to remain dry under normal use must have:

- a minimum coefficient of friction of 0.4 in accordance with the friction test method of AS 4586-2013 Appendix B, or
- be selected from D1/AS1 Table 2.

4.1.4 The slip resistance of industrial and commercial floors that may become contaminated with oil or other slip-inducing spills may be determined from AS 4586-2013 Appendix D. Where processing activities require floors to be profiled or at different levels, the evaluation method given in AS 4586-2013 Appendix E can be used to measure the displacement areas.

4.1.5 Stairs and sloping access routes must have slip resistance determined from either:

- D1/AS1 Table 2, or
- AS 4586-2013 Appendix F.

5 ACCEPTABLE SLIP-RESISTANT MATERIALS

5.0.1 Table 1 [reproduced from D1/AS1 Table 2] sets out acceptable slip-resistant materials for a wide range of floor surfaces and finishes for both dry and wet slip resistance.

Table 1. Acceptable slip-resistant materials.

Amend 6
Jan 2017

Table 2: Slip Resistance for Walking Surfaces				
Walking surface ⁽¹²⁾	Level surface ⁽¹⁾		Sloping surface ⁽²⁾ or stairs ⁽³⁾	
	Acceptable dry slip resistance	Acceptable wet slip resistance	Acceptable dry slip resistance	Acceptable wet slip resistance
Timber				
Uncoated smooth	Yes	No	No	No
Uncoated profiled ⁽⁴⁾				
– across profile	Yes	Yes	Yes	Test
– along profile	Yes	No	No	No
Coated (paint, polyurethane, etc)	Yes	No	No	No
Coated and sand/grit impregnated ⁽⁵⁾	Yes	Yes	Yes	Yes
Portland cement concrete				
Smooth trowelled finish (Class U3) ⁽⁶⁾	Yes	No	Yes	No
Broomed (Class 5 or 6) ⁽⁶⁾ or wood float finish (Class U2)	Yes	Yes	Yes	Yes
Coated (paint, polyurethane, etc)	Yes	No	No	No
Coated and sand/grit impregnated ⁽⁵⁾	Yes	Yes	Yes	Yes
Exposed aggregate finish				
– rounded aggregate	Yes	Test	Yes	Test
– crushed aggregate	Yes	Yes	Yes	Yes
Asphaltic concrete				
	Yes	Yes	Yes	Yes
Marble and granite				
Polished surface ⁽⁷⁾	Yes	No	No	No
Honed finish ⁽⁸⁾	Yes	Test	Yes	Test
Flamed finish	Yes	Yes	Yes	Yes
Fully sandblasted surface ⁽⁸⁾	Yes	Test	Yes	Test
Patterned sandblasted surface	Yes	Test ⁽⁹⁾	Yes	Test ⁽⁹⁾
Split slate				
	Yes	Test	Yes	Test
Terrazzo				
Polished	Yes	Test	No	No
Honed	Yes	Test	Yes	Test
Sandstone				
	Yes	Yes	Yes	Test
Ceramic tiles				
Unglazed				
– smooth finish	Yes	Test	Yes	Test
– profiled	Yes	Test ⁽⁹⁾	Yes	Test ⁽⁹⁾
– grit finish	Yes	Test ⁽¹⁰⁾	Yes	Test ⁽¹⁰⁾
Glazed				
– smooth or polished finish ⁽⁷⁾	Yes	No	No	No
– profiled	Yes	Test ⁽⁹⁾	Yes	Test ⁽⁹⁾
– grit finish	Yes	Test ⁽¹⁰⁾	Yes	Test ⁽¹⁰⁾
Clay pavers				
Wire cut	Yes	Yes	Yes	Test
Smooth texture	Yes	Test	Yes	Test

Amend 6
Jan 2017

Table 2: Slip Resistance for Walking Surfaces (cont'd)

Walking surface ⁽¹²⁾	Level surface ⁽¹⁾		Sloping surface ⁽²⁾ or stairs ⁽³⁾	
	Acceptable dry slip resistance	Acceptable wet slip resistance	Acceptable dry slip resistance	Acceptable wet slip resistance
Concrete pavers				
Dry press concrete	Yes	Yes	Yes	Test
Interlocking concrete block paving ⁽¹¹⁾	Yes	Yes	Yes	Test
Moulded surface (e.g. simulated slate or concrete cobbles)	Yes	Test	Yes	Test
Compressed fibre-cement sheet				
Uncoated	Yes	Yes	Yes	Test
Coated (paint, polyurethane, etc)	Yes	No	No	No
Coated and sand impregnated ⁽⁵⁾	Yes	Yes	Yes	Yes
Rubber tiles/sheeting				
Smooth	Yes	Test	Yes	Test
Profiled	Yes	Test ⁽⁹⁾	Yes	Test ⁽⁹⁾
Vinyl and linoleum				
Smooth or with imprinted pattern	Yes	Test	Yes	No
Profiled (studs or ribs)	Yes	Test ⁽⁹⁾	Yes	Test ⁽⁹⁾
Grit/flaked finish	Yes	Test	Yes	Test
Carpet				
Tufted or loop pile ⁽¹³⁾	Yes	Yes	Yes	Yes
Artificial turf ⁽¹³⁾	Yes	Yes	Yes	Yes
Timber composites (chipboard, cork tiles, etc)				
Uncoated	Yes	No	Yes	No
Coated (paint, polyurethane, etc)	Yes	No	No	No
Coated and sand/grit impregnated ⁽⁵⁾	Yes	Yes	Yes	Yes
Anti-slip tapes⁽¹⁴⁾	Yes	Yes	Yes	Test

Notes to Table 2:

- Level surfaces including surfaces with slopes no steeper than 1:50.
- Sloping surfaces with slopes greater than 1:50 but less than 1:10 for wet conditions, or less than 1:8 for dry conditions.
- Acceptability as shown is based on stair treads without slip resistant nosings. When testing stair treads without nosings acceptability for slip resistance should be on a slope of 1:10. With slip resistant nosings at least 50 mm wide, acceptability criteria for stair treads is based on the requirements for level surfaces.
- Profile at right angles to direction of pedestrian traffic. Algal growth on uncoated timber walkways significantly reduces slip resistance when wet and requires regular removal, e.g. by high pressure waterblasting.
- The sand/grit, which is sprinkled over the complete surface of the final paint coating, should be a hard angular material such as silica sand or calcined bauxite. The particle size should not be less than 0.2 mm so that it is not submerged by the coating and not greater than about 2 – 3 mm so that it remains tightly bound to the surface. If overpainted, testing is required to establish acceptability of slip resistance.
- Concrete surface finishes complying with NZS 3114.
- Glazed or polished surfaces are unsuitable in either wet or dry conditions for sloping surfaces or for stairs because of the effect of foot placement, even though test measurements may indicate adequacy.
- The coefficient of friction can vary significantly with the extent of surface preparation.
- It is noted in AS 4586 that the pendulum slip resistance tests prescribed in that Standard may not be suitable for heavily profiled [or patterned] surfaces.
- When the grit finish has a "feel" rougher than 80 grit sandpaper, the surface may be deemed to have acceptable wet slip resistance, for either level or sloping surfaces or for stair treads, without testing.
- Interlocking concrete block paving to NZS 3116.
- To meet durability requirements of NZBC B2, the surface should have at least a five year life under normal maintenance.
- Validity of the listed typical values for coefficient of friction is uncertain as the test methods may not be applicable to carpets.
- Anti-slip tapes will normally require regular replacement to remain effective. To ensure foot contact, tapes should be placed at right angles to the line of travel and be spaced at no more than 150 mm centres.



Different materials provide different slip resistance in dry and wet conditions.

6 SLIP RESISTANCE IN DEFINED ACCESS ROUTES

6.0.1 An access route is defined by D1 as “A continuous route that permits people and goods to move between the apron or construction edge of the building to spaces within a building, and between spaces within a building.”

6.0.2 Access routes in buildings must meet the slip resistance criteria in clause D1. These can include:

- approaches to buildings
- lobbies and foyers
- escape routes as defined by Acceptable Solution C/AS1 to Building Code clause C *Protection from fire*
- stairs
- corridors in buildings and between tenancies
- common areas in communal residential and multi-unit dwellings
- paths, decks and steps that are part of the main entrance approach to a single dwelling.

6.0.3 Transition zones or areas between parts of an access route that are intended to stay dry under normal use and access routes that may become wet during normal use must meet the requirements for wet slip resistance. Examples of where this may occur are:

- transition zones between wet areas and dry areas such as a building foyer, where water may be carried into the foyer on people’s footwear
- areas such as public toilets where wet cleaning is regularly carried out.

6.0.4 These areas must have:

- water-absorbent matting across the width of the effective walkway and be long enough to remove water from footwear [1.8 m minimum length is recommended], or
- the slip-resistant surface extending into the dry zone

for sufficient distance to allow water to be shed from footwear [typically 6–10 m from an entrance portal], or

- a combination of the two.

6.0.5 Water-absorbent matting should be:

- securely held in place either by a matwell or with adequate grip to the floor
- of a material that does not curl at the edges.

7 SLIP RESISTANCE WITHIN DWELLINGS

7.0.1 Although statistics show the majority of slipping accidents occur within the home, there are no specific requirements in D1/AS1 for slip-resistant flooring [except stairs] within dwellings. Furthermore, designers, builders and homeowners place little emphasis on providing slip-resistant floors.

7.0.2 High-risk areas of residential buildings include bathrooms, showers, laundries, kitchens, stairs and areas adjacent to external doors. The installation of slip-resistant flooring could significantly reduce the number of slipping accidents that occur.

7.0.3 To ensure good slip resistance, floors or floor finishes in dwellings should provide an SRV of 39 or a coefficient of friction of 0.4 in:

- bathrooms, shower rooms and cubicles
- floor areas adjacent to external doors
- changing or drying areas immediately adjacent to a shower
- swimming pool changing rooms
- kitchens/laundries
- decks and balconies
- pool surrounds.

8 IMPROVING THE SLIP RESISTANCE OF EXISTING FLOORS

8.0.1 Where required, the slip resistance of floor surfaces can be improved by:

- applying slip-resistant paint
- adding grit or sand to a painted finish
- installing proprietary anti-slip floor coatings or mats
- installing anti-slip strips at right angles to the traffic flow and spaced at 100–150 mm intervals
- replacing anti-slip materials as soon as they lose their effectiveness
- replacing an existing flooring with one that meets the slip resistance requirements for the use.

9 MAINTENANCE

9.0.1 In order to remain slip resistant, surfaces must be kept clean and well maintained.

9.0.2 Factors that can compromise the level of slip resistance include:

- the application of polish
- a build-up of polish residue
- a general lack of cleaning so that the surface becomes clogged with dirt or spill residue
- incorrect cleaning methods that result in a slippery overlay forming over the floor.

10 TRIPPING HAZARDS

10.0.1 There is a danger of tripping when surfaces:

- have too much grip (generally a coefficient of friction of greater than 0.6)
- have a variable slip resistance across a surface
- are uneven
- have lips at the junctions between different materials.

10.0.2 Stairs can also present a tripping hazard, particularly where the leading edges of treads are poorly defined.

10.0.3 Other factors that can also affect the slipperiness of a floor but cannot be designed for include:

- the type of footwear (if any) worn
- the speed of travel of a person
- a lack of or poor cleaning practices resulting in a build-up of dirt and surface contamination.

11 CODES AND STANDARDS

New Zealand Building Code clauses

D1 *Access routes*

E3 *Internal moisture*

G3 *Food preparation and prevention of contamination*

Standards New Zealand

NZS 3114:1987 *Specification for concrete surface finishes*

AS/NZS 3661.1:1993 *Slip resistance of pedestrian surfaces – Requirements* [superseded]

Standards Australia

AS 4586-2013 *Slip resistance classification of new pedestrian surface materials*

SA HB 198:2014 *Guide to the specification and testing of slip resistance of pedestrian surfaces*



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