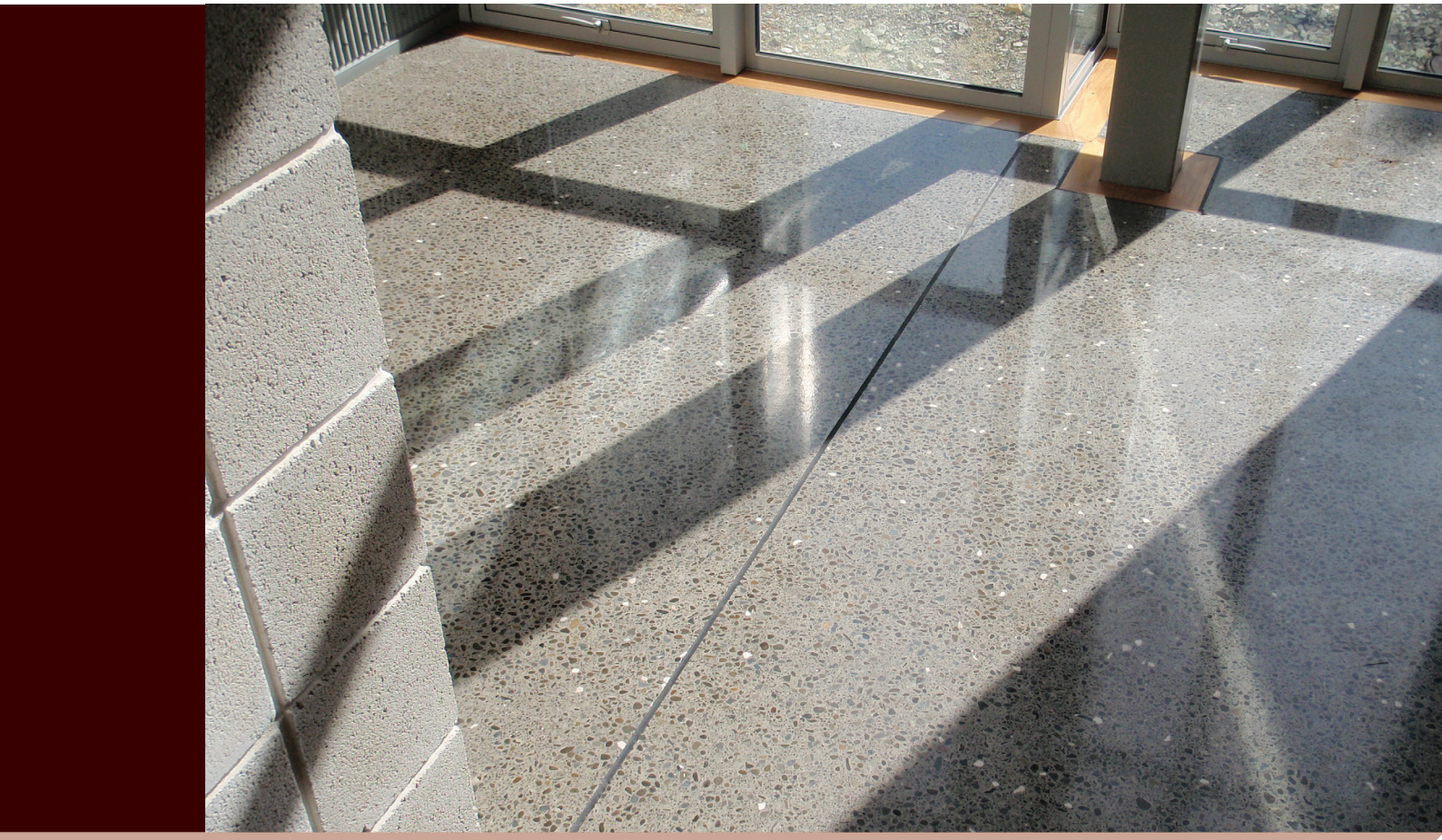
BRANZ

ISSUE 543

BULLETIN



CONCRETE FINISHES

February 2012

There are many concrete finishes possible for residential floor slabs and other applications.

This Bulletin gives an overview of the options and the relevant standards and Building Code requirements that must be met.

Some finishes require specialised skills and the use of an experienced contractor is recommended.

1.0 INTRODUCTION

1.0.1 Concrete is a mixture of cement, water and coarse and fine aggregate (sand), with or without admixtures.

1.0.2 In-situ concrete is concrete that has been placed and allowed to harden in the place where it is required in the completed structure. (The other type of concrete is precast concrete.)

1.0.3 The appearance of concrete can be varied by altering the proportions of the materials used or by using special additives. The material can also be coloured during the mixing process or after it is in place. Once concrete is hardened, the surface can be further treated to give a variety of appearances and finishes.

1.0.4 Concrete can be used with other materials such as brick, timber, stainless steel and tiles to provide additional decorative effects for horizontal surfaces.

1.0.5 Finishing concrete successfully is an acquired and specialised skill. Many techniques described (particularly those using hazardous materials such as acid) should only be carried out by skilled practitioners. Unless a general contractor has the knowledge and experience, the use of a specialist contractor is recommended for placing and finishing of concrete.

1.0.6 Previous bulletins have dealt with the design and construction of floor slabs:
- BU541 *Concrete floor slabs*
- BU498 *Preparation for concrete floor slabs*
- BU491 *Embedded floor heating.*

1.0.7 Although this bulletin deals mainly with interior floor finishes, many of the principles can be applied to other interior and exterior concrete surfaces. Careful selection of concrete finishes can provide a fitting and dramatic way to link interior and exterior living spaces.

2.0 APPLICABLE STANDARDS

2.0.1 The following standards may apply when considering design and construction of concrete slabs and concrete floor finishes.

NZS 3604:2011 *Timber-framed buildings:*
- Clause 2.6 requires concrete to comply with NZS 3104 for manufacture, and with NZS 3109 for construction.
- Clause 7.5 describes requirements for concrete slab-on-ground floors for timber framed buildings with occupancy loading of up to 3 kPa and with a maximum dimension of 24 m (either between free joints or between free joints and slab edges).

NZS 4121:2001 *Design for access and mobility: Buildings and associated facilities*.

AS/NZS 3661.2:1994 *Slip resistance of pedestrian surfaces.*

NZS 3114:1985 *Specification for concrete surface finishes* describes general standards and tolerances for surface plan, colour variation, texture and physical irregularities. Table 2 in the standard, 'Classes of floor, exterior pavement and invert finishes', includes 11 finish classes, some of which are applicable to interior floor slabs - other finishes are more likely to be used in exterior applications rather than for floor finishes, mainly because of texture or roughness:
- U1 Screeded
- U2 Floated (more likely for external use)
- U3 Trowelled
- U5 Shallow textured hard or soft bristled brooms (more likely for external use)
- U10 Special textured
- U11 Ground finish – low-speed coarse stone grinding.

Other finishes listed in Table 2 are more likely to be used in exterior applications rather than for floor finishes (mainly because of texture or roughness).

3.0 THERMAL MASS BENEFITS

3.0.1 Exposed concrete floors are an increasingly common energy efficiency feature, the temperature moderator at the heart of passive solar design.

3.0.2 The thermal mass of a concrete floor is used next to north-facing glazing to absorb solar gains during the day, with the heat reradiated into the building at night.

4.0 SLIP RESISTANCE

4.0.1 Slip resistance is an important consideration in selecting walking and drive-on surfaces. New Zealand Building Code clause D1 *Access routes* requires a slip resistance of a minimum coefficient of friction of 0.4 for level public access routes. It also prescribes minimum requirements for ramps and stairs.

4.0.2 Table 2 Acceptable slip resistance for walking surfaces of D1/AS1 lists acceptable surface finishes to materials including concrete. In some cases, concrete surfaces that have sufficient slip resistance when dry are unacceptable when wet or must be subject to testing. Building Code requirements for public areas include the path to the entrance of a private residence.

4.0.3 It is recommended that the same standards are applied to private residences. NZS 3114 Table 2 notes that class U3 (manual or mechanical steel float finishes) should not be used where a smooth finish could be dangerous in wet conditions. A steel float finish is not recommended, even under dry conditions, for surfaces that are intended for use by ambulant disabled or wheelchair-bound persons. A wood float finish (described as Class U2 in NZS 3114) is preferred in this situation, although this may not be desirable internally.

5.0 PLANNING AND DESIGN

5.1 REDUCING CRACKING RISK

5.1.1 With an exposed finish, it is even more

important to plan and design the project in a way that reduces the risks of cracks forming that can mar the finish quality.

5.1.2 Designing the correct bay sizes and shrinkage control joints is important to handle the shrinkage that occurs as the concrete dries (see *Build* 89).

5.1.3 Taking care with curing of the concrete will also reduce the risk of cracks forming if moisture is lost from the concrete too quickly.

5.2 STRATEGIES FOR SUSTAINABLE DESIGN AND CONSTRUCTION

5.2.1 Cement manufacture has environmental impacts because it is energy intensive and produces carbon dioxide emissions. However, cement only makes up 10—15% of most concrete mixes. Concrete has a relatively low environmental impact after manufacture and delivery to site, is durable and low maintenance and is the most widely used man-made construction material. It can also be recycled.

5.2.2 Designers and specifiers can enhance the sustainability of their projects in a number of ways.

- Specify concrete mixes that use recycled aggregates (such as crushed concrete) or other materials such as crushed glass and supplementary cementitious materials such as fly ash, ground granulator iron blast-furnace slag and amorphous silica.
- When using coloured concrete, specify colour pigments that come from naturally occurring mineral oxides. (These are mostly earth tones.)
- Carefully consider how to deal with the washwater from placing concrete and forming exposed aggregate surfaces. This has high alkaline content and can damage flora and fauna if allowed to runoff to waterways. The New Zealand Ready Mixed Concrete Association's safe environmental guideline On-site management of concrete washwater provides advice on dealing with washwater.
- Recycle abrasive blasting materials.
- Use water-based stains rather than acid stains.

5.2.3 While some concrete finishes may be considered to be relatively expensive to achieve, after factors such as energy efficiency and durability and cost savings when applied over the whole life of the building may outweigh initial cost considerations.

6.0 CONCRETE MIX DESIGN

6.0.1 Careful specification, documentation and communication between all parties are crucial to a successful result for specialised finishes to concrete.

6.0.2 Before starting work on site, the scope of work, materials, procedures and finishes should be clearly understood by all. Ideally an example of a section of an existing floor surface finish (polished, coloured or exposed aggregate for example) should be nominated as a standard for the final floor area, or sample reference panels provided - refer 304.4 of NZS 3114.

6.0.3 Many factors can affect the quality and appearance of the finished concrete surface, including concrete grade, mix constituents and proportions, cement content and colour, workmanship including placement and compaction, curing, and the finishing.

6.0.4 Any impurities in the concrete or variations in the consistency of the concrete after placement may be visible in specialised concrete finishes.

6.0.5 If the concrete placement is not carefully carried out, any variation in density or unevenness in composition of cement paste and aggregate may be visible in the finished floor. Fresh concrete should not be overworked especially for polished floors, because the aggregates will sink deeper below the surface.

6.0.6 Avoid walking through or otherwise disturbing the concrete during screeding and floating as much as possible. Any detritus such as sticks or leaves that fall on to the concrete as it is being worked may become visible after the finishing process. Seamless repair of faulty concrete placement is very difficult to achieve.

6.0.7 The finished surface may need to be temporarily covered to protect it from damage or disfigurement during later stages of the construction programme.

6.0.8 The correct procedures for curing should be followed to minimise cracking. In dry windy conditions or hot weather, during which rapid evaporation occurs, the use of proprietary anti-evaporant alcohols may be considered - refer CCANZ IB 73.

7.0 COMMON FINISHES

7.0.1 Conventional techniques used in concrete finishing to horizontal surfaces include:

- **Screeding** – moving a screed rail in short, quick side-to-side movements across the surface to level the mix, produces a light to moderately striated finish.
- **Steel trowelling** (hand or power float) – using a hand or mechanical steel-bladed trowel to finish the surface after the concrete has been floated, and is sufficiently hardened, gives a hard-wearing, smooth surface
- **Floating** – using a wood float and/or bull float gives a relatively smooth surface which gives a good key for a plastered or tiled finish
- **Broom finishing** – using a hand broom to finish the surface after it has been wood floated, which gives a light, directional, non-slip texture, probably more suited to exterior paving.

8.0 SPECIALISED FINISHES

8.1 EXPOSED AGGREGATE

8.1.1 The aggregate within the concrete mix is exposed by applying a surface retarder (usually immediately after the initial set) that stops the surface layer from fully hardening. The surface is then hosed to remove the top layer of cement paste to expose the aggregate and to give a texture and visual richness to

Figure 1. Power floating.

the surface. Acid washing removes any milky stains left. Muriatic acid reacts with cement and lime in the concrete and cleans up the exposed aggregate finish so that a sealer can be applied to a clean surface. An exposed aggregate finish can also be achieved by scabbling (roughening) or water-blasting the surface of hardened concrete.

8.1.2 The surface finish can be varied by the choice of aggregate used in the mix whether coloured stones, glass beads or smooth worn shells. Exposed aggregate is used frequently as an exterior surface but could be considered in some interior applications. Rounded aggregates are more comfortable to walk on in bare feet. Research at Columbia University, New York, shows that concrete with glass aggregate has better long-term strength and provides better thermal insulation properties than ordinary concrete.

8.2 GROUND

8.2.1 Grinding can be a cost-effective alternative to other applied floor finishes. It removes the cement-rich surface (laitance) to expose the aggregate as a smooth surface. Concrete strength should be at least 20 MPa. Vibration needs to be carried out carefully to provide an even finished appearance. Excessive vibration and dragging of the vibrator pencil through the concrete can produce unevenness. The slab is generally power floated to a class U3 finish before grinding. Decorative coloured aggregates or other materials such as coloured glass beads can be seeded before grinding to produce a dramatic design element.

8.2.2 The first grinding is usually carried at least 1–2 weeks after concrete placement (depending on weather and other factors). Small surface defects such as air holes are filled with cement paste before completing the grinding process. The final grinding can be carried out once the building is closed in. A sacrificial sealer is applied to temporarily protect the floor while other trades such as plastering and painting are completed.

8.3 DIAMOND POLISHED OR HONED

8.3.1 Diamond polishing is a further refinement on the grinding process. The first grind is carried out with 120 grit metal-bonded diamonds, followed by coating the surface with a penetrating sealer that fills the pores of concrete pores and hardens to produce a dense surface. Further polishing is carried out to produce an almost marble-like sheen to the surface. The finish can vary from matt to semi-gloss to gloss, as required.

8.3.2 Non-slip penetrating sealers should be considered in areas such as bathrooms and kitchens. These may have to be re-applied at two or three yearly intervals to maintain the slip resistance of the surface.

8.4 DECORATIVE SAW CUT

8.4.1 Decorative saw cuts should not be confused with cuts intended for crack control. Precision saw cuts used in conjunction with a honed finish, for example, can produce a tiled look while retaining the improved thermal benefits of an exposed concrete surface.

8.4.2 Decorative saw cuts (not necessarily in a rectangular grid pattern) are generally 2—3 mm deep and the width can vary between 6—10 mm. Saw cuts (particularly wider cuts) can be grouted with coloured grouts. Narrow saw cuts can be left without grout. Grooving can be formed with multiple parallel saw cuts.

8.5 PIGMENTS

8.5.1 Coloured concrete can be produced with pigments or liquids either added to the wet mix or applied (as a dry shake) to the wet concrete surface after placing. Adding oxides to the concrete mix results in a uniform surface colour, while sprinkling and trowelling pigments into wet concrete will produce more mottling and variation. When several different coloured pigments are applied to wet concrete paving, for example, the pigments can be artistically worked to produce a finish that resembles watercolour painting.

8.5.2 There is a wide range of pigment oxides and compounds to select from, and these can be combined to create an endless range of colours:

- Iron oxides - reds, browns yellows, blacks
- Chromic oxides - greens
- Titanium oxide - whites
- Cobalt and copper compounds.

8.5.3 Concrete that has been coloured with pigments, mostly in earthy tones or pastel colours, can be intensified by applying sealers. The composition of the concrete mix (aggregate size and colour and cement colour) has a significant effect on the final concrete

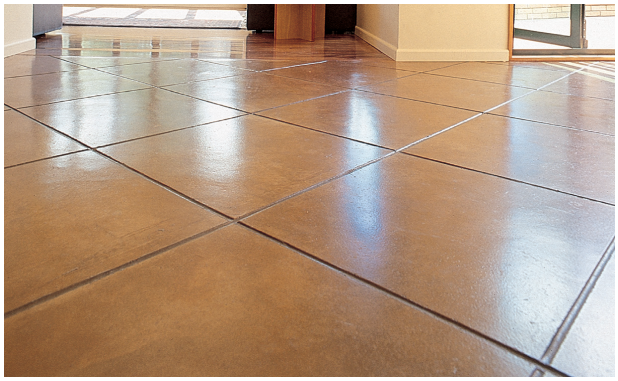


Figure 2. A coloured and saw-cut slab floor.

colour. White cement will result in pastel shades, but is more expensive than ordinary Portland cement. Coloured concrete can also be used to good effect in conjunction with coloured aggregates or crushed coloured glass, and the coloured concrete can be further treated by acid wash or some other techniques described (such as abrasive blasting or imprinting).

8.6 SEALS AND STAINS

8.6.1 Spills can stain concrete if the surface is not treated. Clear finishes and stains give some protection.

8.6.2 The main advantage of stains over pigments is that they can be applied at any stage after the slab has hardened (even to old floor slabs). The process can be more carefully controlled to produce better results.

- Acid staining is a chemical process where metallic salts in an acidic solution react with hydrated lime in hardened concrete. The process permanently alters the appearance of concrete. Work with acid is best left to experts, as it can be dangerous. Staining when coated with clear sealers can result in rich brown, reds and yellow surfaces. Use with caution because of adverse environmental effects and health risks.
- Water soluble staining is applied to the wet concrete mix before placing and generally results in a random mottled rather than even finish

8.7 ABRASIVE OR 'SHOT' BLASTING

8.7.1 Abrasive blasting of an existing concrete floor is often used to prepare the surface for subsequent coatings. The technique however can also be manipulated to varying degrees for decorative effect, from a fine sandpaper-like finish to a coarser exposed aggregate. Masking off areas is an effective way to produce an infinite variety of textures and patterns.

8.7.2 Abrasive blasting on a new concrete floor usually occurs after concrete has cured for 28 days. The materials most frequently used for blasting in on-site situations are crushed garnet or glass, (rather than steel shot which is used in factory-based abrasive blasting). The process is quite noisy and dusty, but the blast material should be collected for re-use.

8.8 STAMPED OR STENCILLED

8.8.1 To give a tile or cobblestone look, a coloured hardener powder is applied to the wet concrete surface and a pattern made with rubber mats or metal stamps.

8.8.2 Many special effects can be created with rollers, profiled screeds or pattern-making stamps, or by placing items (river stones, tile fragments, pebbles, or glass) into the surface of the wet concrete. Pebbles are readily available in a wide range of shapes and colours for inlaying in concrete.

8.9 ACID WASH AND STAIN FINISH

8.9.1 Acid washing uses muriatic acid (a diluted form of hydrochloric acid) to clean and remove stains from concrete, and for preparing the surface for staining. At higher concentrations, the product can etch concrete. This should be done by specialised contractors only.

8.9.2 Acids with opaque or semi-transparent coloured stains can be used to create patterns and designs on old or new concrete floors. Stains are applied to properly prepared (cleaned and degreased) surfaces by spray, brush or roller. Different colours, layers, and masking with stencils can be used to create irregular or geometric patterns and shapes on the floor surface.

8.9.3 Hydrochloric acid is hazardous to skin, eyes, the respiratory system and internal organs, and should only be applied by experienced contractors. Material safety data sheets should be consulted and the product used in accordance with the supplier's instructions at the recommended dilution rate. Before starting the acid washing or staining, the collection and removal of washwater must be planned to avoid the toxic end product entering drains and waterways. Acid staining and washing should only be carried out in well ventilated areas, and protective clothing must be worn.

8.9.4 Newer 'eco-friendly' water based concrete stains are far less toxic and easier to apply using similar techniques to acid stains.

8.10 RESURFACING SYSTEMS

8.10.1 Other surface finishes available with proprietary systems and techniques include:

- painting with specialised sealers and paints (including paving paints and/or epoxy resins)
- surface abrading, bush hammering or scabbling (roughening) - these finishes are probably more suitable for small areas for decorative effect rather than for walking on
- sealers and non-slip finishes
- proprietary coating systems approximately 2–3 mm thick applied over existing plain concrete to create tile, slate, flagstone, marble or seamless effects.

9.0 REFERENCES

CEMENT AND CONCRETE ASSOCIATION OF NEW ZEALAND (CCANZ) INFORMATION BULLETINS

- IB 18 *Architectural surface finishes*
- IB 33 *Specification and production of concrete surface finishes*
- IB57 *Concrete at home*

BRANZ PUBLICATIONS

- Bulletin 370 *Slip resistance of floors*
- Good Practice Guide *Concrete Slabs and Basements (2012 edition)*

WEBSITES

- BRANZ - www.branz.co.nz
- Cement and Concrete Association of New Zealand - www.ccanz.org.nz
- New Zealand Ready Mixed Concrete Association - www.nzrmca.org.nz

Cover photograph: Deborah Cranko

BRANZ

THE CORE PURPOSE OF BRANZ IS TO IMPROVE PEOPLE'S LIVES THROUGH OUR RESEARCH AND OUR DRIVE TO INFORM, EDUCATE AND MOTIVATE THOSE WHO SHAPE THE BUILT ENVIRONMENT.

BRANZ ADVISORY HELP LINES

FOR THE BULDING INDUSTRY
0800 80 80 85

FOR THE HOME OWNER AND PUBLIC ENQUIRIES
0900 5 90 90

Calls cost $1.99 per minute plus GST. Children please ask your parents first.

HEAD OFFICE AND RESEARCH STATION
Moonshine Road, Judgeford
Postal Address – Private Bag 50 908, Porirua City 6220,
New Zealand
Telephone – (04) 237 1170, Fax – (04) 237 1171
http://www.branz.co.nz

Standards referred to in this publication can be purchased from Standards New Zealand by phone 04 498 5991 or by visiting the website: www.standards.co.nz.

Please note, BRANZ books or bulletins mentioned in this publication may be withdrawn at any time. For more information and an up-to-date list, visit BRANZ Shop online: www.branz.co.nz or phone BRANZ 0800 80 80 85, press 2.

ISSN 1170-8395