BRANZ

ISSUE 641 BULLETIN

CONCRETE TOPPINGS

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Concrete toppings are often used to overlay concrete floors where the existing surface has deteriorated and needs upgrading or a new function or decorative effect is required for the floor surface.

Concrete toppings are durable and water resistant and can be a cost-effective method of floor finishing.

This bulletin provides a design and construction guide for those considering the use of concrete toppings for the first time. It updates and replaces Bulletin 389 of the same name.

1.0 INTRODUCTION

1.0.1 This bulletin provides a design and construction outline for those considering the use of concrete toppings for the first time.

1.0.2 Replacing an existing floor is often difficult to achieve in a cost-effective way and toppings can be a viable alternative. However, if the existing structural slab is unsound or alteration of existing floor levels is not possible, removal and replacement of the existing slab may be the only alternative.

1.0.3 There is an increasing use of concrete as a decorative finish. Concrete toppings are an effective method of achieving this.

1.0.4 This bulletin updates and replaces Bulletin 389 of the same name.

2.0 CONCRETE TOPPINGS

2.0.1 Concrete toppings are slabs placed over a thicker structural concrete slab or another stable floor structure. They vary in thickness, typically from 20 mm to 100 mm, depending on the method chosen for laying and the type of topping. They are used:

- as decorative finishes
- to form a gradient to the floor surface
- to provide a surface with different characteristics to the structural floor
- to improve the wear resistance of a floor surface
- to repair an existing floor surface.

2.0.2 The two types of concrete toppings are bonded and un-bonded. The two types vary in thickness, and the choice of type used depends on a number of factors such as the preparation required, the ability to change floor levels and the end use.

2.0.3 Concrete toppings should not be confused with thinner, jointless floor finishes that are generally bonded to a base material. Examples of thin, bonded floor finishes are:

- cement rubber latex
- cement-based finishes that are laid on a base slab that is still green to form a chemical bond with the base slab concrete
- mortar
- proprietary floor finishes such as epoxy resins, polyurethane screeds, and paint and clear-coat finishes that are generally less than 10 mm thick.

3.0 PROBLEMS WITH CONCRETE TOPPINGS

3.0.1 Concrete toppings have a tendency to curl, caused by differential drying between the top and bottom surfaces. A greater moisture loss of the top surface, leading to shrinkage of the surface, causes the topping to curl upwards. As drying proceeds, the deformation becomes permanent. This tendency is overcome either by bonding the topping to the substrate or having a sufficiently thick and heavy topping to compensate for the build-up of stresses caused by the differential drying and applying appropriate curing methods (curing compounds, plastic sheets) to the slab.

3.0.2 Permanent curl in a concrete topping can result in an uneven surface, drumminess, 'rocking' on the structural base, and eventually, uncontrolled cracking of the topping.

3.0.3 Bonded toppings reduce the risk of curling, drumminess and cracking.

3.0.4 Reinforcing in toppings such as steel mesh, or polypropylene or steel fibres, may reduce the risk of shrinkage cracking but will not prevent the curling effects. Reinforcing is only practicable for toppings more than 50 mm thick.

4.0 CONTROLLING CRACKING

4.0.1 Construction joints are required in concrete, including concrete toppings, to control cracking caused by shrinkage as the concrete dries and cures. The effects of cracking can be controlled by dividing the topping into areas or bays separated by construction or shrinkage control joints. Construction joints in the topping slab must mirror those in the underlying slab.

4.0.2 Construction joints control the location of cracking by creating a weak point in the concrete along which cracking can occur. They are made by saw-cutting concrete at the joint location typically within 24 hours of the concrete being placed (where curing is slower saw cutting within 48 hours is acceptable), then filling the sawcut with sealant (Figure 1). The location of joints and the size of bays has a significant effect on movement in the topping and the type of cracking that may occur.

4.0.3 Eccentrically shaped concrete slabs and toppings with abrupt changes of direction or re-entrant angles are prone to cracking across their narrow dimensions, so they should be divided into two or more regular shaped sections or bays to avoid cracking (Figure 2). Shrinkage control joints should be provided at all T junctions, L junctions and direction turns and around openings such as access hatches to avoid uncontrolled cracking beginning from the corner.

4.0.4 For bonded toppings, the ability of the concrete to shrink is restricted. The bay size must be limited to avoid the build-up of undue stresses which can lead to uncontrolled cracking. Maximum bay sizes for bonded toppings are:

- 15 m^2 for toppings up to100 mm thick
- 30 m^2 for toppings up to 150 mm thick.

4.0.5 The shape of bays also affects the likelihood of cracking. A rectangular bay with a proportion greater than approximately 1:2 is more prone to random cracking as it dries and shrinks. The ideal bay shape is square. Smaller-sized bays will decrease the tendency to crack but increase the effects of curling.

4.0.6 If a floor heating system is to be embedded in the topping, bay sizes will need to be selected to suit.

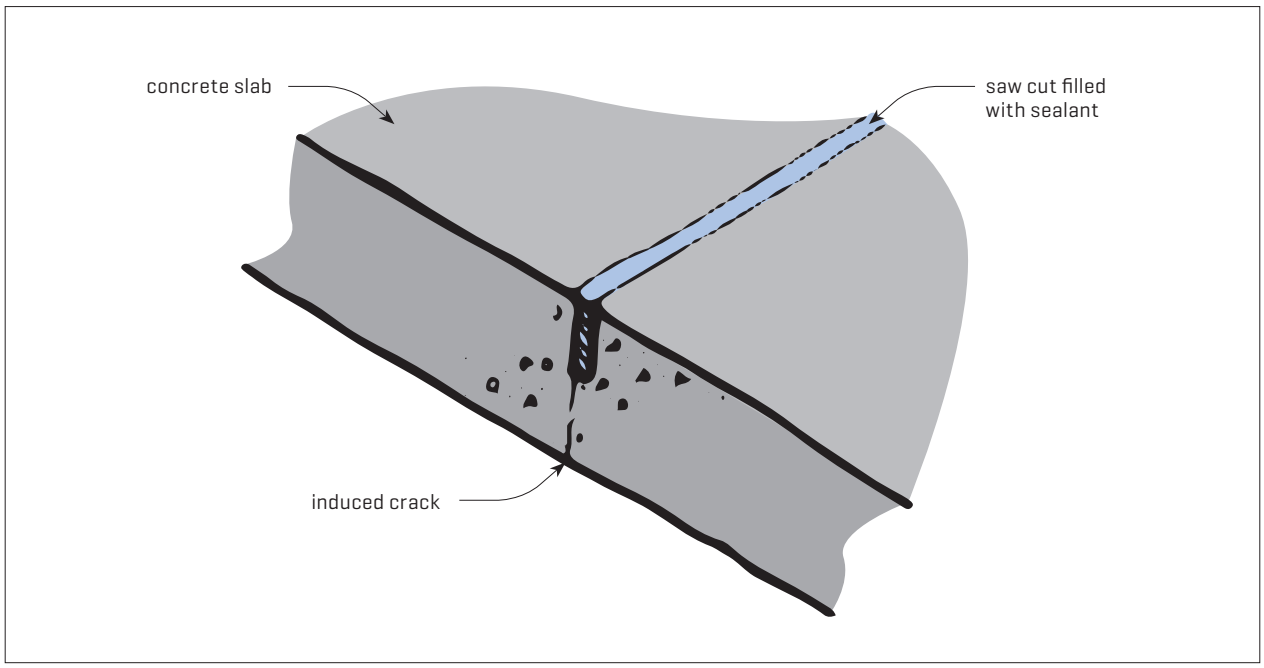

Figure 1. Shrinkage control joint.

4.1 FORMING CONSTRUCTION JOINTS

4.1.1 Construction joints in toppings can be made (Figure 3):

- as simple butt joints against removable formwork (with fillets to concrete edges)
- by pouring against either permanent timber or metal screed rails fixed to the floor
- by deep saw-cutting after the topping has been placed
- by using proprietary movement break strips or crack inducers to separate bays.

4.1.2 As joints are visible, they should be expressed as a feature of the floor. Careful consideration needs to be given to the layout and patterning of joints relative to the room.

4.1.3 Construction joints or cracks in the structural slab below, must have joints replicated in the topping slab directly above. The positions of columns, posts and other floor penetrations will need to be incorporated into the pattern layout to avoid eccentrically shaped bays that can lead to the topping cracking.

4.2 TOPPING MIXES FOR SHRINKAGE CONTROL

4.2.1 The shrinkage potential of a topping is greater for a sand aggregate mix than for a concrete of granular mix. In general, the aggregate in the mix should be graded

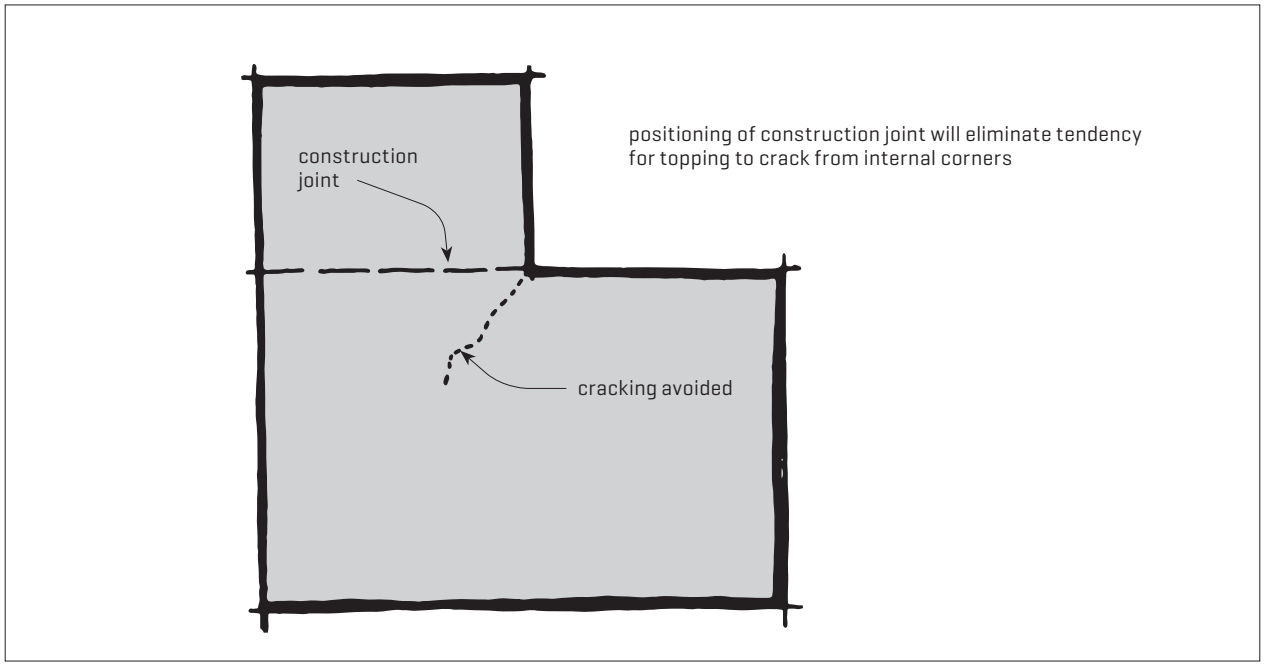

Figure 2. Construction joints.

up to the maximum size possible but never greater than one-third the thickness of the topping.

4.2.2 Specially designed shrinkage-compensating mixes are available that can be used to restrict the amount of drying shrinkage, thus minimising the risk of debonding and random cracking. They can be used in the formation of extra large bay, 'jointless' toppings or toppings of unusual shape but they must be treated with care and specialist advice sought.

5.0 BONDED TOPPINGS

5.0.1 Bonded toppings are typically laid onto an existing concrete slab that has been mechanically roughened (scarified, scabbled, shot or sand blasted). A cementitious or epoxy-based bonding agent must be applied immediately before pouring the topping so the concrete topping is well bonded to the slab beneath.

5.0.2 A bonded concrete topping is typically 20–40 mm thick but should not exceed 40 mm thickness as a thicker topping is more likely to lose adhesion due to higher curling stress on the topping.

5.1 PREPARATION BEFORE LAYING A BONDED TOPPING

5.1.1 The key to a successful bonded topping is good surface preparation. The slab must be roughened so that the coarse aggregate is exposed and the surface cleaned of dust and debris.

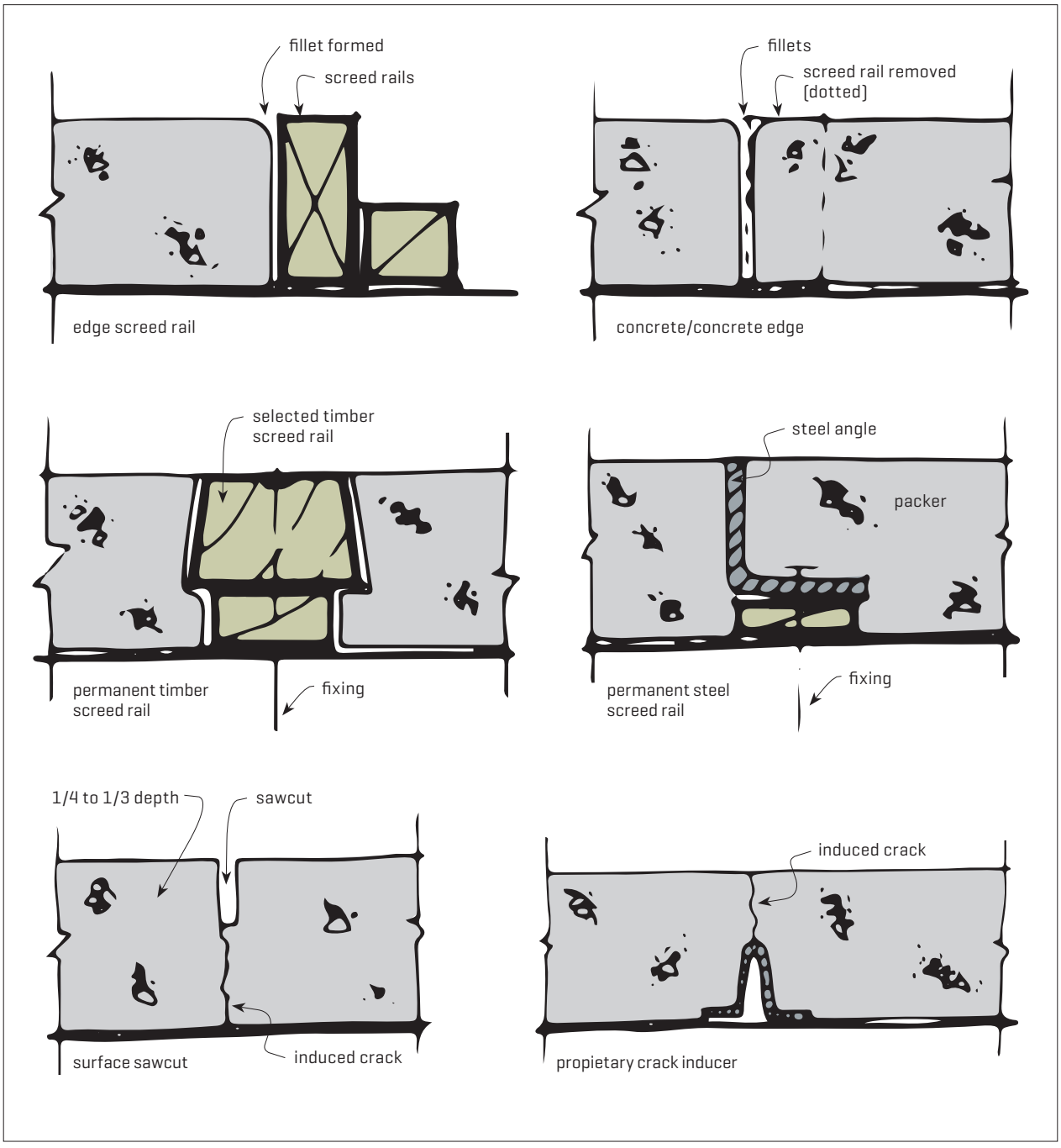

Figure 3. Construction joint types.

5.1.2 The best surface cleaning method is to vacuum using a small brush attachment. The dust in the pores on the concrete surface must be completely removed to achieve a sound bond. Brooming or blowing to remove dust is not effective as dust will ultimately settle back onto the surface. The vacuum unit should be located and emptied outdoors as even units with high filtering systems can release dust back into the air when the unit is emptied. Sweeping may also leave an oily residue that can inhibit bonding.

5.1.3 When laying a bonded topping:

a. Roughen the structural slab to a minimum depth of 5 mm as this depth of texture is needed to be able to resist significant shear.
b. Remove all loose material and dust from the surface by vacuuming.
c. Thoroughly wash down the slab and drain or mop excess water (or remove with a wet vacuum.
d. Check the water absorption rate of the base slab before placing the topping slab by pouring a small amount of water onto the base slab – if the base slab is too dry it will draw water from the topping slab too quickly resulting in a weaker concrete and poorer bond to the existing slab. If the water is absorbed within a few minutes, the slab must be kept wet for four hours. Excess water must be completely removed before placing the topping concrete.
e. Brush a cement/water slurry or other proprietary bonding agent onto the slab while the slab is still damp.
f. Lay the concrete topping immediately after applying the slurry, and thoroughly work it into place.
g. Toppings less than 40 mm thick require a specifically designed fine aggregate mix (maximum size 10 mm) and a higher sand content.
h. A proprietary bonding agent may be used instead of cement slurry, but the other requirements for good slab preparation must be followed. Obtain specialist advice when selecting a bonding agent.

5.1.4 An alternative bonded topping is a proprietary self levelling/compacting mix which can be applied in 3-30 mm thickness.

5.1.5 Where a bonded topping slab is to be laid over precast concrete units, additional roughening of the base surface should be specified at the production stage of the precast units. Precast units must not be mechanically roughened on site without the approval of the manufacturer under any circumstances.

6.0 UNBONDED TOPPINGS

6.0.1 Unbonded toppings are used when:

- laying over a damp-proof membrane
- a bond cannot be achieved – for example, if the base concrete is contaminated with oil or there is a surface coating such as a curing compound applied to the original slab
- the structural slab surface is smooth providing no mechanical key for the topping
- laid on a resilient layer of insulating material such as polystyrene or polyurethane.

6.0.2 Unbonded toppings may have a minimum thickness of 50 mm but 75 mm and preferably 100 mm minimum thickness is preferred to minimise the likelihood of curling occurring.

6.0.3 Care must be taken to minimise the damage to the isolating layer when constructing an unbonded slab over polystyrene ore polyurethane boards floating topping because if the support of the resilient material is weak, it will magnify the effect of any weakness in the concrete topping.

7.0 CONSTRUCTION JOINTS AND FORMWORK

7.0.1 Topping formwork must be carefully placed and levelled to ensure that the topping remains the required thickness. Permanent formwork can be left in place as part of the decorative finish of the floor.

7.0.2 Levelling a topping slab using pre-place levelled mounds of the concrete mix can be used with topping slabs to allow screeding to the finished level.

8.0 LAYING THE TOPPING

8.0.1 Bonded toppings require careful preparation of the structural slab surface (described in Section 4.2).

8.0.2 When applying the bonding agent, do not have the grout too wet or allow it to dry out before laying the topping.

8.0.3 Consolidate the topping mix with vibrators as appropriate. Thorough consolidation is important if the topping is to be strong and bonded to the underlying slab.

8.0.4 As toppings are thinner than slabs, extra care must be taken to ensure there is no damage to insulating material, the damp-proof membrane, embedded services or causing formwork to dislodge.

8.0.5 Concrete toppings require careful finishing to avoid imperfections in the surface. When placing the concrete ensure that the:

- the mix is not too dry (or too wet)
- the minimum topping thickness is being achieved across the floor area
- in-built services such as heating cables are undamaged.

8.1 COVER TO ELECTRICAL AND OTHER SERVICES

8.1.1 Small pipes and cabled services are often laid in concrete toppings. Where possible, they should be ducted around the perimeters of rooms or at the bay junctions to avoid cracking the topping.

8.1.2 Where a topping has a heating system incorporated in it, consideration must be given to movement joints when crossing between bays. Wrap the pipe or cable in a slip layer such as tape or grease coating for a minimum of 150 mm each side of the joint.

9.0 CURING

9.0.1 Curing means restricting the early loss of

water from the concrete to avoid shrinkage stresses developing while the concrete is establishing its early strength. Failure to cure properly will lead to cracking and curling of the concrete topping.

9.0.2 Concrete must be cured correctly in order to achieve the maximum surface strength, maximum resistance to surface abrasion and low permeability of the concrete, and avoid or minimise the development of shrinkage cracks. Good curing also reduces the effect of differential shrinkage and therefore curling by delaying the effect of differential drying until the concrete has developed sufficient strength to resist its effects.

9.0.3 With all curing methods, the aim is to keep the surface of the topping surface moist for at least 7 days after concrete placement. Curing is most critical during the first 24 hours after topping placement, with a decreasing effect over the 3–7 day period.

9.0.4 The curing method curing will depend on the location and time of installation of the concrete topping in the building sequence. Curing by spraying water is the most frequently used method but may be impractical if the topping is being laid inside a finished building or on an upper floor where water spillage will cause damage to the floors below.

9.0.5 Other curing methods that may be considered:
- Sealing the topping in plastic sheeting – after achieving an initial set, polythene sheet may be laid over wet topping. Ensure that there are no folds in the polythene and if possible, tape the edges.
- Application of a proprietary curing compounds as long as it does not affect the topping (for example, a coloured topping) or any future coatings that may be applied.

9.0.6 When a topping is to be decorative, care must be taken to avoid permanently damaging the surface. Ensure that it is evenly exposed to water misting hoses or to contact sheeting.

10 PROTECTING THE TOPPING

10.0.1 Protecting the finished topping during the construction process is critical, particularly where the topping is to remain permanently exposed. Any damage will affect the final appearance. Damage can be caused by stains, contaminants, rust, plaster droppings, dust, oil, paint and chipping of the surface. Protecting the topping with cover sheets or old carpet placed over the polythene sheeting, should be arranged as soon after curing as possible.

10.0.2 Avoid stacking building materials on the topping, as this will affect the curing process and risk permanent marking.

11 FINISH OPTIONS

11.0.1 Topping slabs may be:
- coloured
- sealed
- left exposed with a ground and polished finish
- left exposed with a steel trowel finish (incorporating colour)
- tiled
- overlaid with carpet or resilient flooring.

11.1 COLOURED TOPPINGS

11.1.1 An increasingly popular use of concrete toppings is to use colour additives to provide a decorative finish. A wide variety of decorative effects can be achieved with the added advantages of a flooring finish that:
- has structural integrity
- is permanent
- is low maintenance.

11.1.2 There are a number of methods of introducing colour depending on the decorative effect required. Colouring techniques include:
- full-depth colour
- dry shaking
- chemical stains
- applied finishes.

11.1.3 If considering colour additives, expert advice should be sought. Only pigments specially formulated for use in concrete should be used. They are available in either powder or liquid form. Use at the recommended dosage levels only to avoid adversely affecting the essential characteristics of the concrete.

11.1.4 Samples of the pigmented effects can be useful but these should be treated as indicative only. Final results are affected by:
- aggregate mix
- water content
- depth of topping
- curing methods
- surface finish
- sealer coats.

11.1.5 Mix proportions must be determined in advance to optimise the use of expensive pigments and to ensure that the required finish can be replicated. Full depth colour toppings should be prepared as a single batch to avoid batch variations.

11.2 SEALERS

11.2.1 Sealers may be applied to exposed concrete toppings to:
- protect the surface against abrasion
- prevent the staining
- form part of the colour treatment.

11.2.2 A large range of sealers is available on the market. Sealers vary in their chemistry, quality, design working life and rating for internal or external usage. Guidance should be sought to ensure the correct type is chosen. Select the sealer as part of the topping specification, to ensure that it is compatible with the installation process (especially curing) and will achieve the desired end result.

11.2.3 Sealers must only be applied after the concrete topping has achieved its initial drying. Early application of the sealer risks entrapping water under the coating. For clear sealers, this may result in a 'milky' build-up or whitening of the slab.

11.2.4 Preparatory work must be undertaken with care. Before sealing, vacuum up any loose material and dust. Gypsum dust from other work activities can permanently discolour concrete toppings. Aggressive cleaning can cause surface colour and texture variations that will be highlighted when a sealer is applied.

11.2.5 Follow the manufacturer's instructions at all times, particularly regarding preparation of the topping (for example, whether acid etching is required), and the temperature range required for application and drying of the sealer.

11.2.6 If etching or 'prepping' of the topping is required, wet the concrete first to avoid causing burn marks from the etch coating. After initial effervescence has ceased, rinse off thoroughly with clean water and mop up any excess. Internal floors may require wet vacuuming. After prepping:

- apply a neutraliser coating to the still damp surface
- wet vacuum the topping and dry off before applying the sealer coat.

12 FURTHER INFORMATION

12.1 NEW ZEALAND STANDARDS

NZS 3109:1997 *Concrete construction*

NZS 3114:1987 *Specification for concrete surface finishes*

12.2 BRANZ BULLETINS

BU469 *Damp-proof membranes to concrete slabs*

BU498 *Preparation for concrete floor slabs*

BU586 *Embedded floor heating*

BU535 *Repairing cracks in concrete*

BU626 *Slip resistance of floors*

BU623 *Curing concrete*

12.3 CONCRETE NZ PUBLICATIONS

B 04 *Curing concrete*

SB 1 *Concrete floors*

IB 33 *Specification and production of concrete surface finishes*

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