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Briefing

Colouring, Stencilling and Stamping Concrete Flatwork

The surface of concrete flatwork (floors and external pavements) can be treated in a variety of ways whilst concrete is passing from its plastic to hardened states. This Briefing discusses the techniques for colouring and/or providing patterns on the concrete surface transforming the surface of 'ordinary' concrete with colour and texture.

COLOURING

General

Colour can be provided to concrete floors and pavements by one or more of its constituents, eg off-white cement, special aggregates, adding mineral oxide pigments, or by the application of chemical stains, dyes, tints, and coloured surface coatings. The choice of method or combination of methods depends on factors such as the colour required and its consistency over the surface, the durability of the colour, whether patterns are required, and whether the concrete surface is new or existing.

Off-white Cement

Using off-white instead of the normal 'grey' cement can change the colour of the concrete.

Off-white cement is manufactured in Australia and is often used for architectural finishes as it tends to give a more consistent colour **Figure 1**. Some colour variation may still occur, and if consistency of colour is important, the use of a pigment is recommended.

Off-white cement is also recommended when mineral oxide pigments are to be used to give more-vibrant colours. Normal 'grey' cements tend to give darker, more-earthy colours when pigments are added.

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Figure 1 Off-white cement used in concrete topping

Figure 2 Mineral oxide pigments come in a range of colours

Figure 3 Floor placed in chequerboard pattern to conceal colour variations between concrete batches

If white concrete is required, the use of off-white cement with a white titanium oxide pigment may provide a more effective solution than using the costly imported white cement. The pigment both brightens and gives a more consistent colour.

Mineral Oxide Pigments

General

The most widely used products for colouring concrete are mineral oxides **Figure 2**. They are available as powders, granules or liquids. Powders are generally added to the concrete truck in bags that dissolve during mixing, while liquids are often used at major batching plants as they avoid dust and can be connected to automated batching equipment for accurate dosage.

Naturally occurring or manufactured inorganic mineral oxides may be used; the latter known as synthetic mineral oxides. Most colours (reds, yellows, browns and blacks) are oxides of iron. Some colours such as blue, green and white may be more expensive due to the manufacturing process to produce these special metal-oxide pigments.

Mineral oxide pigments are ultra-fine particles a fraction of the size of cement particles. They are insoluble in water and colour the concrete by masking the cement matrix. The ultra-fine particles disperse as fine solids throughout the concrete mix and become bound into the cement matrix in the same way as aggregates.

As pigments are made from metallic oxides or materials in their most basic form, there is no mechanism for them to degrade or change colour over time. They are not affected by the sun's ultraviolet rays, are light fast (eliminates fading) and once bound into the concrete matrix they provide a permanent colouring solution. They are also insoluble (prevents leaching out), chemically inert (do not interfere with the hydration of the cement), alkali resistant (suitable for concrete which has high alkalinity) and harmless to the environment,

By correct proportioning, pigments should not have a significant effect on the strength of concrete. The amount of pigment required will generally be 3–8% of the weight of the cement in the mix. For best results, a colour should be selected from a manufacturer's or supplier's colour chart and their recommendations followed regarding pigment requirements for particular mixes.

As mentioned earlier, the colour of the cement and fine aggregates affects the final colour of the concrete; off-white and grey cements will tint differently. Moreover, cement colour varies between suppliers. Whatever the cement colour, all cement for a project should come from a single source if colour consistency is important.

Integral colouring

Integrally-coloured or colour-through concrete refers to the addition of pigments to the concrete or topping mix in order to colour the entire volume of concrete. Mineral oxide pigments are added at the batching stage or to a concrete truck on site, and thoroughly dispersed through the concrete mix.

For uniform colour, every aspect of the concrete proportioning, mixing procedure, method of placement, finishing and curing should be consistent. If an exact colour match from batch to batch is difficult, borders of different colours, concrete pavers or other materials can be used to divide large areas into smaller more manageable sections which can be placed from a single batch. This helps to mask any minor colour variations and can create acceptable patterns **Figure 3**.

If differences in colour occur, correction with dyes may be possible. Mild-acid washes should be a last-resort method of moderating colour intensity or colour variations and should be attempted only by contractors experienced with the technique. Note that when using such chemicals, all required safety and environmental protection measures should be strictly observed.

Figure 4 Surface coloured by chemical staining. Thin topping layer used to provide more consistent colours over large areas

Figure 5 Dry-shake topping being applied

Figure 6 Dry-shake toppings used to provide surface colour to plain concrete

The following points should be considered when colour-thorough concrete with mineral oxide pigments is used:

1 ***Mixing in the pigments***. For uniform colour, a consistent mixing procedure is crucial, whether it is done at the batching plant or in the barrel of a pre-mixed concrete truck. Results are improved if the concrete mix design, the proportions of water and pigment, and the method of mixing do not vary from batch to batch.
2 ***Test panels***. Test panels or sample sections are useful to find the right mix and colour, and provide the basis for quality control.
3 ***Placing and finishing***. After placement, the concrete surface is screeded, floated and finished in the same way as non-coloured concrete.
4 ***Curing***. Keeping the concrete continuously moist for a specified time, allows the cement hydration reactions to continue and the concrete to reach its potential strength. Coloured surfaces must be cured carefully to produce uniform colour; colour variations will result if different areas cure at different rates: the curing method must maintain uniform moisture content across the surface.

Covering the surface with polythene sheeting (clear or light coloured for exterior applications) is an effective and common method of curing non-coloured concrete, but is not generally recommended where a uniformly coloured surface is required. Uneven contact caused by wrinkles and folds can result in uneven condensation under the polythene and hence colour variations. If using polythene, the sheeting should either be lifted each day after placement, and the surface saturated with water to reduce variations in moisture, or the sheeting should be suspended just above the surface on say narrow timber or metal spacers/battens. The edges should be held down to prevent wind lifting them and drying the concrete surface.

Spray-on chemical curing compounds slow evaporation by forming a film on the surface which degrades over time with exposure to ultraviolet light. If a surface sealer is to be applied, curing compounds will affect the adhesion and penetration of the sealer and must be completely degraded/removed from the surface prior to applying the sealer. An alternative is the use of a same-day sealer which is applied to the concrete surface immediately after it has been finished, while the concrete mass below the surface is still moist. Same-day sealers are not as effective as curing compounds or other conventional curing methods but they generally provide a satisfactory solution for coloured concrete finishes. The final sealer can also be applied directly over the top after the concrete has reached a hardened state.

Other common curing methods such as covering with hessian or sand that are kept wet or ponding are not recommended where consistent colour is required.

5 ***Cracking***. Minimising shrinkage cracking and maximising surface strength are particularly important for coloured surfaces. Basic quality issues relating to the compaction and curing of the concrete are often the simplest measures available to reduce the risk of cracking.

Cracks can affect the appearance, while a weak surface will be prone to dusting, abrasion and chipping. Note that inadequate compaction and curing could result in the concrete at the surface reaching only a fraction of its design strength.

Coloured toppings

Topping slabs may be monolithic, bonded or unbonded, depending on the topping thickness and time of placement.

If the topping is placed while the concrete substrate is still in its plastic or pre-hardened state, the topping can be worked into the surface of the slab below and the two will bond together into a single element, ie a monolithic topping. Toppings applied to hardened concrete or an existing slab can either be bonded to the surface (bonded topping) or separated from it (unbonded topping).

Figure 7 Adjacent surfaces (slabs and walls) should be protected

Figure 8 Dark colours may require three applications of colour hardener to ensure consistent colour

Figure 9 Sealing the surface to prevent staining

The maximum thickness of monolithic and bonded toppings is usually 50 mm. Thicker toppings should generally be considered as independent (unbonded) slabs and designed and reinforced accordingly. To incorporate reinforcement and to control curling, the minimum thickness for an unbonded topping is about 70 mm.

Toppings are normally coloured integrally by introducing a pigment to the entire mass of the topping concrete.. Other methods of colouring such as dry-shake toppings, stains, dyes and tints are normally applied directly to the surface of the structural concrete slab. However, with stains and dyes, providing a special thin (5- to 10-mm) bonded topping applied at the end of the project may be beneficial in avoiding damage from construction activities. It will also provide a surface layer that will readily accept stains and dyes and produce a more uniform colour over the area **Figure 4**.

Reinforcement is generally not required for monolithic or bonded toppings. However, to assist with the control of shrinkage cracking, a light mesh (eg SL42) positioned (and supported by bar chairs) 20 mm below the top of the slab could be used. Concrete can also be reinforced with steel fibres. Polypropylene fibres are available and will help control shrinkage cracking but do not increase the tensile strength of concrete as do steel bars, mesh or fibres.

Unbonded toppings should be jointed and reinforced as for new slabs. The maximum aggregate size should not exceed one third of the topping thickness; one quarter is recommended, particularly where reinforcement is provided. After placement, the surface of the topping is screeded, floated and finished in the same way as a normal concrete slab.

Bonding to existing slabs When bonding a topping to an existing (hardened) slab, the surface should be clean, rough and structurally sound. Any grease, oil or paint could affect the bond and should be removed. Old concrete surfaces that are disintegrating must be chipped back to a sound substrate. Smooth concrete should be scabbled back to reveal the coarse aggregate in order to provide a key for the new topping. The surface should be hosed and scrubbed to remove all dust and debris before placing the topping.

Unbonded toppings Unbonded toppings are placed on a smooth, structurally sound slab, and separated from it by a bondbreaker such as a plastic membrane.

Joints The area of toppings should generally be limited to 15-m^2 sections to allow adequate time for placing and finishing. For unbonded toppings, the length of a section should not exceed 1.5 times its width.

Joints will be required as follows:

- Isolation joints that allow the topping and adjacent structure to move independently should be provided where the topping abuts walls, penetrations (columns, pipework) or other structures.
- Contraction joints that control the location of drying shrinkage cracks can be formed by making grooves or saw cuts in the surface, using crack inducers (eg brass/zinc strips similar to those used in terrazzo work) or other proprietary joint formers that create a line of weakness that controls where shrinkage cracking occurs and therefore minimise the risk of random cracking. When toppings are placed over existing hardened slabs, it is crucial that new joints are aligned with those in the existing slab to avoid cracks reflecting through the new topping from movement of the slab below.
- Construction joints are used where concrete placement must be temporarily ceased (eg because of bad weather, plant breakdowns or the end of work for the day). Construction joints are rarely used for toppings and paving because other types of joints which are generally spaced 3 to 4 m apart provide convenient points at which to terminate placement. Construction joints can be simple, square-finished butt joints with a break to the full depth of the topping. If reinforcement is used it should continue across the joint.

Figure 10 Mottled finish typical of chemically stained concrete (on stamped surface)

Figure 11 Dyes and tints produce strong vibrant colours (red, yellow and orange) not possible with chemical stains [**a**] Chemical stain used for mottled green background and patterned border) [**b**] Dyed image on concrete floor, work by Gerald Taylor, original artwork by Christy Shaffer courtesy of Dover Publications *(with permission from Gerald Taylor)*

Dry-shake toppings

A dry-shake topping is a blend of mineral oxide pigment, cement and sand which is broadcast evenly over the fresh concrete **Figure 5** and worked into the surface by trowelling to produce a thin coloured monolithic topping. Products that contain a surface hardener are referred to as 'coloured surface hardeners'. They come as ready-to-use pre-mixed products, are available in a wide range of colours and while often used in conjunction with stencilled and stamped pattern finishes, can be used to simply provide colour to the surface of plain concrete paving **Figure 6**.

Dry-shake toppings can also be made on site from similar materials. The usual blend is 1 part cement to 2 parts clean sand (by volume); plus mineral oxide pigment measured by weight in the ratio of 1 part pigment to 10 parts cement (ie 10% of the weight of cement in the mix). The powdered pigment is first blended with dry cement before combining with the sand.

The manufacturers of coloured surface hardeners claim that correct use of the products produces 40- to 60-MPa surface strengths; considerably increasing the abrasion resistance of the typical 20-MPa concrete specified for most flatwork, including stencilled and stamped concrete finishes. Note that being cement-based products, they must be finished and cured in the same way as concrete to achieve optimum strength.

All traces of bleedwater must be allowed to evaporate before applying the dry-shake topping. Using the dry-shake topping to soak up bleedwater is bad practice, and invariably results in a much weaker surface, which will wear quickly, and may dust, delaminate or chip. A concrete mix with just enough water to make it workable minimises the amount of bleedwater, allowing earlier application of the dry-shake topping. Adding polypropylene fibres also helps bind the mix and reduce bleeding.

The rate of application of a dry-shake topping will typically be a minimum of 2 kg/m^2.

The procedure is as follows:

1 ***Protect adjoining surfaces***. Before placing concrete, use plastic sheeting to protect adjoining surfaces from splashes of concrete and colour. Pigments and cement are fine powders that can be easily carried by breezes and may be difficult to remove from adjacent finishes **Figure 7**.
2 ***Place the concrete slab***. Place, screed and float the concrete to its finished level. During hot weather, the use of a surface set retarder prolongs the plastic (workable) state of the surface, which may otherwise harden prematurely and reduce the time available to finish the work.
3 ***Apply dry-shake topping***. Evenly broadcast the dry-shake topping over the surface in two stages to ensure uniform colour and thickness. Usually two thirds is applied for the first 'coat', and one third for the second, which should be applied in a direction perpendicular to the first. For dark colours such as charcoal (black), it may be advisable to apply a third 'coat' to ensure a uniform colour **Figure 8**. Each 'coat' is thoroughly worked into the surface by trowelling and all edges and joints should be tooled before and after each application.

   A second colour (and third) can be added while the surface is still plastic, to produce colour flecks or mottling.
4 ***Finish the surface***. Common techniques can be used to finish the surface including brooming, steel trowelling, sponging, woodfloating, or dragging with hessian.

   If a smooth finish is required, additional steel trowelling of the surface will increase the hardness (advisable in commercial or industrial applications).
5 ***Cure the surface***. Take particular care with curing to ensure strength and colour consistency. Coloured surface hardeners will not produce high surface strengths unless the concrete is cured adequately. The method of curing may also result in colour variations. See *Integral Colouring*.
6 ***Seal the surface***. The main reason for sealing the surface is to prevent

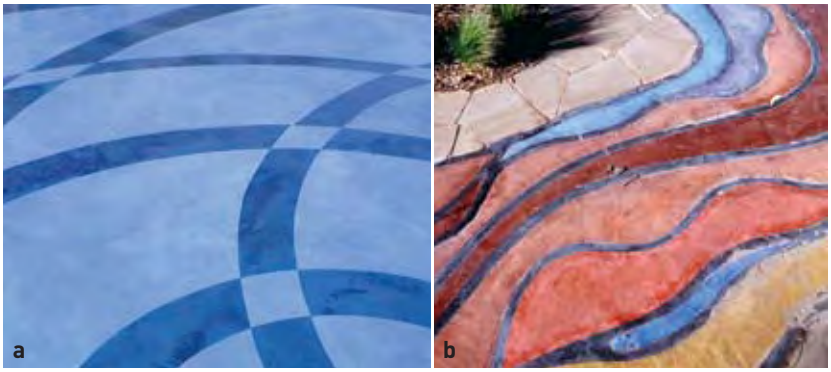

Figure 12 Cement-based coatings
[**a**] Dark blue areas are a coloured cement-based micro-topping approximately 1 mm thick trowelled onto the surface, light blue colour is from dye washed over surface [**b**] Coloured cementitious paint coating used to create designs *(with permission from Ability Building Chemicals)*

Figure 13 Worn areas apparent on surface coating

staining **Figure 9**. Cleaning stains from an unsealed surface, with cleaning compounds or solvents, may affect the colour. Sealing is also used to highlight the colours by imparting a 'wet' appearance to the concrete surface.

Most sealers cannot be applied to moist concrete without problems such as the sealer turning a milky-white colour. Special same-day sealers have been developed so that they can be applied to the 'set' surface of the concrete while the concrete is still 'moist'. They are generally not as effective as normal sealers or curing compounds for retaining moisture in the slab, but are a satisfactory alternative.

The use of same-day sealers should be followed with an application of the final sealer when the concrete has reached its design strength.

Chemical Stains

Chemical stains are usually applied to hardened (or existing) concrete. They chemically react with its constituents to produce products that permanently colour the concrete.

Stains typically produce a unique mottled coloured finish due to the variability with which they penetrate into the concrete. Two or more colours are often used to produce mottled finishes resembling stone, create patterns or to provide an antique appearance to the concrete **Figure 10**.

Colouring concrete by the use of chemical stains may appear simple, but in fact requires careful planning and a high level of skill in its application to achieve a good result. Release agents and curing compounds can also affect the rate at which the stain will penetrate into the concrete surface and thus the end result.

Staining of large areas and those with flat or smooth finishes is best carried out using spray equipment to avoid brush or roller marks unless specific patterns are required. Coarser textured finishes such as stamped surfaces will tend to conceal brush and roller marks.

Dyes and Tints

Dyes and tints contain coloured particles in either a water or solvent solution and can produce colours that are not available with chemical stains, eg red and yellow **Figure 11**. Dyes have very fine coloured particles and will penetrate into the concrete producing mottled finishes similar to chemical stains. Tints have larger particles, are opaque and remain on the surface of the concrete; the flowers in **Figure 11** are an example of the opaque finish achieved.

Unlike chemical stains, dyes and tints do not react with the concrete. This makes the results more predictable and less dependent on the consistency of the concrete or the weather conditions. For this reason, dyes and tints can be used to correct the results from chemical staining by colouring areas where the stain did not provide the required colour.

Dyes and tints produce strong vibrant colours and, along with other colouring options, extend the palette of colours possible to provide a vast range of colouring solutions for both large and small projects.

The UV resistance, and hence the suitability of a product for external use needs to be established for each dye or tint.

Applied Coatings

Coatings range from various paint systems and concrete 'sealers' to formulated coloured cementitious materials that provide coloured finishes with improved colour uniformity than integrally coloured concrete. Cementitious coatings which are usually applied thicker than normal paving paints are often referred to as micro-screeds/toppings and may be applied by brush, roller or trowel depending on the thickness required **Figure 12**.

Coatings provide a uniform colour over the entire surface. However, as with any product applied to the surface, they are subject to wear and must be maintained. Reasons for their use may include colour variations being unacceptable, to simplify the creation of patterns, achieve particular colours, protect the surface from abrasion and/or staining and assist with cleaning. With adequate thickness they will conceal

Figure 14 Some of the many standard stencilling patterns
[**a**] Face brick pattern [**b**] European fan pattern *(with permission from Concrete Colour Systems)*
[**c**] Flanders weave pattern [**d**] Flagstone pattern *(with permission from Concrete Technologies)*
[**e**] Mediterranean tile pattern *(with permission from Concrete Technologies)*
[**f**] Ashlar slate pattern *(Box Hill TAFE College, Victoria, Paterson + Pettus Landscape Architects)*

Figure 15 Examples of special motifs/stencils
*([**a**] with permission from Concrete Colour Systems)*

Figure 16 Placing and embedding the stencil into the 'wet' concrete
[**a**] Border placed first [**b**] Stencil trowelled/rolled into surface (note plastic sheeting to protect adjoining surfaces)

Figure 17 Applying coloured surface hardener over stencil

Figure 18 Stencil being removed
*([**b**] with permission from Concrete Technologies)*

the substrate and, depending on the type of product used, may provide a moisture and/or degrading chemical-solution barrier to the concrete. Depending on their properties and the number of coats or layers applied, this may extend the design life of the concrete element.

If a combination of individual coats of paint/coating and/or sealer is required, the products should be compatible. The manufacturer(s) should be consulted to ensure that a compatible paint or coating plus sealer system is specified.

As any product applied to the surface of a concrete pavement will be subject to weathering and abrasive wear, some coatings will need to be re-applied at regular intervals to restore original appearance **Figure 13**.

STENCILLING

Stencilled patterns are made by manipulating the surface of the concrete pavement after the concrete has stiffened, but before it has hardened. The process for stencilling is relatively simple; however, the timing of each stage is critical to the success and durability of the finish.

There are a variety of patterns resembling brick bonds, stone or random paving **Figure 14**. Special stencils can also be made to allow motifs, pictures and specific designs to be incorporated into the surface **Figure 15**. The surface texture can also be varied (eg by brooming) to produce coarser textures that improve slip resistance on steep grades.

In coloured and stencilled work, cardboard stencils laid on the surface of the pre-hardened concrete **Figure 16** mask the surface from the subsequent application of the coloured material **Figure 17**. When the concrete stiffens the stencil is removed **Figure 18** producing a coloured pattern with grey joints – the colour of the base concrete.

The procedure for stencilling concrete in conjunction with dry-shake toppings is as follows:

1 ***Protect adjoining surfaces***. See *Dry-shake Toppings*.
2 ***Place the concrete slab***. Place, screed, bullfloat and trowel concrete to its final level.
3 ***Lay the stencils***. Points to note include:
   — Wait until all bleed water has evaporated before placing stencils.
   — Features such as rosettes or motifs are normally placed first, followed by borders; finally, the main stencilled area is placed and cut in around other items **Figure 16a**.
   — Carefully work the stencil into the surface with a suitable roller or a trowel **Figure 16b**.
   — Stencils placed on concrete that is too wet may become embedded too deeply and will be difficult to remove, resulting in uneven 'joint' depths.
   — Stencils that have not been adequately embedded or are not well bonded to concrete will tend to adhere to the applied colour, leaving ragged outlines when removed. The colour may also creep underneath the stencil and stain the 'joint' lines. Evaporative retarders such as aliphatic alcohols can be used to help keep the surface of the concrete plastic during drying conditions and thereby increase the working time available.

Figure 19 Various surface textures can be applied to improve slip/skid resistance

— When placing and aligning stencils it is good practice to lift them, rather than drag them into position.
— Shrinkage control joints in stencilled concrete can be 'wet-formed' such as tooled joints (grooves) or 'hard-formed' such as sawn joints. Wet-formed joints are best placed under a stencil 'joint' line so that they are not repeatedly trowelled over, while hard-formed joints should be located to suit the pattern where possible. Note that the stencil is generally laid to suit the location of joints that have been formed in the pavement.

4 ***Apply coloured surface hardener***. Evenly broadcast the coloured surface hardener over the surface in two stages **Figure 17**. Highlight or flecking colours must be applied while the surface is still plastic to ensure bonding. For dark colours such as charcoal it is advisable to apply a third coat for more even colour distribution and to avoid mottling. See also to *Dry-shake Toppings*.
5 ***Apply surface texture***. While the surface is still plastic it can be lightly textured by brooming, wood floating, sponging, or by use of a hessian-drag to give a more slip-resistant finish **Figure 19**.
6 ***Remove the stencils***. The stencils can be removed once the concrete surface has stiffened sufficiently **Figure 18**. Note that this phase of stiffening or setting is 'drying', rather than curing. The appropriate time for lifting the stencil is very dependent on the weather conditions.

After the stencil has been removed, clean off any debris with a leaf blower rather than with high pressure air and avoid walking on the concrete with heavy or industrial footwear. If necessary the leaf blower can be attached to a long pole for greater reach.

7 ***Cure the concrete***. See *Integral Colouring*.
8 ***Seal the surface***. See *Integral Colouring*.

STAMPING

The procedure for stamping is similar to that for stencilling. After placing and screeding the concrete it is left to stiffen, and the bleedwater is allowed to evaporate before the application of any dry-shake toppings, if required.

After the application of colour, the pattern is imprinted or stamped into the surface with metal moulds or rubber mats. Many of the available stamped finishes resemble natural stone paving, from relatively smooth slate-like patterns having shallow impressions to coarser cobblestone and rock textures having deep impressions **Figure 20**. Special features can also be stamped into the surface of the concrete **Figure 21**. Where very fine details are required to be reproduced in the surface, stamping into a mortar topping may be necessary to avoid coarse aggregates interfering with the profiling of the surface **Figure 22**.

To better resemble natural stone, patterned concrete produced by stamping often combines two or more colours.

Stamped finishes may be combined with surface texturing such as exposed aggregate **Figure 23.**

Note that the thickness of a stamped concrete slab is measured from the bottom of the impression to the underside of the slab. This is important as the strength or load-carrying capacity of the paving depends on the minimum concrete thickness and not the average thickness. For example, if the slab thickness needs to be 100 mm, and a 15-mm-deep stamp is used, the formwork will need to be set at 115 mm to ensure the minimum thickness is achieved. This will also ensure sufficient cover and protection for the reinforcing mesh.

The procedure for stamping concrete is as follows:

1 ***Protect adjoining surfaces***. See *Dry-shake Toppings*
2 ***Place the concrete slab***. Place, screed, bull float and trowel concrete to its final level. Points to consider in relation to joints within the pavement include:
— Wherever possible, joints should coincide with grooves in the

Figure 20 Some of the many stamped patterns and textures available
[**a**] Random blue stone *(with permission from Concrete Colour Systems)*
[**b**] Flagstone *(with permission from Concrete Technologies)*
[**c**] Large diamond tile *(with permission from Concrete Technologies)*
[**d**] Seamless *(with permission from Concrete Technologies)*
[**e**] Rock texture [**f**] Slate texture

Figure 21 Many other objects can be used to stamp patterns into the surface

Figure 22 Finishes requiring reproduction of fine details stamped into a mortar topping [**a**] Timber pattern [**b**] Artistic pattern – colour from chemical staining

Figure 23 Stamped finish with aggregates exposed

Figure 24 Crusting around edges of stamped pattern due to drying of the surface prior to stamping

Figure 25 Access to all parts of the surface should be made available to ensure uniform application and trowelling of dry-shake topping *(with permission from Concrete Technologies)*

pattern. The sawn joint in the foreground of **Figure 22a** should have been aligned with the pattern, similar to the joint in the background.

— Wet-formed control joints can be tooled after stamping is finished, while the surface is still plastic, although this is difficult if the stamping makes deep impressions.

— Key joints should be formed before placement, note that they may interfere with stamping of deeper patterns.

Install isolation joints against abutting structures before placement. Installing them after will probably damage the finish.

3 ***Apply coloured surface hardener***. See *Dry-shake Toppings*.

The use of integrally-coloured concrete may give the paviour more time to apply highlight colours, and stamp the surface, which is helpful in drying conditions.

Concrete mixes for stamped finishes contain a finer grade of sand than those for stencilling in order to better reflect the texture of the stamping moulds. Consequently, the coloured powders need to be carefully worked into the surface, with trowels, for even application.

Some items to note include:

— When two or more colours are to be applied, a low-bleed mix may be necessary to reduce the time required for bleeding and hence commencement of application of the coloured surface hardener. Being able to apply the colour sooner allows more working time to apply subsequent colours and trowel them into the surface.

— In hot, dry or windy conditions, evaporation retarders should be applied to the surface to increase the working time. Without their use the surface may dry prematurely causing a 'crust' to develop on the surface of the slab. When deforming the surface during the stamping operation, such a crust may result in cracking around the edges, particularly with deep profile; this is known as crusting **Figure 24**.

Evaporation retarders have an added benefit of reducing the incidence of plastic shrinkage cracking. They should be re-applied each time the surface is worked, and during extreme drying conditions. They should not affect the colour, and will generally aid in the finishing operation.

— When large areas are to be finished, access to the areas beyond reach should be provided by laying planks over the work **Figure 25**. It is important that the entire surface is able to be given the same attention with respect to the application of colour hardener and release agent.

— Where slip resistance is required (eg a steep driveway) a surface can be textured at this stage with special rollers or stiff bristle brooms **Figure 26**.

4 ***Apply surface release agent***. After the application of the base colours, a coloured release coat is applied **Figure 27**. The surface release agent (powder or liquid) has two purposes:

— It prevents concrete adhering to the stamping mould and ruining the appearance of the pattern.

— It serves as a highlight colour, creating a variety of two-tone effects.

Release agents come in a range of colours to match that of the coloured surface hardener. Stamping with sufficient pressure will ensure an adequate bond of the colour release agent to the base coats, which is why the highlight effect generally occurs in deeper joints and impressions.

Note that the surface release agent is not a curing agent.

A thin film of clear polythene plastic can be used as an alternative bond breaker but may interfere with the stamping of some textures. It is placed over the prepared concrete before stamping, preventing the concrete sticking to the moulds **Figure 28**.

5 ***Stamp the surface***. It is always necessary to plan the stamping

Figure 26 Surface textured prior to stamping to provide slip resistance

Figure 27 Applying release agent to surface

Figure 28 Plastic sheeting used to prevent concrete sticking to the mould – cobblestone texture

sequence to produce a good result where the pattern meets walls and fixtures and extends over joints **Figure 29**. In many cases hand pads and hand-held jointing or ironing tools will be required to complete the edges **Figure 30**.

Textures can vary from shallow **Figure 30** to coarse **Figure 31**, and can be formed by a variety of methods including mats, rollers **Figure 32** and open-grid metal moulds **Figure 33**. 'Seamless' stamping mats that provide a textured surface without a defined pattern are also available **Figure 34**.

6 ***Cure the concrete***. The surface release agent does not allow the use of curing compounds as it prevents them bonding to the concrete surface. To avoid colour variations in uniformly coloured stamped work, initial curing with plastic sheeting is not recommended. In these cases, the release agent is removed the next day, the surface is allowed to dry, and the sealer is applied. Note that some loss of strength at the surface will occur due to the lack of initial curing.

With two-tone finishes, minor variations in colour resulting from the use of plastic sheeting are less noticeable and the surface could be cured for a minimum of three days (seven days is preferred) using polythene sheeting (clear or light coloured for exterior flatwork).

7 ***Remove the release agent***. After curing, remove the release agent using high-pressure water or by scrubbing with a detergent-based wash (taking care not to damage the surface) **Figure 35**.

8 ***Seal the surface***. Apply surface sealers evenly with a broom or brush, using two or even three coats. Glass grit, carborundum dust or fine silica aggregate may be sprinkled over the final coat to provide a non-slip finish if required.

For steep driveways the sealer may need to be thinned down to allow it to soak into and key with the concrete surface, rather than remain as a thick layer on top which may become slippery when wet.

Always ensure that the surface of the concrete is dry before applying the sealer. The concrete may have set and appear stiff, but it may not be dry. The premature application of sealers can result in moisture being trapped under the sealer film. This often causes surface imperfections, which will detract from the final appearance.

SPRAY-ON TOPPINGS

Existing slabs can be sprayed with coloured and textured finishes (varying in thickness from 3 to 5 mm) **Figure 36**. Spray-on toppings are available as cementitious or acrylic-based materials. They can look similar but their life expectancy may vary. The supplier should be consulted about suitability and performance of these toppings.

The procedure for applying spray-on concrete toppings is as follows:

1 ***Prepare the surface of the substrate***. The success of any topping depends on the bond to the substrate. Clean the existing pavement to remove grit, paint, oil, and other substances that will affect the bond and finish. Use high-pressure water cleaning or acid etching (a mild solution of 1 part hydrochloric acid to 25 parts water). Where severe surface deterioration has occurred, the use of concrete grinding or dustless shot blasting to produce a clean, even and sound substrate may be necessary.

Take care when preparing acid solutions. Wear appropriate protective clothing and always add the acid to the water, never the reverse.

2 ***Repair the substrate***. Most sprayed finishes are applied to existing concrete surfaces to improve the appearance. Any

Figure 29 Stamping with textured rubber mats – slate texture aligned with joints

Figure 30 Completing edges

Figure 31 Coarse textured rock finish

Figure 32 Stamping with a purpose-made roller

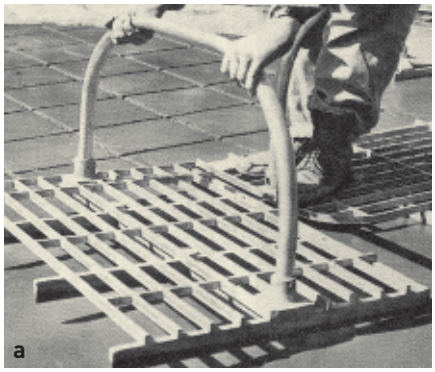

Figure 33 Stamping with open-grid metal moulds
[**a**] Large grid [**a**] Small grid

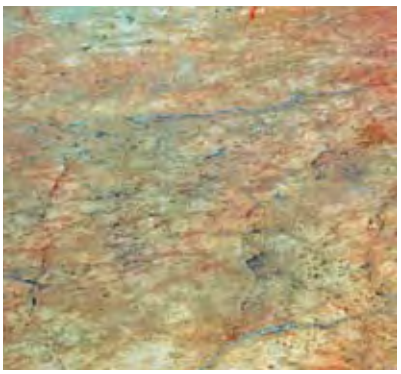

Figure 34 Seamless stamping mats used to produce continuous rock-like textures

Figure 35 Removing the release agent with high-pressure water

Figure 36 Some of the many spray-on patterns available
[**a**] Random blue stone *(with permission from Concrete Technologies)*
[**b**] Tile *(with permission from Concrete Colour Systems)*
[**c**] Large flag *(with permission from Concrete Colour Systems)*
[**d**] Special designs are easily achieved *(with permission from Concrete Colour Systems)* [**e**] Large flag pattern to existing balcony

defects within the existing slab that may detract from the appearance should either be repaired or, if satisfactory repairs are not possible, they should be incorporated into the new pattern or design. As a last resort, some sections of the existing pavement may need to be replaced to achieve a satisfactory outcome. Note that matching finishes and colours between replaced sections and the existing slab is generally not an issue as the spray-on topping normally includes a base coat that will conceal the entire substrate. For patterned finishes where joint/grout lines are left exposed and no base coat is applied, the colour consistency of the concrete substrate may be more important.

Defects that may need to be repaired prior to spraying a topping can be dealt with as follows:

— ***Cracks*** can be filled with either a rigid material such as cementitious or epoxy grout if they are dormant (not moving), or with a flexible material if they are live (still moving). However, while live cracks can be filled and sprayed over, continuing thermal or ground movements will cause the crack to be reflected through the new topping material, albeit generally narrower and less noticeable.

— ***Different levels*** of adjoining slabs (caused by tree roots, expansive soils, moisture problems and subsidence) can be made flush with a topping or purpose-made levelling compound, prepared and applied strictly in accordance with the manufacturer's recommendations. The cost of levelling compounds may be prohibitive, moreover they are not recommended for external use because of the possibility of warping and delamination. Where there is a serious case of subsidence, and the slab has lost support, an alternative to replacement is the injection of grout under the slab ('slab jacking'). This is expensive but may be necessary in some cases.

— ***Broken corners*** can be repaired by fixing a new section of concrete to the existing. The fixing may be a reinforcing bar (or a stainless steel pin if enough concrete cover is not possible) glued into the existing concrete.

— ***Joints*** are difficult to repair because movement may cause failure of the repair.

— ***Spalling*** is usually caused by rusting reinforcement. Exposed and rusting bars can be locally cut back to give the required cover, before patching with a repair mortar, but if the cause of the spalling is not eliminated, problems may recur. Also, before any reinforcement is cut out, a structural engineer should be consulted to determine the implications of

its removal. As repair of spalling concrete is a specialist job, for extensive areas it may be better to remove and replace the section of paving.

— ***Surface defects*** that are shallow can be filled with a spray-on topping material. A purpose-made repair mortar can be used for deeper depressions.

Repairs should be carried out by specialists. Also, if extensive repairs are necessary, consider replacing the existing damaged pavement with a new slab. The total cost of repairs and a sprayed finish may be greater than the cost of removal and replacement.

3 ***Provide joints***. As a general rule, joints in a new topping or coating should correspond with existing joints. Since the latter allow or control movement in the slab, if they are filled and sealed over, continued movement of the pavement could cause the joint to rupture and the topping to spall.

The location of existing joints may govern the direction of any surface patterns. If any new joints are cut into the existing pavements (existing joints too far apart or not able to adequately control movement) these should, if possible, be located to suit the new pattern.

In certain situations to relieve stresses, isolation joints may need to be provided or re-established around structures (posts and walls) adjoining the slab.

4 ***Protect adjoining structures***. Protect adjoining surfaces from over spray or splatter. See *Dry-shake Toppings*.

5 ***Apply bonding products***. Bonding products can be used to increase the strength of the bond of the topping to the existing substrate. They are usually supplied with the application kit or incorporated into the spray material. Products should be applied in strict accordance with the manufacturer's recommendations as incorrectly used bonding agents can have a de-bonding effect.

6 ***Apply base coats***. A base (or primary) colour coat is applied over the bonding agent (where required); this becomes the colour of the 'joints' in stencilled patterns.

Base coats are fairly workable and can be levelled with trowels, broad floats or squeegees. The condition of the slab, existing falls and depths of any depressions will, however, influence the choice of slump.

After the base coat has dried (a period specified by the manufacturer), smooth the surface with fine sanding, light grinding or rubbing over with open-mesh rubbing blocks to remove minor imperfections. Fill any minor holes. Remove dust and grindings from the immediate area so it is not walked onto, or blown back onto, the pavement.

7 ***Apply stencil to the surface***. Stencils are usually self-adhesive for fixing directly to the base coat or prepared surface. They are available in a wide range of patterns, similar to those available for standard stencil applications. Stencils with special patterns can be made to order.

8 ***Apply topping coats***. The final coloured coat is mixed according to the manufacturer's recommendations. This may include additives sold with the application kit. Varying the slump and viscosity of the topping can produce different textures. A more fluid topping (with a high slump) will produce a smooth finish; a drier mix (lower slump) is used to produce rough textures. Increase the slump by adding both fluid and binding materials, not only fluid. Watering down of any product will weaken the mix.

The colour can be applied through a dual-line feeder or hand-held hopper with a gravity feeder. An even application is crucial. A second coat is usually applied and allowed to dry in accordance with the manufacturer's recommendations. A third, or highlight coat (with an iron-oxide fleck for example) can be applied.

After the surface is set, the stencils are removed and the residue is blown off.

9 ***Cure the concrete***. As with any cementitious product, curing is essential in order to produce optimum results. See *Stencilling*.

10 ***Sealing***. A same-day sealer can be applied for immediate protection. Once the surface has achieved its design strength, two coats of a high-quality sealer are recommended to ensure the lasting serviceability of spray-on surface finishes.

REFERENCES

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2 *Exposed Aggregate Finishes for Flatwork,* Cement Concrete & Aggregates Australia, Briefing 02, 2007

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CCAA OFFICES

SYDNEY OFFICE:
Level 6, 504 Pacific Highway
St Leonards NSW Australia 2065
POSTAL ADDRESS:
Locked Bag 2010
St Leonards NSW 1590
TELEPHONE: (61 2) 9437 9711
FACSIMILE: (61 2) 9437 9470

BRISBANE OFFICE:
Level 14, IBM Building
348 Edward Street
Brisbane QLD 4000
TELEPHONE: (61 7) 3831 3288
FACSIMILE: (61 7) 3839 6005

MELBOURNE OFFICE:
2nd Floor, 1 Hobson Street
South Yarra VIC 3141
TELEPHONE: (61 3) 9825 0200
FACSIMILE: (61 3) 9825 0222

PERTH OFFICE:
45 Ventnor Avenue
West Perth WA 6005
TELEPHONE: (61 8) 9389 4452
FACSIMILE: (61 8) 9389 4451

ADELAIDE OFFICE:
Greenhill Executive Suites
213 Greenhill Road
Eastwood SA 5063
POSTAL ADDRESS:
PO Box 229
Fullarton SA 5063
TELEPHONE: (61 8) 8274 3758
FACSIMILE: (61 8) 8373 7210

EXTRACTIVE INDUSTRIES OFFICE
PO Box 243
Henley Beach SA 5022
TELEPHONE: (61 8) 8353 8151
FACSIMILE: (61 8) 8353 8151

TASMANIAN OFFICE:
EXTRACTIVE INDUSTRIES OFFICE
PO Box 246
Sheffield TAS 7306
TELEPHONE: (61 3) 6491 2529
FACSIMILE: (61 3) 6491 2529

WEBSITE: www.concrete.net.au

EMAIL: info@ccaa.com.au

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