

# Briefing

## Colour and Texture in Concrete Walling

An unlimited range of colours and textures can be provided on the surface of concrete. The method of achievement varies depending on whether the treatment is undertaken when the concrete is in the plastic or the hardened state, and whether walling is cast insitu or in a precast factory. This publication provides an overview of colouring and texturing concrete and outlines the key points to achieve the required finish. Additional information about off-form concrete finishes can be found in the CCAA's publication *[Guide to Off-form Concrete Finishes](#)*.

### Overview

#### COLOUR

##### General

Colour consistency is usually an important consideration in architectural concrete. Its achievement requires an understanding of the many factors that can influence the colour. These include the concrete constituents and their proportions, pigments, method and duration of curing, form oils, release agents, and the type and absorbency of the formwork. The key to colour consistency is to keep all aspects of the concrete composition and construction method as consistent as possible.

It should be noted that colour variations are more apparent in plain surfaces than textured surfaces where they are – to varying extents – masked by the texture.

#### Cements

Cements in Australia are produced in grey and off-white colours. White cement is imported. The availability of concrete made with off-white and white cement should be checked with the supplier prior to specification. Concrete made with off-white cement is generally available in most major cities; the availability of concrete made with white cement is limited.

## Pigments

Most pigments are oxides of iron – reds, yellows, browns and black. They can be naturally occurring minerals or manufactured, with the latter often referred to as synthetic oxides. Some colours such as blues and greens may cost more as they are special metal oxide pigments. Titanium white oxide pigment is also available, and used with off-white cement may be an economical way to obtain a 'white' concrete. Pigments can be added directly to the concrete (integral colour), contained in a topping or render, or applied to horizontally cast surfaces by using the 'dry-shake' method.

Black pigment used to colour precast retaining-wall panels



Pigments used to colour the concrete for a building facade (General Purpose North 3 Building, The University of Queensland)



Aggregates come in a range of sizes and colours

## Aggregates

The fine and coarse aggregates will influence the perception of colour in exposed-aggregate finishes. The colour of sand or fine aggregate (and the cement matrix) will tend to dominate in the case of light abrasive blasting or acid etching; the colour of the coarse aggregates will dominate with techniques such as heavy abrasive blasting, tooling, water washing, honing and polishing. The size and colour of the aggregates, along with their proportions should be specified if they are to be exposed.

## Chemical stains, dyes and tints

Chemical stains are liquids that penetrate into the concrete and react with the constituents of the concrete to permanently colour it. Along with dyes and tints (coloured liquids), which can be used to produce vibrant colours and extend the palette of available colours, a vast range of colouring solutions is possible for both small and large projects. Because these products rely on penetrating the concrete surface, they are more commonly used on horizontally cast elements where the stain can be allowed to pond on the surface. Due to the variability with which they penetrate the surface, a uniform colour cannot be achieved, rather a uniquely mottled finish will be produced. The colour intensity depends on various factors such as the cement colour and permeability of the concrete surface, which in turn will be affected by the degree of concrete compaction, curing and surface trowelling. As chemical stains react with the calcium hydroxide produced by the hydration of the cement, the time of their application will influence the colour intensity achieved. Chemical stains should be used in accordance with the manufacturer's recommendations.

Chemical stains produce mottled finishes



Variable absorbency of chemical stains can add to the affect



Dyes and tints (used for flowers and red background) produce vibrant colours. Green area was chemically stained



Four coats of red dye sprayed onto walls to achieve deep yet translucent red colour. (Shrine of Remembrance Courtyards, Melbourne)

## Applied finishes

Applied finishes include cement renders, applied coatings and paint. They are normally specified if a consistently uniform colour is required over a large area, as a moisture/durability coating, or to provide some texture to the surface. Advances in paint technology have resulted in longer-life paints and a greater range of applied finishes.

Acrylic paint coating used to produce uniform colour over large areas



Acrylic paint coating used to provide uniform colour for individual concrete panels

Coating containing powdered copper was applied to formwork prior to concrete placement to produce green copper oxide colour with weathering



## TEXTURES

### General

Textures available for concrete finishes vary from smooth/patterned off-form finishes to an extensive range of other treatments providing, for example, highly polished surfaces or an assortment of fine- or coarse-textured finishes. Often a number of alternative methods are available to achieve the same appearance at perhaps a lower cost. For example, acid etching and abrasive blasting can produce similar results to bush hammering, while formliners can replicate the textures of most finishes.

Concrete can reflect even the finest detail of the surface against which it is cast. (National Emergency Services Memorial, Canberra)



### Off-form

Off-form finishes are produced by casting concrete against a mould, formliner or form face which impart their textures or patterns to the surface of plastic concrete. Smooth or plain faces are among the most common. Some of the earliest examples of texture were board-marked surfaces and simple liner details from timber battens. Not only do these earlier finishes continue to be refined but also innovative ways of imparting texture continue to develop. Various formliners are now available that replicate almost any texture – from timber, rope and tooled finishes to various brick, block and stone profiles. Note that as the aggregates



are not exposed in off-form finishes, they do not contribute to the colour of the wall surface. Also, as formliners can generally be reused many times, greater repetition will offset the initial cost and make their use economical.

Varying board thicknesses used to give three-dimensional board-marked finish



Timber battens used to create details to resemble stone foundation. Applied coating used



Textured surface (left) produced by casting concrete against plastic sheeting over packers (right). Integral colour used



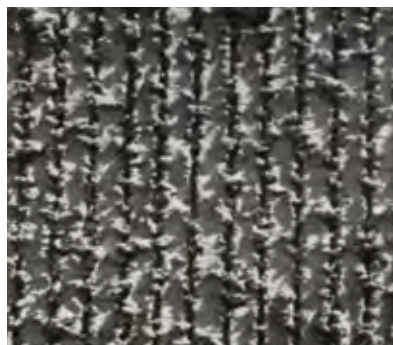
Rope finish at 45° provides texture and banding by alternating direction of rope. Integral colour used

Layers of formply used to create three-dimensional image on surface. Integral colour used



### Scoring

Scoring the surface with tools or brooms is done when the concrete has stiffened but before it has hardened. In the past, makeshift rakes comprising nails and timber battens have been used to score the surface, producing interesting results. A number of formliners are now available to more easily produce this finish. Stiff bristle brooms can also be dragged over the surface to produce coarse textures that reflect the movement of the broom. Panels must be cast horizontally to enable scoring to be carried out.

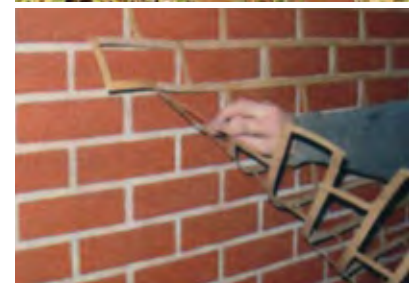


Raked finish produced with a makeshift rake of nails and timber

### Stencilling

Stencilling involves embedding a cardboard stencil into the surface of the plastic concrete and applying/working in a thin coloured topping, typically in the form of a dry shake material which is hand-cast over the surface or coloured spray-on coating which can be applied over stencils on new or existing concrete. Once the concrete and topping have stiffened sufficiently, the stencil is removed to reveal the colour of the generally grey concrete below. The contrast with the coloured topping defines the pattern, which may vary from brick and tile to various stone patterns. While normally carried out on walling panels cast horizontally, recent developments extend the application to vertical surfaces, providing the potential for use with existing structures.

Stencil pattern and dry-shake topping used to achieve brick pattern on precast walling elements

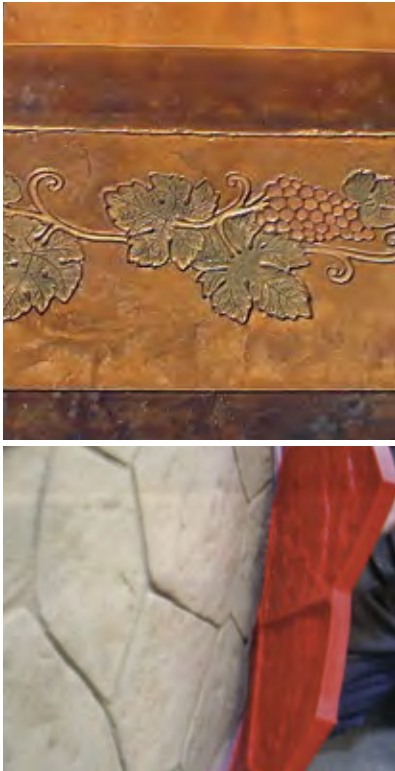


Existing vertical surface is coated with a thin topping which allows embedment of stencil and application of colour [reproduced with permission from 'Concrete' Vol. 40 No. 3 April 2006]

### Stamping

Stamping or imprinting the surface with moulds or other tools is done when the concrete has stiffened but before it has hardened. Metal dies and textured rubber mats are widely used to replicate stonework, but any device can be used to make impressions in the surface. Quite intricate patterns are possible. Note that wall panels must typically be cast horizontally (ie precast in a factory or on site) to allow stamping of the surface. An alternative method suitable for both new or existing work is to provide a thin render coat to the vertical surface and use stamping mats to profile the surface with various textures/patterns.

Stamped patterns can have intricate designs. Concrete chemically stained



Stamping of vertical surfaces  
*[reproduced with permission from 'Concrete' Vol. 40 No. 3 April 2006]*

### Exposed aggregate

Exposed-aggregate finishes can be produced using a variety of techniques that result in different depths of exposure and texture. Techniques vary depending on whether the panels are cast vertically or horizontally, and whether they are carried out before or after the concrete has hardened. They include abrasive blasting, high-pressure water blasting, acid etching, water washing (often in combination with a surface set retarder), rope and various tooled finishes such as bush hammering, point tooling, grinding, honing and polishing. Needle scabbling tools can also be used to locally remove the surface paste, allowing intricate patterns and text to be engraved into the concrete surface.

Angle grinder with abrasive disc (pictured) used to locally expose aggregates to create 'stone' pavement appearance. Pattern lines cut using small diamond blade (yellow) on angle grinder. Surface chemically stained



Needle scabbling tool used to expose dark aggregates and create intricate details

### Applied finishes

Depending on the finishing technique and equipment used (eg textured rollers), a variety of textures can be provided to cement renders, applied coatings and paints.

Textured granosite coating to concrete walls



Acrylic paint to precast concrete walls. Polished concrete floor with integral colour *[architect Strine Design Pty Ltd with permission]*



## Key points for specifiers and builders

### COLOURING

#### Key points when using off-white and white concrete

- There are many different shades of off-white and white, and if these colours are required, a test panel should be provided to confirm the acceptability of the concrete colour.
- To minimise the risk of colour variations it is advisable to specify that the cement be from a single source for the duration of the project.
- Colour consistency over large areas tends to be less of a challenge with off-white concrete, as it is more consistent in colour than grey concrete.

#### Key points when using pigments

- The use of pigments is the most common method of colouring the full depth of concrete, providing a coloured surface on all faces of a concrete element and eliminating the need for subsequent surface coatings/paints.
- Pigments are available as either powders, granules which dissolve, or liquids. The ultra-fine particles of pigments do not dissolve and stain the concrete materials, but disperse as fine solids throughout the concrete matrix and are bound into the concrete in the same manner as the aggregates.
- Pigments are not affected by ultraviolet rays (eliminating fading), are insoluble (do not leach out of the concrete), chemically inert (do not react with the concrete constituents), alkaline resistant and once bound into the concrete matrix they provide a permanent colouring solution.
- As a guide, the amount of pigment required is generally 5% to 8% of the mass of the cementitious material in the mix. At these percentages pigments are not expected to affect the potential strength of the concrete.
- For exposed aggregate finishes, the amount of pigment required is typically reduced to about 1% or 2% as the predominant colour will come from the aggregates.

- As the colour achieved is affected by the pigment concentration and the tinting strength of the pigment, colours should be specified by either selecting a particular colour from a manufacturer's range, or specifying a colour in conjunction with the manufacturer.
- The colour of the cement will affect the final colour of the concrete.
- If pigments are added on site, the concrete should be thoroughly mixed to ensure an even distribution of pigment.
- The use of pigments will generally mask minor colour variations between different batches of concrete.

Pigments come in a range of colours for any application



Integrally coloured concrete blends with red rock environment

#### Key points when using coloured toppings and render

- A monolithic topping is a layer of concrete that is placed on top of an insitu or precast panel while it is still in the plastic state. This allows bonding of the two as they harden simultaneously, effectively producing a monolithic unit. The appearance can be the same as for integral colour, but of course the colour appears only on one side. Cost savings are possible as a result of the reduced amount of pigment required.
- Dry shake topping products are a form of monolithic topping and can be supplied as pre-bagged mixtures of pigment, cement and sand. They can also contain a surface hardener to increase the strength of the concrete surface and consequently its resistance to abrasion. The method involves broadcasting the powder by hand onto the surface of pre-hardened concrete, following the evaporation of bleed water. The surface is floated and finished in the same way as general concrete. Curing requires care to avoid patchiness of colour. After hardening, a thin monolithic coloured layer results.
- Bonded toppings are thin layers of coloured material applied to the surface after the concrete has hardened. Preparation, bonding of the topping to the existing surface and timing of application are critical aspects if delamination is to be avoided. For a concrete topping mix containing a 10-mm aggregate, a practical range would be a thickness between 20 and 40 mm.
- Renders are a form of bonded topping typically applied to vertical, rather than horizontal surfaces. See *Key points when using applied finishes*.
- Regardless of the method of topping/rendering, consistency of the colour is important. Pre-bagged products should be from the one production lot and the same quantity of water added to each bag when mixing, as variations may cause colour changes. Similarly, all pre-mixed concrete should be from the

same load or batch. If more than one batch of concrete is required, provision should be made to allow for some colour variation between batches, albeit minor. If hand batching smaller loads, the proportion of all ingredients should be kept constant, and minor colour variations between mixes should be expected.

#### Key points when using exposed aggregates

- The size of the aggregate should reflect the scale of the element and the viewing distance. As a guide 10- to 20-mm stones are appropriate for a viewing distance up to about 12 m, 20- to 25-mm stones up to about 20 m, and 25- to 32-mm stones up to about 27 m.
- Single-sized aggregates achieve a better density of aggregate on the exposed surface, especially if the water-washing technique is used.
- Expensive aggregates can be seeded onto the surface and trowelled in (for horizontally cast elements) to avoid using them throughout the concrete mix.
- For specific applications, the proportion of different aggregates within the mix can be specified, eg 80% of a particular river gravel and 20% white quartz.
- Tooled finishes such as point tooling, hammered nib and abrasive blasting can be used for insitu work. Techniques such as acid etching, water washing and seeding the surface, generally, require the element to be cast horizontally.
- Increased cover to reinforcement may be required to allow for the depth of tooling or exposure of the aggregates.
- Exposed aggregate finishes can also be achieved by embedding stones into the surface of elements cast horizontally. The size and spacing can be designed to achieve various results.

Colour of aggregates will predominate once exposed.  
Point tooled finish



Stones embedded in surface of precast sound barrier panels

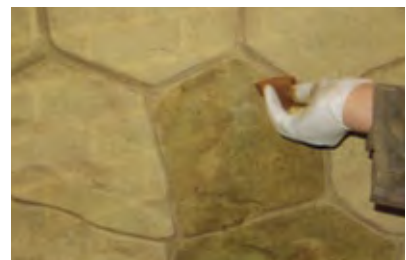
While the aggregates do not cover the entire surface, their scale and viewing distance provide a coloured and textured solution.



Stones embedded in precast panels used for the Hull Bridge at Mt Hotham  
*[architect Fooks, Martin, Sandow & Anson Pty Ltd (FSMA) with permission]*

#### Key points when using chemical stains

- As the colour intensity is affected by the colour of the cement and its content, these should be specified. For example, portland cement (Type GP) will produce more-intense colours. A high cement content will also be beneficial in this regard.
- Concrete supply, placement, compaction and curing should be as consistent as possible to ensure a reasonably even penetration of the stain. While stains will always produce a mottled finish, the intensity of colour may vary between batches and areas where finishing and curing procedures have varied.
- Spray application should be used for consistent colour over large areas. Work should proceed uniformly from one point and spray pattern should overlap the previously coated area. The applicator should stand on unsprayed areas and work away from completed work to avoid marking the surface.
- Application by brush should be limited to small areas or those where some brush marks and lighter/darker areas can be tolerated. For applications where non-uniform finishes are required, brush marks may enhance the appearance.
- Application on vertical surfaces can be made using a sponge to prevent runoff and allow absorption into concrete surface. However, it is generally easier and more cost effective to apply stains to horizontal surfaces such as precast and tilt-up walling panels. The ability to pond stains on the surface will typically result in greater stain penetration and therefore improved colour intensity.



Applying chemical stain to a stamped vertical surface using a sponge  
*[reproduced with permission from 'Concrete' Vol. 40 No. 3 April 2006]*

## OFF-FORM FINISHES

### Key points for smooth finishes

- Smooth finishes from materials such as plastic-coated plywood and fibreglass should not be used on surfaces that will be viewed close-up, ie from closer than three metres. This is because it is difficult to ensure that such surfaces are blemish-free and very difficult, if not impossible, to repair areas and have them match the adjacent finish and/or colour. However, they are appropriate for surfaces visible only from greater distances.
- Achieving consistent colour over large areas can be difficult. Without any texture on the surface to mask minor colour variations, smooth finishes tend to highlight any colour variations.
- If colour control is required, similar to other types of finishes, all aspects of the construction from concrete material to placing, finishing and curing must be kept consistent. The absorbency of the form face must also be uniform to avoid colour variations. Lightly sanding the form face with fine sandpaper will help improve colour control as will 'pickling' the formwork surface before use.
- Joints between form face sheets should be tight and preferably sealed, to avoid grout or water loss that may cause staining of the surface or areas of honeycombed concrete. Horizontal construction joints may also need to be sealed to avoid grout loss and staining of completed work below.

### Key points when using formliners

- Textured or modelled surfaces disguise imperfections in concrete surfaces.
- Formliner materials include styrene foam, rigid plastics, fibreglass, polyurethane rubbers, silicone rubbers, profiled steel sheet and timber battens. The choice of the formliner material will be based on the complexity and depth of the modelled surface, and the number of reuses. Undercut surfaces, for example are formed with flexible, elastomeric

liners such as polyurethane or silicone rubbers to allow the mould to be stripped without tearing the concrete from the panel.

- Good seals at joints of abutting liners prevent leakage of cement paste. In the case of rigid formliners, it is advisable to stop the moulded surface short of the panel edges to control the tightness of joints, and minor misalignment of panels.
- The release agent must be compatible with the formliner material.
- Cement hydration increases the concrete temperature. High temperatures may degrade some formliners. Stripping the forms after 24 hours avoids prolonged exposure to increased temperature. Also, the forms should be shaded from direct sun during the casting process.
- The concrete should be well compacted by vibration.
- The forms should be cleaned before reuse.

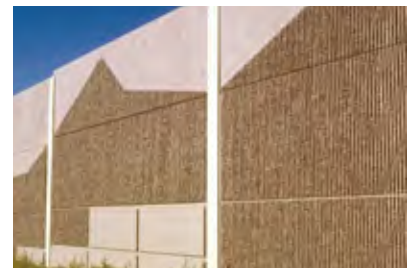
### Panels produced with rubber formliners



### Panels produced with plastic formliners



### Formliner used to create rough texture (note rebates used between panels to produce clean lines and avoid joints in formliners)



### Formliner used to create recurring pattern – integral colour used





Identical panels integrated to achieve unique appearance as a whole (Art Panel at Galleria Apartments, Brisbane)

Fine casting against a formliner can produce intricate patterns resembling wall paper [reproduced with permission from 'Concrete' Vol. 40 No. 3 April 2006]



## EXPOSED AGGREGATES

### Key points when using honing and polishing

- Honing is the process where the surface is ground with 30 to 220 grit abrasive to expose the aggregates and give a matt finish. Polishing the surface requires further grinding with finer abrasives and generally produces a surface that has a high lustre resembling polished granite.
- Not all aggregates will polish to a high lustre. Most commercial quartzites, limestone and basalt can be honed but not highly polished. Granites can be highly polished and are available in a broad range of colours. Quartz, and river gravels composed primarily of quartz, can also be highly polished, although the colour range is limited.
- A concrete mix with continuously-graded aggregates in the usual proportions will generally result in a non-uniform distribution of the coarse aggregates.
- To achieve uniformity, the intermediate aggregate sizes are often omitted in what is called a gap-graded concrete mix. In gap-grading, a larger percentage of coarse aggregate and a smaller percentage of fine aggregate – sufficient for workability – are used.
- Aggregates should be stockpiled in sufficient quantities for a project to ensure uniformity of colour.
- Test panels should be used as a basis for specification, tendering and quality control during manufacture.
- The cement matrix can be coloured with pigments. See *Key points when using pigments*.
- Areas requiring hand work should be minimised to reduce costs.
- For surfaces with projections, the corners at the base of the projections will require hand polishing unless rebates around the projection can be incorporated to provide an edge capable of being machine polished.
- Polishing machines will pass over grooves and other rebates leaving them unpolished. To reveal the aggregates, the grooves can be

abrasive blasted or etched prior to polishing the surface.

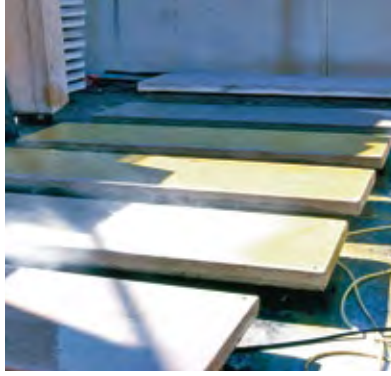
- For panels containing different finishes, areas to be honed/polished should be separated by either wide grooves or be slightly higher than adjacent areas to allow the grinding machine to grind to the edge of the area.
- Convex surfaces with a radius of 3 m or more can be polished by computerised polishing machinery. However, concave surfaces are unsuitable as the polishing head, even in smaller hand tools, is generally flat. Polishing of concave surfaces can be achieved as either a series of narrow, flat strips or by profiling the grinding head: the latter is rarely employed due to the increased cost.
- Columns ranging in diameter from 200–1200 mm can be polished and should be sized to allow rotation under the available polishing machine.
- Sharp edges are vulnerable to chipping during polishing and transporting. Bevels or chamfers of a minimum of 10 mm are recommended. These can also be polished.
- If it is necessary to have lifting ferrules in a polished surface they should be stainless steel and recessed. Attempting to disguise them with flush filled patching is not recommended; the use of stainless steel cover plates or caps, or polished reconstructed stone plugs is preferable.

Polished concrete panels provide excellent weathering characteristics with no sealer required



### Key points when using acid etching

- Diluted acids are used to remove the surface skin of cement paste to reveal the underlying aggregates – usually sand and the smaller stones.
- Concrete must be well compacted, cured for a minimum of 7 days, free from cracks and have sufficient cover for reinforcement to allow for depth of etching.
- Textures resembling fine sandpaper are commonly specified, although deeper etching that reveals coarse aggregate is possible.
- Contractors should be experienced. Etching involves controlled and deliberate action over small areas at any one time. Different operators may produce slight variations in finish; results are usually better if the same operator works on the entire panel. Operators should be coordinated to improve consistency between adjoining panels.
- Precast panels or elements should be inclined during etching to prevent ponding, which should be avoided.
- After etching, the surface must be thoroughly washed with water to remove any residual acid.
- Acid etching is often done to improve the colour uniformity of panels. However, during the manufacturing process different panels may be subjected to varying levels of ambient humidity. Initially, tonal variations in colour might be considered unsatisfactory, but are likely to moderate when the panels have balanced moisture content.
- The combination of etching and honing produces a surface characterised by flat coarse aggregate, which is slightly proud of the underlying matrix. Pedestrian pavements are treated in this way to improve slip resistance.



Acid etching process (above) and light and medium textures (below)



### Key points when using abrasive blasting

- Abrasive blasting using either sand or grit (boiler slag or carborundum) produces a cost-effective finish with good weathering characteristics. The sand or grit can be either airborne or air/water borne. The choice of medium is best left to the contractor.
- The concrete should be properly placed and compacted. Sandblasting may reveal air voids/blow holes or areas of honeycombed concrete resulting from inadequate placing and compaction.
- Abrasive blasting is usually followed by a light acid wash to clean the surface.
- Grades of abrasive blasting may be described as follows:  
**Brush blasting** produces a light surface texture that feels like sandpaper. It does not reveal the coarse aggregates. The resulting colour is that of the cement matrix. Brush blasting can be done at any time after seven days from casting.

**Light blasting** removes the surface skin to reveal the fine aggregates (sand) and a little of the coarse aggregate. The sand dominates the colour; the colour of the cement paste and the coarse aggregates are secondary. Light blasting can be done between 7 and 45 days.

**Medium blasting** exposes the coarse aggregate so that it projects about 6 mm from the surface. As two-thirds of the stone should remain embedded in the concrete, this will dictate the use of a minimum 20 mm aggregate size. Coarse aggregate should be hard enough to resist the extended blasting so it too is not eroded at the same rate as the cement matrix. To assist with the removal of the cement matrix, medium blasting should be carried out at an early age, usually before seven days from the time of casting.

**Heavy blasting** results in exposing up to one third of the coarse aggregate. To increase the texture achieved, a larger aggregate could be used. To achieve uniformity a higher proportion of coarse aggregates is generally needed. The colour is dominated by the coarse aggregates. Heavy blasting should be carried out prior to any substantial strength gain in the concrete, usually within 24 hours from the time of casting.

- A surface set retarder is recommended for medium and heavy blasting. This will generally help achieve a more uniform finish at lower cost.
- Sample panels are recommended to assist in making selections and to become the basis for approvals.

Light blasting produces a coarse sandpaper-like texture





### Key points when using water washing

- After stiffening, but before final setting, the concrete surface is washed with water and lightly brushed to remove the cement matrix to the specified depth. Often the surface may be re-trowelled and the washing operation repeated to improve the uniformity of aggregate in the surface.
- Exposure of the fine aggregates (sands) or coarse aggregates (stones) will contribute significantly to the overall colour of the surface. To ensure adequate bond into the concrete, no more than one third of the stone should be exposed.
- The low absorption of the aggregates results in reduced staining from airborne grime, and in improved weathering over time.
- Dense coarse aggregates such as river gravels, crushed granites and quartz with a rounded or cubical shape are the most suitable.
- A gap-graded aggregate, or one with a single sized stone, is preferred. Water washing can remove the smaller stones from a continuously graded mix. This reduces the aggregate density at the surface and could result in a non-uniform appearance.
- While the stone size is typically 10–14 mm, larger stones can be used to create coarser textures to suit the scale of larger buildings/spaces. Larger aggregates increase the amount of cement paste that needs to be removed from between stones. Returns and reveals are also more difficult to detail.
- Fine and coarse aggregates should be stockpiled for a project to ensure uniform colour throughout the work.
- The cement matrix can be coloured with the selection of cement, sand and pigments, to complement or contrast with the stones.
- Panels are normally cast 'face-up'. However, 'face-down' casting is possible by applying a surface set-retarder to the face of the form. Water washing commences after the panel is removed from the form.

- Alternatively, the surface of panels can be 'seeded' with selected aggregates, which reduces the cost by eliminating the need for expensive aggregates throughout the mix. They are cast over the surface and tamped/bull-floated to embed them beneath the surface. The surface is floated and trowelled, and washed in the same way.

### Key points when using surface set retarders

- Set retarders slow the setting process without impairing the final hardening or the ultimate strength of the concrete. Once stripped, the concrete surface should be washed or blasted to remove the retarded cement paste as soon as possible, and before the concrete surface hardens.
- Different types of surface set retarders are available to suit different applications and conditions. Some are solvent based, some water based.
- Different grades of retarder result in different depths of paste removal.
- The mix design will influence the degree of paste removal. Proportions of water (water-cement ratio), aggregate grading, admixtures (eg plasticisers), and the type of cement will all affect the depth of paste removal. Test panels are essential. Heat curing (steam curing) reduces the degree of paste removal.
- Thicker elements or high strength concrete can develop high temperatures at an early age. This may result in an increased rate of strength development, which in turn, may affect the depth of paste removal. Test panels should be based on the actual panel thickness.
- Careful placement and compaction of the concrete is required to ensure that the surface set retarder (applied to the form face) remains in its correct location.
- Use of fugitive dyes may assist in achieving a uniform coverage of the surface set retarder.

Selective exposure of aggregates produced by painting set retarder onto form face, followed by water washing



### Key points when using tooled finishes

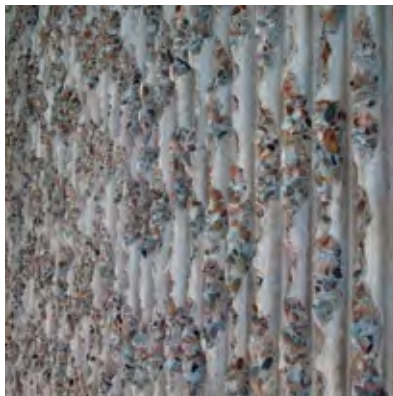
- Tooled finishes involve mechanically tooling or hammering an off-form finish to produce a rough texture. Tooling should be carried out after the concrete has reached its design strength. Additional concrete cover to reinforcement must be provided to allow for the depth of removal during tooling.
- The depth of removal depends on the process being used. Bush hammering may vary from removal of the surface cement paste to extensive removal of the matrix and possible fracturing of the stone. The depth of hammering must be specified (typically 1 to 8 mm) and the appearance verified by a test panel.
- Point tooling provides a very coarse texture about 15 mm in depth. It will generally remove or conceal any surface imperfections; a large aggregate should be used. Note that this type of coarse texture is generally suited to larger-scale projects or spaces.
- Hammered-nib finishes involve producing a smooth off-form striated finish and then hammering the nibs to produce a rugged broken appearance that highlights the coarse aggregate. The base striated finish and degree of hammering must be specified. Striated finishes can vary from square and curved profiles to triangular shapes, while the options for hammering range from producing a continuously fractured nib, to hammering only at specific centres (eg 250 mm) or hammering alternatively from each side of the nib.
- The strength of the aggregates should prevent excessive fracturing or wearing away of the stone during the tooling process.

Abrasive blasted finish on left.  
Point tooled finish on right.



Hammered nib finish

Hammered nib using 'V' shaped nib and larger aggregates. Note how from a distance the aggregate colour predominates



Hammered nib finish replicated with silicon rubber formliner. Note absence of exposed aggregates to provide colour

### VENEERS

#### Key points when using stone veneers

- Stone veneers are large relatively thin pieces of stone fixed to a structural concrete panel/wall.
- The method of attachment should take account of concrete shrinkage, stresses from handling and transport, different coefficients of thermal expansion, and service loads, particularly wind suction.
- Mechanical anchors for stone veneer should be flexible to allow relative in-plane movement.
- The precast backing panels should be low-shrinkage concrete with a thermal expansion coefficient that approximates that of the stone. The coefficient of thermal expansion of concrete can be varied by changing the aggregate type.
- Direct adhesion between stone and concrete should be prevented by installing a bond breaker such as membranes or spray-on compounds between materials.
- A moisture barrier between the concrete and the stone should prevent efflorescence on the stone.
- Impact drilling for anchors may induce micro cracking. Diamond tip drills should be used.
- Thickness of stone should generally be 30 mm or more.
- Repairs, if required, should be made with a mixture of epoxy, stone dust and colouring agent.
- Split rock and cobbles can be embedded in concrete panels by first laying them in a sand bed in the bottom of the form and placing structural concrete backing over them. After removing the panel from the form the sand is washed from the surface.
- The subsequent treatment of the surface will determine the strength of the stone to be used. For example, bush hammering will require a higher strength than polishing.





Randomly shaped pieces of marble are mechanically fixed to the backing concrete with anchors and separated with a bond breaker. These panels have been honed and polished.

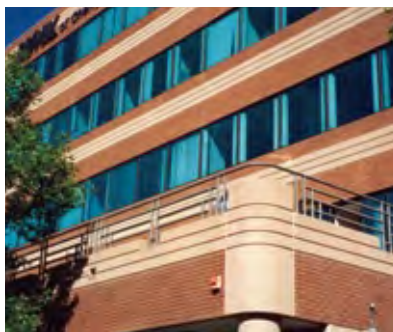
Stones laid in sand bedding and backed with structural concrete panel. Feature brickwork corners conceal joints between panels



### Key points when using brick veneers

- Thin brick tiles or batts can be embedded into the face of concrete panels by laying them face down in purpose-made rubber form liners or plastic carrier-guides which, when removed after casting, form the 'joints'.
- Reinforced concrete is placed to form a structural, backing panel.
- A thin coloured layer of concrete can be placed over the bricks to vary the 'mortar' colour between the brick units prior to placing the remainder of the panel with normal grey concrete.
- Panel lengths and corner returns should be designed to match the brick pattern so that joint locations have a regular bond pattern.

Brick batts used as a surface veneer on selected areas of precast panels.



### APPLIED FINISHES

#### Key points when using cement render

- Cement render bonds to the substrate through the chemical reactions of the cement particles that are drawn into the surface of the substrate by the suction of water (containing the cement particles) from the render. The degree of suction is adequate on low-strength concrete (eg 20 MPa) but is inadequate on high-strength mixes (eg 50 MPa or more) or other non-porous substrates. Any debonding agents, curing compounds, paint or other coatings which could affect the bonding mechanism must therefore be removed prior to application of render. Providing a mechanical bond by, for example, using metal lath fixed to the wall is an alternative solution in these

situations. Note that scabbling the surface of concrete will not improve suction but will increase the surface area for adhesion and provide some mechanical bond.

- Shrinkage and cracking are essentially related to the water content of the render. The more water the greater the likelihood of shrinkage. The demand for water can be reduced by careful choice of sand (ideally well graded) with negligible clay fraction and of good particle shape (rounded or cubic).
- Admixtures that improve workability, such as acrylic polymers, have been shown to reduce the requirement for water and impede evaporation, which in turn reduces shrinkage.
- Smaller areas divided by joints will reduce the risk of cracking.
- Joints should be provided at all changes of material and direction and at built-in items such as damp courses.
- Joints should be provided in render, and aligned with joints in the background panel. Render should not be continuous across joints in the structure as movement at the joints may cause cracking.
- Textures range from smooth surfaces (similar to fine sandpaper) produced with a variety of hand-held floats, to coarse textures such as 'bagged' finishes (a relatively low-cost rustic-style finish that masks the defects), and a machine-sprayed coarse, spatter-texture finish. Other decorative finishes are made by combing or raking the surface, or using special tools.
- Cement render can be coloured with pigments.

Coloured render being applied to wall  
[reproduced with permission from 'Concrete' Vol. 40 No. 3 April 2006]



### Key points when using stencilled and stamped finishes

- The correct timing of the cardboard stencil and colour hardener application is critical to the success and durability of the finish. If the cardboard stencil is inadequately bonded to the surface it may adhere to the topping and leave ragged edges when removed. The colour may also penetrate beneath the stencil and colour the pattern lines formed by the stencil. If the concrete is too wet and stencils are embedded too deeply, they will be difficult to remove and also leave ragged edges and uneven 'joint' depths.
- The timing of stamping is also critical to avoid crusting of the surface (from drying) and consequent cracking of the concrete where stamps are pressed into the surface.
- Joints should be incorporated at existing joints in the building.
- The colour should be applied in two stages at 90° to each other to ensure an even distribution of colour. For dark colours, the application of extra colour hardener (third coat) should be considered to ensure no lighter coloured areas remain and result in a mottled finish.
- The surface must be cured to allow the cementitious colour hardener to gain strength for durability.
- The release agent used for stamped finishes (to prevent moulds from adhering to the concrete) must be thoroughly removed prior to the application of the surface sealer to ensure adequate bond to the surface and minimise the risk of efflorescence.

### Key points when using applied coatings and paints

- Surfaces should be clean and free of oil, release agents, curing compounds, laitance, efflorescence and any other material that may affect the bond of the coating/paint to the concrete surface.
- Surfaces should be prepared and the coating/paint applied in accordance with the manufacturer's recommendations, especially if a waterproofing or durability function is required from the coating/paint.
- Product should be thoroughly mixed to ensure uniform colour is achieved. This is particularly important for cement-based products where regular mixing may be required to prevent settlement of the constituents and colour variations.
- Coating/paint should be alkali resistant as concrete is highly alkaline. A suitable sealer may be required.
- If applying close to the ground where moisture or rising damp may exist, a suitable moisture resistant coating/paint should be used. If coating/painting rendered surfaces near the ground, a joint should be incorporated at the damp course level to prevent rising damp affecting the adhesion/colour of the coating.
- Cost savings can result from pre-priming and painting precast panels before delivery to site.
- If cement-based paints and coatings are used, any specific requirements by the manufacturer relating to the curing of the material should be followed.

Pigmented cement-based paint can provide permanent colouring of walls





**Briefing 03 September 2006** supersedes Briefing 03 July 2000

**OTHER BRIEFINGS** available online from [www.concrete.net.au](http://www.concrete.net.au) are:

**Briefing 01** *Colouring, stencilling and stamping concrete flatwork*

**Briefing 02** *Exposed aggregate finishes for flatwork*

**Briefing 04** *Concrete panel homes*

**Briefing 05** *Polished concrete floors*

**Briefing 06** *Form liners achieving surface relief and texture*

**Briefing 07** *Concrete floor heating*

**Briefing 08** *Concrete panel buildings*

**Briefing 09** *Passive solar design*

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