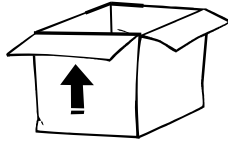




This is an outline and guide for curing of decorative concrete for horizontal applications. The guide does not include any guidelines for vertical applications. Please refer to ACI 303.



This guide is different to many other guides on curing and stresses thinking outside of the box (ACI 308) with decorative concrete. One of the primary purposes of curing is to slow the moisture loss from the concrete and reduce carbonization (ACI 302 9.1 The Purpose of Curing).

The Guideline recognizes that normal curing for decorative concrete is unrealistic, in some cases. When executing decorative curing practices, it is highly recommended that all materials be on the job site and ready to use when the appointed curing window becomes open. All parties involved must perform this critical operation as quickly as possible.

When making use of decorative concrete applications, with either stamping or trowel finish or colored floors, consider the weather and the effects on the concrete. Low humidity, windy and hot weather all increase the rate of bleed water evaporation and should be avoided if construction schedules allow postponement of pours. When possible, schedule decorative concrete pours at different times from than normal concrete. The final look of decorative concrete is typically much more important than the speed of placement. When postponement of a pour is not possible, the use of wind breaks, misting to increase humidity and early morning or late evening pours are within the guidelines of ACI 308 1.4.1 can be effective mitigation techniques. For pouring on windy and hot days, refer to ACI 308 Nomograph on evaporation rates.

The Nomograph calculates the

- #1 Air temperature in / F
- #2 Humidity in percentage
- # 3 Concrete Temperatures in / F
- # 4 Wind speed

You can then with some simple math find the rate of evaporation in the concrete knowing this can aid in finishing procedures.

Reference ACI 305

ASTM C 1064

Mix designs that optimized aggregate gradation will have lower water demands. Use of clean, sound, hard aggregates is recommended for decorative concrete applications. Aggregate sources that contain more than two-percent materials passing a number 150 μm (No. 100) sieve or that have low durability should not be used. Aggregate that is known to be reactive shall not be used. Lower water-cement ratios reduce the amount of water and result in better concrete color as well as durability for the concrete.

Air-entrained mixes properly compacted and graded subgrades and surface hardeners reduce slab surface dehydration rates. This can reduce the risk of carbonization on the surface of the concrete. Many stamped and stenciled concrete projects make use of fiber reinforcement. Fiber reinforcement helps reduce plastic shrinkage cracking and should be considered for use as many decorative applications cannot be cured as quickly thus the need for fibers in help with control of early shrinkage.

The use of chemical admixtures should be considered as they reduce the mixes water demand and increase workability, which aids the placement of decorative concrete. Please note that color suppliers of both integral and hardener, and curing manufactures should be contacted for their preferred methods of curing and compatibility of cures with coloring agents, especially dyes and stains!



CURING OF DECORATIVE CONCRETE

A Guide for Curing of Decorative Concrete

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References:

- ◆ *ACI 302 Concrete Floor and Slab Construction*
- ◆ *ACI 308 Guide to Curing*
- ◆ *ACI 310 Decorative Concrete*
- ◆ *ACI 305 Hot weather*

- ◆ *ASTM C156 Test for Moisture Retained After Cures are Applied*
- ◆ *ASTM C309 Specification for Curing*
- ◆ *ASTM C1315 Test for Cures with Special Properties*
- ◆ *ASTM C 1064 Temperature of fresh concrete*

- ◆ *ICRI Guideline 03732 Guide for Selecting Profiles for Floor Coatings and Surface Preparation Methods*

CURING (ACI 308)

The term curing describes the process in which hydraulic cement matures and develops the hardened properties of the concrete. The rate of evaporation greatly affects how well curing takes place. The rate of evaporation depends on the environment surrounding the concrete and the measures taken to limit the loss of hydration water and heat (note ACI 308-81 and ACI 308 2.3.2 on rapid evaporation loss).

The use of evaporation retardants can be extremely effective in decorative concrete applications. Even when the weather conditions are ideal for concrete placement, the inherent nature of coloring and antiquing of decorative concrete can delay standard curing methods. Every extra step that can be done should insure the concrete has maximum protection during the early stages of hydration.

Evaporation retardants slow moisture loss and should NEVER be worked into the fresh concrete if labels say finishing aid be sure and call the manufacturer to insure the material will be properly used.

Protection on bright sunny days is also critical to the decorative concrete especially when colors are involved careful placement and cure methods are vital on these days, when pouring against buildings or walls they may reflect heat and sunlight onto the slab therefore affecting the look of the colored concrete

Proper curing allows the concrete to hydrate and slows early moisture loss. The curing period is defined from the beginning of placement to until the desired properties of the concrete have been achieved. Concrete that is well cured will darken the look of the concrete while poorly cured or un-cured concrete can result in an uneven look.

This guideline will follow ACI 308 and add additional information as approved through ACI 308 and ACI 310.

When curing concrete it is important to remember that some methods used have been misinterpreted. Although decorative concrete practices have been used for many years, proper curing has been avoided and the difference between curing and sealing has been misunderstood. Both liquid release agents and evaporation retardants *do not* qualify as concrete cures but have been used so in the past.

Every effort should be made to cure decorative concrete as soon as possible. Curing should take place immediately after finishing when no damage will be done to the concrete surface. Curing too soon, (which happens often on grey concrete) can alter the appearance of the decorative concrete. Refer to ACI 308 1.4.2.2.4 and 1.4.2.2.5 for more information.

Many membrane cures that are sprayed on too quickly can slightly damage the surface sometimes giving the look of raindrops. Membrane cures are usually used with decorative concrete since appearance is usually of the utmost importance. The membrane cure should be carefully chosen before placement to insure the proper cures are used and must be applied properly. Even application of internal and external curing must take place to reduce the risk of damage (including light and dark spots) to the concrete surface. Be sure that no visible damage will be done to the concrete surface when membrane cures are applied. With decorative applications, normal cure practices will be delayed for a time depending on what method is used.

Who should know when curing should begin:

- ◆ Owner
- ◆ Architect
- ◆ Testing firm
- ◆ General contractor
- ◆ Concrete contractor
- ◆ Engineer
- ◆ Ready mix supplier
- ◆ Sub-contractor (who may apply stains, dyes or polishes floors)
- ◆ Any sub-contractor who will be on the concrete in the first 72 hours

Care must be taken for floors or other concrete slabs that will later receive decorative toppings such as:

- ◆ Stains or dyes
- ◆ Micro toppings or stamped overlayments
- ◆ Polished concrete
- ◆ Epoxy urethane or special types of sealed floors

When such floors are specified, pre-job checklists should be provided and a pre-job conference should address such issues before construction begins. Open communication between contractors and suppliers will result in a successful, durable concrete slab. Attendance at pre-job meetings should be by all parties involved including:

- ◆ Color suppliers
- ◆ Curing supplier
- ◆ Ready mix supplier
- ◆ Testing labs (cylinders should also be taken on mockups including one for color review)

The rest of this guide will focus on curing techniques and notes specific to decorative concrete including:

- ◆ Imprinted Concrete (stamped and stenciled)
- ◆ Floors and Pavements (colored and stained)
- ◆ Polished Concrete

Who should apply curing compounds or materials?

- Experienced concrete finishers
- Who understand the methods and application rates
- Finishers who understand the importance of curing

IMPRINTED CONCRETE

Curing is very important to keep decorative concrete lasting as long as possible. It was not long ago that curing was avoided and curing compounds were used exclusively as sealers. Little was known about:

- ◆ Water/cement ratios
- ◆ Types of cures
- ◆ Air entrainment admixtures
- ◆ However, we have learned a lot and continue to learn increasing life cycle costs, providing a sustainable product is key to the continued success of decorative concrete, and finding as well as curing will only increase the demand, and the success of this phase of concrete.

Add to this the fact that most traditional curing methods did not work well on stamped, colored and stenciled concrete. Early stamping methods were also done exclusively with powdered release agents, and curing was not an option with membrane cure types. Early membrane compounds would discolor the concrete, which was fine for normal concrete but not for decorative concrete. Concrete manufacturers and suppliers were more concerned about normal concrete and the up and coming laws affecting cures and sealers (SEPT 1999 VOCs) governing their use. As prices were rising almost monthly, not much effort was put forth to better the curing methods until the past few years.

The use of decorative concrete has increased the need for proper curing methods. Proper curing methods are now at the forefront of the concrete industry and it is important to find better ways to cure. With the use of liquid release agents, it has become much easier to cure certain types of imprinted concrete.

Curing of decorative concrete should be done as soon as possible after the final finishing of the concrete. This is when no visible damage will be done to the concrete surface that will affect the final appearance.

It is also important to mention that there are significant differences between curing and sealing. Curing holds moisture in the concrete while sealing keeps moisture out. Sealing should always be done according to the method by the sealer manufacturer. There are some curing products that are specified for both curing and sealing. These should have the allowed time between the cure application and the seal application. Sealers should also be compatible with the curing agent used or removal of the curing agents may be required. Early sealing on jobs can result in the sealer taking on a milky/white look in most cases. This is early hydration water being trapped and sealed in too soon.

STAMPED CONCRETE

Stamped concrete is one of, if not the most, popular methods of coloring, imprinting, providing texture, and use of concrete as a sustainable material. Its use began to grow in the early 1950's by Brad Bowman and the founding of the Bomanite Company. Today stamped concrete is widely used in all 50 states and now much of the world has followed suit to provide stamped concrete as a successful sustainable building material. Manipulating the texture of concrete was originally provided with metal tools, which quickly involved to rubber, textured stamping mats, which are now used daily in stamped concrete projects across the world.

STAMPED CONCRETE WITH INTEGRAL COLORING SYSTEMS

The addition of color can be used to enhance the effects of stamped concrete. Introducing color to concrete was first provided through broadcast color hardeners. A powdered releasing agent (usually a different color) was used to provide a contrasting or antiquing look. Today's methods involve using both integral colors and broadcast colors (color hardeners). These chemicals should meet ASTM C979 otherwise, even effective curing methods may lead to uneven looks in the colored, textured concrete.

Curing of stamped concrete should be done as quickly as possible. The use of a membrane compound that meets ASTM C1315 or ASTM C309 will allow for curing soon after stamping is completed. These

compounds also need to be compatible with any sealers or secondary colors that may be used. The use of dissipating cures may be needed when other colors are to be later applied. Some curing papers may also be used. Several companies offer a waxed or water-based curing compound of the same color. These can be very effective means on the one color system of decorative concrete. These cures should be of high quality materials that keep color true and not amber or wear off quickly.

Note: The use of dissipating cures requires a longer period for applying secondary colors or sealers. Be sure that both owners and other contractors know that while they are effective methods they will slow the construction process. The use of sodium silicates does not meet the requirements of ASTM C 309. They state that they are a chemical reactive and not membrane, however, contractors have used this method with no negative, visible results for years. (ASTM 309 1991 STATEMENT)

The use of some solvent borne cures containing small amounts of colored release powders can provide both a cure and antiquing effect on stamped concrete. When this method is used, the manufacture should specify the guidelines and coverage rates. Some of these methods may require thinning of the curing compounds. If this method is used, it should be with materials that meet both local and federal standards.

When this method is used contractor experience, look desired, color of release agent, type of texture will all factor into the amount of both powder and cure used.

STAMPED CONCRETE WITH AN ANTIQUING AFFECT

Several companies now offer antiquing solutions. These can be applied shortly after stamping. Curing compounds may then be applied after these materials have sufficiently dried. If these antiquing methods are to be used, be sure they are compatible with the curing agent that will be applied. These methods have been field proven with very good results. There are, however, some concerns with these products. These types of compounds cannot be applied if a powdered release agent has been applied to the concrete. These compounds can be easily applied to concrete but if stains, dyes or other treatments might be applied, some curing compounds should not be used or they will need to be stripped completely before application of these materials. As of now, no liquid or membrane curing compounds can be applied over either stamped or stenciled concrete where a powdered release agent has been used. The use of impervious paper or non-wrinkling staining, Kraft paper or curing blankets may be used with caution as some can promote efflorescence. These methods should *always* be done with mock-ups and be approved before construction begins.

Use of the one-time rolls of paper is the most effective concerning both labor and cost. These papers should meet ASTM C309 for moisture retention in compliance with ASTM C156. This material should also meet the requirements of ASTM C171.

The use of one-time roll papers can keep hydration water in for extended time but each job should be evaluated and approved in mock-ups. Care will need to be taken that these materials are as wrinkle free as possible to avoid a blotchy look on the concrete's surface. If curing blankets and paper are to be used, they should also be inspected for any organic impurities. It is important for the papers to be installed properly, for the paper to be as wrinkle free as possible and to ensure that the edges are properly covered to make these materials as effective as possible. If curing paper is used, consult the manufacturer. Curing in colder weather or wet weather can lead to issues with efflorescence in the concrete. Carefully decide if curing papers are the best for the job. Several contractors have successfully laid curing papers over stamped concrete when release powder has been used with no negative results.

This guide does not address issues with saw cutting of fresh concrete when a curing paper is used, or curing compounds. This guide suggests that for each job that a curing paper is used should be considered on a case-by-case basis. All procedures and curing methods should be the same on the mock-up as on the project. All work should be done by the same person that will also be on the job. Saw cuts should be planned out at pre-job meetings before placement.

Note: If saw cutting is done before application of cures or sealers, any dust MUST be removed before the curing agent is applied. Traditional methods of cutting of control joints for the most part cannot be done in decorative jobs. All excess must be removed if cuts are done after curing. Have procedures in place to remove all dust immediately. Joints should be always preplanned and work within the period of any curing method. Avoid excess water when cutting colored concrete as this can affect the final appearance.

STAMPED CONCRETE CURING METHODS

One successful method used by many contractors, has been to add an additional layer of release powder when the texturing is complete and then to cover with plastic, or curing blankets. If this method is to be used, the excess release should be swept up before any release is washed off. Follow all manufacturers' recommendations for washing and disposing of excess release. Take note that washing off release powder and applying cure and seal products 24-48 hours later is not defined as curing. When this method is used, the concrete surface should be completely dry all construction joints should be checked for water. A leaf blower can be used to dry these joints out before application.

With the use of liquid release agents, curing on stamped concrete can be done much more effectively. Most of these products leave behind no adverse residue, which will affect cures. Contractor experience can play a great role in the success of the contrasting colors. Ask the supplier beforehand if any residue will need to be removed as other curing methods may have to be instituted. If rinsing is required on any new decorative application, avoid power washers. Power washers force too much water into the new concrete surface, and apply a pressure on the new concrete, which may affect the hydration process. A rinse and scrub method, while more work, is best for the concrete.

Note: Liquid release is many times known as "bubble gum" because of an added admixture that smells like bubble gum.

Liquid releases evaporate quickly. One advantage of using a powdered release is the antique effect may be added during the stamping operation to the liquid release. A small amount may be added and mixed into the liquid release. This will allow for curing compounds to be applied as soon as the release has dried. Always be sure that the liquid release has dried. Neither water-based or the solvent-lacquer is compatible with the liquid release so curing will be slightly delayed until the material is dry. **NEVER USE THE SAME SPRAYER FOR RELEASE AND CURES!**

When using liquid release and powdered release agents color, amount used, texture, desired look and contractor experience will determine the amount too to use.

When using membrane-forming compounds on stamped concrete it is highly recommended that experienced concrete finishers perform this stage of the finishing operation. When application is done with pump-up sprayers use quality sprayers. Keep a backup sprayer and extra replacement parts. Never place pump-up sprayers on the fresh concrete as the pressure may cause a small ring look. Also, take care in refilling. Have a workstation to contain any spills and use a funnel to pour. On larger projects, use a floor mat to wipe boots before entering the work area. When using solvent cures always wear protective gloves and eyewear. Always use a clean sprayer for curing. Do not pour out release and then refill with a curing agent. Properly mark all sprayers and containers to avoid mix-ups on jobs. Consider color-coding sprayers to avoid any problems during application.

When using solvent cures inside, provide proper ventilation, use a respirator, tightly close, and seal all air ducts during installation. Whether spraying or rolling, protect the area from over-spray or splashing from the roller. Use only lint free solvent resistant rollers.

Each cure may have different coverage rates. The use of a small rope with the approximate S/F coverage per 1 gallon can help estimate the coverage. Even coverage is vital for an even, consistent look when using membrane compounds. On textured concrete care will need to be taken so that application does not run off the higher areas and accumulate in the grooves.

Application of a cure and seal (most are solvent borne; that meet ASTM C1315) will darken the appearance of the concrete. If the same material is then used as a sealer, it will darken even more. Follow the manufacturer's guidelines for time of application when these materials are used for sealing. Note that neither liquid nor powdered release agents meet the requirements of a curing compound at this time.

Liquid release agents do form a membrane but evaporate quickly, therefore, they do hold in hydration water, but not enough to meet a standard for curing compounds Powder release does cover the entire surface but does not meet the curing specifications. Note that release agents are classified as bond breakers not cures. Tests have shown the release powders do aid in moisture retention.

One of the most effective curing methods is the use of water curing either by ponding, wet burlap (or other like materials) or fog spraying. Water curing by ponding or wet burlap should not be used on colored or stamped concrete. These methods, while effective on normal concrete, can have negative

effects on decorative concrete. The wet surface can effectively lighten the color and give a blotchy appearance (much like plastic sheeting). Water curing of colored concrete may also contribute to efflorescence issues. Fog spraying or misting may be used if care is taken not to allow any moisture to be in contact with colored concrete's surface. This method requires that a high humidity be maintained just above the concrete.

Note: Any colored or textured concrete surface involving decorative concrete should be evenly compacted, well drained and provide adequate slope for drainage. Even grading is necessary for decorative concrete slabs to insure that hydration and curing are as even as possible.

While ACI 310 stresses the importance of mock-ups, it also realizes that on many jobs this may not be possible. When this occurs, pre-plan with careful written documentation of both curing and sealing procedures that outline periods for the stated cures and sealers.

STENCILED CONCRETE AND COLOR HARDENERS

Although there are not many proper procedures for the use of color hardeners, and how they should be cured. ACI 308 and 310 advise curing. ACI 302 advises that the use of plastic sheeting, curing paper, or wet burlap will lead to uneven color, staining or efflorescence. These outlines, however, are only for floors with no texture or use of release agents (ACI 302 8.8.2 paragraph 14). The previously mentioned guidelines for curing of stamped concrete have also been successful when using color hardeners.

One advantage using of color hardeners is that they offer a lower permeability. They still, however, require a cure. Never use water, or plastic for curing. These methods of cures may also cause a blotchy appearance when used for color hardener applications. Several manufacturers offer water-based pigmented cures, which can be successfully applied after finishing or texturing. Note that these area-type cures will wear off and will not cover finishing errors though.

Stenciled concrete presents a major problem with curing and needs to be addressed. Although the above methods can be successful on stamped concrete, stencils cannot be left in place for the time that is required for keeping curing paper on, as most methods require a 3-7 days cover time. Stencils will need to be removed usually within 4-8 hours of placement. Stencil removal will also require some clean-up before the concrete is recovered. As the stencil is removed, small pieces of concrete become dislodged and, if covered with the curing agent, can be difficult to remove. It is not possible to cure as quickly with stenciled concrete as with stamped concrete. In addition, while one might use extra release agent with the stamped concrete this is not feasible with stenciled concrete.

The use of hay or absorbent materials should never be used in decorative applications.

Using finishers with experience in color hardener applications can also help with proper curing methods. These applications, along with the integral systems, need to be evenly floated or towed to ensure a consistent color before the application of cures. Curing methods should be predetermined and approved by both the architect and owner.

Avoid calcium chloride admixtures on colored concrete, as they will lead to discoloration, which neither cures nor sealers can change. Any use of non-chloride admixtures should be predetermined before concrete is poured. These admixtures should not be used unless a mock-up is done and approved during the construction process.

BROOMED OR FLOAT FINISHED CONCRETE

Broomed or float finished concrete can present some of the most difficult situations for the decorative contractor. Customers want even color on these projects. While stamped and stenciled concrete have tolerances because of texture and different patterns, broomed finishes do not have that option. Careful placement, the same water-cement ratios and slumps are required. The concrete must be cured evenly. This also requires even and well drained compacted subgrades.

Failure to provide even, timely curing will result in an uneven look. When the exterior surface of the concrete in a freeze-thaw area is left uncured, the surface is much more prone to scaling. As bad as scaling is for normal, grey concrete it is much worse when color is involved and much more unsightly.

For the best results on broomed or finished concrete, membrane compounds must be applied carefully and according to the manufacturer's directions. When applying the first coat, spray about 2/3 of the required

amount then apply the remaining apply from a different angle. The same holds true if application is done with rollers. Whether using sprayers or rollers protect surrounding areas and avoid overspray.

Use rollers for either the first application or the backroll method. These rollers should meet the required resistance for the cure being used. The use of rollers can many times lead to marks; take care when using this method.

The use of curing paper or water curing is not recommended for broomed or float colored finishes. The use of membrane cures meeting either ASTM C309 or C1315 and that are non-yellowing will give the best look for these finishes. Pigmented cures with a matching color can also be used. Even though some curing papers have provided successful results there is not enough evidence at this time to prove their use consistently.

Both ASTM C309 and C1315 are divided by classes. Classes are based on reactions with UV rays and the tendency to amber.

ASTM C309 CLASSIFICATIONS

- ◆ Type I: Clear with no dye
- ◆ Type I-D: Clear with dye
- ◆ Type II: White pigmented (some dissipating contain dye)
- ◆ Class A: No restrictions
- ◆ Class B: Must be in a resin form

ASTM C1315 CLASSIFICATIONS

- ◆ Type I: Clear
- ◆ Type II: White pigmented (dissipating are water-based only)
- ◆ Class A: Non-yellowing
- ◆ Class B: May have a moderate yellowing
- ◆ Class C: May darken severely and should never be used when color or appearance is a issue

References:

- ◆ *ASTM C309*
- ◆ *ASTM C1315*

Several curing suppliers now offer compounds that are special blended resins for application on colored concrete, consult manufacturers for their use, these are very effective but also are more costly than traditional cures.

The use of water or fogging can also contribute to a blotchy look. This might be acceptable on a colored streetscape where durability is the primary concern and the concrete would not be subject to color scrutiny. When fogging is done, a light cure of ASTM C309 - Type I should then be applied. (water-based only)

While some of these methods can be done with textured concrete, color variations can be accepted because of the texture. Carefully pick cures that are both clear and non-yellowing. Pick cures that will be compatible with any sealers to be used later. Also, be advised that some effective cures will not allow the use of a penetrating sealer that might be applied later. This should be brought up in the preconstruction conference.

The texture of the broom finish can also affect the look of concrete when cures are applied. It is important to remember that even brooming means even curing, which means an even look.

Texture on concrete surfaces may create the look of un-even color but the texture gives the appearance of a different color. (example is a major league baseball field the grass is all the same color green but the way its mowed looks like different colors where in reality it is the same color.

Note: Curing of broomed finishes may be done with a dissipating cure and a clear or colored penetrating sealer may be applied after minimum of a 28-day dry cure time.

EXPOSED AGGREGATE

Exposed aggregate finishes require the removable of the concrete paste at the surface and without the proper curing the top 1/8 – 1/4 in. of the concrete may lose up to 1/2 of the desired strength (ACI 308). Refer to ACI 310 for details on exposed aggregate placement. Traditional methods and even early moisture loss from the surface will not be nearly as critical on this particular method. (Because of the early removable of the paste)

With exposed aggregate, the wet cure method or curing paper method may be used after the paste is removed. A membrane cure should be applied after all saw cuts are made and the surface is dry. Application can be done by either a spray method or a roller method. Many manufactures offer a cure/sealer with a light brown tone that hides slight imperfections and highlight the exposed stone classed as ASTM C1315.

Some of the older exposed aggregate methods require the use of a plastic covering immediately following finishing. This can aid in curing, however, the plastic is only left in place a few hours before paste removal.

Note: New types of retardants now allow for a less exposed aggregate look. When this method is used, the curing process should begin as soon as possible.

Exposed aggregate finishes can also now be colored and stained. Coloring is done with the integral color method where the color is added at the job site or at the ready mix plant. If stains are to be used, care must be taken so any curing compounds do not affect the staining process. The use of a water-based cure applied lightly and evenly after the paste is washed can be effective means of curing. Even though the mix contains much more coarse aggregate, avoid applying cure/seal products until a 28-day dry time.

FLOORS AND PAVEMENTS

Several non-wrinkling curing methods are now available for concrete floors. Care must be taken when curing with these methods over vapor barriers or retardates because efflorescence can be a major issue. The importance of pre-job meetings and mock-ups cannot be over emphasized for any floor of any size when color is used. Follow all specified guidelines and use light colors (preferably white). All edges should be lapped and sealed. Edges should extend downward along formed edges. Any tears should be repaired immediately and the job should be checked at least twice a day during the curing period. There are now polyethylene backed fabrics that are said to be non-staining. Construction traffic will need to be limited during the early cure time with this method to avoid moving of sheets or tears.

If a non-wrinkling curing paper is specified, the manufacturer of the material should be at the pre-job meeting and provide data for its use. They should also be at the mock-up and first pour to insure that the material being used properly. The manufacturer's representative should inspect the vapor barrier system and the subgrade and subbase design. Expectations are high in decorative concrete and advances in curing paper should be coming soon to this expanding industry.

Note: As more colored floors are designed, membrane cures are at an advantage as they rule out wet cure methods. They thereby become a more sustainable flooring method as the excess water is eliminated from the construction, and the burlap or paper is eliminated from the construction costs. (ACI 302 8.6.2)

Much of today's construction is fast track and can be built on undesirable subgrade that during the construction process has lost drainage capabilities. If these conditions exist, care should be taken in selecting a curing method.

Just as impervious coatings have issues with moisture, colored concrete floors have moisture issues. Careful consideration will need to be taken with curing of colored concrete floors. The most effective curing method on colored floors is a non-yellowing membrane cure, which can be either a water-based or solvent, or lacquer based. These need to be applied evenly over floors with approximately 2/3-3/4 of the cure for the first coat and the remaining for the second application. The use of special pigmented cures that matches the floor color is also a very effective cure for colored, singled colored stamped or broomed finished floors. Most meet and exceed the requirements for moisture of ASTM C309. The use of sprayers for this type of application requires a pump-up or power sprayer (either gas or electric). With either type of solvent or lacquer cures, the flash point should be checked and safety precautions followed before application begins. Safety of all cure methods should be addressed at the pre-job meetings or contractor safety meetings. The curing material should leave the sprayers wand in a cone or fan pattern, never in a stream.

Even experienced finishers will not get 100% coverage with this type of system and therefore will need to apply a second coat. All cures should be applied in a light even fashion with the second application from a cross angle much like how color hardeners are applied. Uneven curing can result in an uneven color. Over application can darken the appearance of the concrete while under application will lighten the appearance of the concrete.

A backroll method with a wide, short nap, solvent resistant roller will also help with an even coverage. Never allow curing compounds to puddle in low spots on the concrete. When using roller pads many contractors apply tape with the sticky side out around their hand and roll over the pad to be sure it is lint free.

When applying curing compounds to a large floor area, provide a workstation for filling of the spray equipment. Also, provide a mat to wipe feet before entering the floor. Use protective, disposable boots or shoe coverings when walking on the floor. Never use a hand sprayer and pump-up pressure on the fresh concrete as the downward pressure can leave a ring look on the floor.

POLISHED CONCRETE

Stained, dyed or polished floors still must be cured. If a floor is to only be polished (without a stain or dye), several methods can be used found in ACI 302 and ACI 308 specifications

With a polished floor, some of the paste will be removed and many will be treated with a silicate type hardener or densifier during the polishing process. This allows many wet curing methods to be used. Water curing by ponding, sprinkling or fogging can be used, however, ACI 302 9.2.1 notes that this method should not be used if there are joints in the floor and a vapor barrier installed. This could lead to unsettling of the compacted subgrade. If water is used, the best results will be if the water temperature and concrete temperature are within 20°F of each other.

Wet curing by burlap or polyethylene coverings can also be used for grey, polished floors. The polyethylene method is the most effective for keeping the normal concrete color. These methods require a moist cure from 72 hours to 1 week in most cases. The lighter the color of the material the more effective it can be.

Plastic sheeting can be used with polished floors, but it will leave an uneven color, which may or may not be apparent after the polishing process. This can also be determined by the final grit of the polished floor.

Plastic will also give an uneven appearance if floors are selected to be stained or dyed later.

The Kraft paper/impervious/non-wrinkling curing paper is effective with stained and dyed floors. To ensure proper effectiveness all stains, dyes and any sealers that will be applied:

- ◆ The area must be properly cleaned and rinsed before application
- ◆ The floor should be tested in at least one area before application begins
- ◆ The test area should be approved *in writing* by the owner or general contractor
- ◆ The floor should be prepared according to ICRI Guideline 03732

LIQUID MEMBRANE FORMING COMPOUNDS

Liquid membrane forming compounds should always be predetermined before use on imprinted concrete, polished floors, colored floors. Careful considerations should be given to their use on all types of polished floors, colored floors, and those that might be stained or dyed later.

Most water or solvent/ lacquer membrane cures (more so the solvent/lacquer cures) will leave a film that will cause interference with stains and dyes. Most cures contain either a wax or a resin that is emulsified in water or dissolved in a solvent. The membrane formed by these compounds is what helps retain the moisture content in the freshly poured concrete. Even dissipating type cures can have an adverse effect on the stained and dyed floors. If membrane cures are to be used, the manufacturer of the curing compound should submit a letter of compatibility for the stain or dye that is to be used. If a dissipating cure is selected to be used, avoid over application and the use of a pigmented type cure will help in seeing the coverage rate. These types of cures must be re-mixed before application begins.

Application by proper methods is critical, not only the appearance of the concrete's surface but the durability as well. The use of nozzle spray tips that provide even coverage should always be used. When wear to the nozzle orifice becomes apparent they should be replaced. When spraying, distance should be considered along with the coverage rate. Spray angles, distance, flow rate, pressure and wand length will all play a part in proper coverage. In addition, overlap of 25-30% will give the best results for coverage. When hand sprayers are used, two applications from opposite angles will provide uniform coverage. Apply 2/3 of the chemical on the first pass and 1/3 on the second pass with a 25-30 % lap. Larger projects, such as floors, may require the use automatic machines such as ones used on paving projects. If these are used, the manufacturer of the machine should be present for the initial application.

There are four typical spray patterns:

- ◆ Full cone
- ◆ Hollow cone
- ◆ Flat
- ◆ Fan

Several states have requirements on VOC's (volatile organic compounds) and legislation has been passed that restricts VOC's in curing compounds.

Many contractors prefer to roll on cures when this is done follow the same procedures for safety do not over apply avoid any drips or puddles, use a roller that is lint free and compatible with the cure used avoid over application in grout lines of imprinted concrete, over application of some cures can result in bubbles

DCS cannot overstate both the importance of finding methods to cure decorative concrete and providing even cure over the concrete. It also cannot overstate the importance of selecting quality mix-designs. While the practice of the concrete industry has been to provide an economical mix for normal concrete placement, decorative concrete is produced to satisfy not only durable concrete but provide a different look. It is now being used widely to offer a sustainable building material at much lower costs not only to the end user but also for the environment. In summary, today's decorative concrete is more than just cement, water and aggregates. This technology is used to replace and duplicate many materials. To do this, effective curing needs to be provided.

Curing is also part of the finishing process and should only be done by experienced concrete finishers

This guide is a reference point for finding methods to successfully cure decorative concrete mix-designs , sealers & experienced finishers are not substitute for curing of concrete, even though decorative concrete presents challenges for curing carefully planning and finding ways to cure will result in more durable and add increased permeability to decorative concrete.