Concrete stains and dyes: Surveying

Mixing and matching of chemistries, substrates inspires creation of varied artistic interpretations

With creative designs and application techniques, stains allow for truly unique concrete installations that enhance hardscape and flooring settings. Photos courtesy of Butterfield Color Inc.

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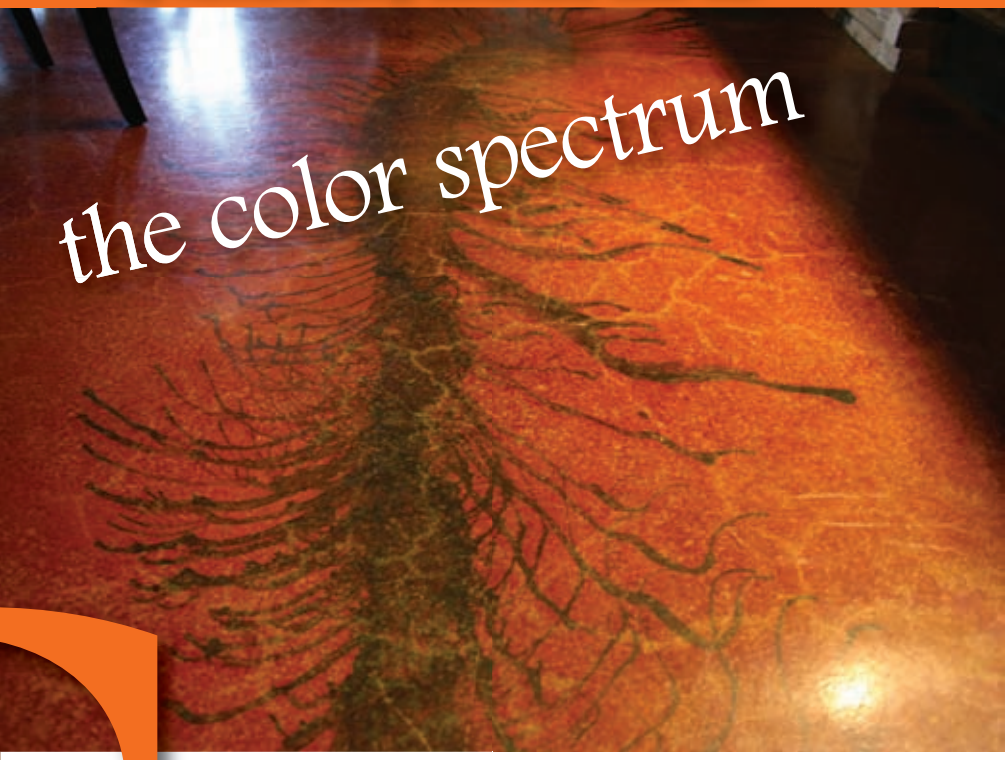
the color spectrum



Concrete can be regarded as an inherently attractive building material, one that conveys the natural impression of stone as a result of its composition, mass, and relative permanence. With the addition of natural-looking color variations, concrete can be given the look of stone in an even more realistic and visually interesting way.

The use of concrete stains can prove to be a highly effective technique for reproducing colors often found in natural earth and rock. When combined with simple and creative application techniques, stains allow for truly unique concrete installations that complement a variety of hardscape and flooring designs.

Stains can also prove quite useful in creating finishes that convey a more contemporary, customized appearance. The use of stains has helped make concrete floors, countertops, and walls very much in demand.

Stains can facilitate the innovative use of concrete in both interior and exterior construction, as we will seek to illustrate in the following discussion. We will address product selection, surface preparation, application techniques, and maintenance as they relate to the application of stains to concrete.

The materials

Stains for use on concrete include three types: chemically reactive stains, non-reactive stains and dyes, and opaque stains.

Chemically reactive stains

Concrete can be colored during installation or after it is fully cured or hardened. Coloring processes employed following cure involve topically applied stains or dyes. Depending on the stain, mottled, variegated earth tones or opaque, vibrant colorations are possible. Including a limited range of translucent, potentially highly variegated, and mottled earth tones, chemically reactive stains consist of metallic salts in an acidic solution that react with the hardened concrete.

The curing or hardening of concrete involves several distinct chemical reactions. One of the by-products of these chemical reactions is the production of calcium hydroxide—$3Ca(OH_2)$—also referred to as hydrated lime. The acid in the chemical stain "opens" the surface of the concrete, allowing the metallic salts to penetrate and reach the hydrated lime deposits. The water in the stain solution then initiates the coloring reaction. If the chemical stain is unable to penetrate the concrete surface because of dirt, sealer, wax, or oil residues, then the coloring reaction may be inhibited. Therefore, surface cleaning prior to chemical staining is critical, even on new concrete.

With chemically reactive stains, most manufacturers offer a limited range of stan-

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dard colors, and custom colors are difficult to produce. The use of many faux painting techniques, however, can broaden the palette of colors and create many interesting effects. A sealer is applied after the staining process is completed to protect the colored surface.

Non-reactive stains or dyes

Non-reactive stains or dyes encompass a broad range of translucent, mottled hues, and are based on color concentrates mixed with water or solvent, depending on the manufacturer's formula. As the name implies, non-reactive stains/dyes do not create color by a chemical reaction. Instead, the color concentrate's ultrafine pigments are carried into the concrete surface by the solvent or water. Surface cleaning and preparation is particularly important with these products, since the material must penetrate the concrete as opposed to drying on the surface like a paint or coating.

As with chemically reactive materials, non-reactive stains and dyes should only be applied to hardened and cured concrete. They should be used when chemical stains cannot produce the desired color due to limitations on the available palette, or when the reaction of a chemical stain is inhibited due to the condition of the concrete. Custom colors are more readily available with non-reactive stains, and colors can also be mixed in the field. For example, dark brown can be mixed with white to produce a light brown.

Additionally, a non-reactive coloring system can be used if concerns about the safety or environmental effects of applying an acid-based material are a factor. It should be noted, however, that not all dye products may be UV-stable and suitable for outdoor use. Again, a sealer should be applied after the staining process is completed.

Opaque stains

Opaque concrete stains are offered in a wide range of colors, usually with more color choice than is the case with chemical and non-reactive stains. Earth tones as well as bright and vibrant colors can be easily produced with opaque stains. The color produced is generally more uniform compared to chemical and non-reactive stains, and will completely hide or mask the underlying concrete color. Depending on the manufacturer, opaque stains are available as single- or multi-component systems that are mixed with water. These stains produce a low-gloss and abrasion-resistant surface, and are suitable for coloring new (cured 28 days) and existing interior concrete floors and exterior concrete hardscapes. They are ideally suited for recoloring previously colored concrete or renovating weathered or discolored concrete surfaces. It may not be necessary to apply a sealer following application of an opaque stain.

Generally, manufacturers provide a different color chart for each opaque stain product. Even though comparable hues may be found among different staining systems, the product lines have their own distinct palette, properties, and attributes, often dictating which product should be used. It is advisable to contact the manufacturer to verify that the stain product is aesthetically and functionally suitable for the given project.

Surface preparation

Surface preparation prior to stain application is highly important, particularly for older, dirtier concrete surfaces. If the substrate is dirty or contaminated, the coloring stains will not penetrate or "wet" into the pores of the substrate, which will affect color development and sealer durability. This is particularly critical for the chemically reactive stains.

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Chemically reactive stains and, to a lesser extent, non-reactive stains or dyes will produce color variations. The degree of variation is a function of concrete porosity, texture, age, application method, and the original color of the substrate.

The surface must be free of curing compounds, sealers, wax, mastic, grease, oil, and other contaminants that can block the pores of the substrate. Interior floors that have received a hard-trowel or burnished finish may also impede stain penetration. The extent of penetration can be judged by wetting the surface with water. If the water is readily and evenly absorbed and darkens the surface, it's likely that extensive preparation is not required. If the water beads on the surface and darkening does not occur, surface preparation is necessary before stain application commences.

Detergent washing combined with scrubbing with a black pad on a rotary floor machine can remove dirt, soil, grease, and oil. Sealers and coatings may require mechanical grinding or chemical stripping. It is important to note, however, that mechanical grinding and chemical stripping, and even scrubbing with a black pad, may change the surface texture and color. Cleaning with muriatic acid is not generally recommended.

All cleaning procedures should be evaluated with test sections before proceeding with the project as a whole. Once surface cleaning and preparation are completed, another test for penetration by water should be done.

Preparation of new concrete

Concrete should be at least 21 days old and dry before stain is applied. After the concrete has been placed, the surface should be protected from all construction activity prior to staining, employing protective coverings while the various trades are likely to come into contact with the surface. The protective coverings are removed after work is completed.

Lumber, steel, plumbing, masonry, chemicals, or liquids should not be stored on the newly placed concrete floor, and dirty water, food, and drink should not be allowed to come into contact with the concrete. Construction activity should be minimized on the floor to prevent damage or discoloration of the concrete.

The surface should be pressure washed or scrubbed with a rotary floor machine to remove dirt and dust from the surface, using a low-foaming, alkaline cleaner and scrubber with a black pad. Then, the surface is thoroughly rinsed and wet-vacuumed to remove cleaning residues. These cleaning methods are generally effective for water-soluble contamination prior to the application of topical stains and sealers. Finally, the surface should be tested for water penetration prior to chemical staining.

Preparation of existing concrete

Older concrete must be free of sealers, wax, mastics, grease, oil, and other contaminants that block the pores of the substrate. Hard-troweled interior floors will require mechanical abrasion using a 60- to 80-grit screen on a low-speed floor machine and employing water to control dust. For more aggressive cleaning or on textured surfaces, brushes with polyethylene bristles and water should be used. It should be noted that mechanical preparation may change the surface texture and color. The effectiveness of the preparation process should be evaluated thoroughly before proceeding.

Once surface cleaning and preparation is completed, a low-foaming, alkaline cleaner should be employed to scrub the floor with a black pad, followed by a rinse and wet vacuum to remove any residue generated during preparation and removal of contaminants. Again, the surface should be tested for water penetration prior to staining.

The value of mock-ups

Chemically reactive stains and, to a lesser extent, non-reactive stains or dyes will produce color variations. The degree of variation is a function of concrete porosity, texture, age, application method, and the original color of the substrate. Experience with a particular stain on a project does not guarantee the same result on the next project using an identical color. The final

Application of a protective sealer is usually recommended for stained surfaces. Periodic application of a maintenance wax, in turn, protects the sealed surface from scratching, excessive wear, or damage.

color of a stain application can be determined by producing and approving a mock-up on the actual surface that will be stained. A mock-up should include all the tools, techniques, and materials that will be used on the job, including cleaning and preparation, saw cuts, designs and texture, stain, sealer, and maintenance wax (in the case of an interior floor).

As stains produce a translucent color, shade variations in the concrete prior to staining will likely remain noticeable after application. Therefore, stains are not used to hide construction errors or dramatic color variations in the substrate. For the same reason, a randomly patched concrete floor may not be a good candidate for staining. Not only will the patched areas remain visible, but they may also produce a very different coloration from the adjacent concrete surfaces. If these conditions exist, the "problem areas" are included in the mock-up to assess their impact on the project. If those problem areas are objectionable, the use of an opaque stain might be a more aesthetically effective option.

Stain application

Stains should not be applied to frozen concrete or to a concrete slab if the temperature will drop below freezing within four to six hours after application. On the other hand, elevated ambient and slab temperatures, low humidity, or high wind will result in rapid drying of the stain, which may necessitate additional applications or modification of the application methods to achieve the desired coloration.

All surfaces to be stained must be clean and dry, and adjacent surfaces that are not to be stained (or will be stained a different color) should be protected with plastic. Duct tape should not be used, particularly on surfaces that will be stained, since adhesive residue may leave a shadow or inhibit the stain's penetration; blue painters' tape is preferred. Plastic sheeting or tape should be removed from masked areas as soon as staining is complete, particularly on hot and sunny surfaces.

The surface to be stained is divided into smaller working areas utilizing walls, control joints, and other fixed objects as natural termination points, ensuring a wet edge during application. Application is planned to minimize walking through the wet stain and possible tracking into other areas.

Chemically reactive stains

For application of chemically reactive stains, application tools such as brushes, sponges, containers, and sprayers must be acid-resistant. Brush bristles must be capable of holding the stain without excessive dripping. Application equipment with metal components cannot be used, nor should tools that will soften or deteriorate, or leave a color residue when in contact with the chemical stain. Also to be avoided is the use of a paint roller, as it will create distinct overlap lines. During application, it is important to avoid random dripping, spillage, and rundown from the equipment, as this may produce undesirable colorations that will be difficult to remove. For most applications, a manually pumped or pressurized garden sprayer can be used to apply chemical stain in a random or circular motion.

The chemical stain should "fizz" when applied. If it does not, additional cleaning is needed, or the concrete is too old and does not contain enough reactive materials to produce a chemical-stain reaction. During application, a wet edge should be maintained at all times, with the saturation amount consistent throughout application. If chemical stain is splashed, dripped, or puddled, those areas will produce darker-colored effects. Again, it is recommended that application equipment and techniques be evaluated with a mock-up panel.

The chemical stain is allowed to react on the surface for a minimum of four hours; reaction time may vary with ambient and slab temperatures, wind, and humidity. For single-color and multicolored applications, a small area should be scrubbed and rinsed for effective color evaluation, with additional chemical stain applied as needed to achieve the desired colorations. The use of shallow saw cuts can be used to effectively separate different colors.

The reaction of chemical stain with the concrete will produce a powdery residue, and this residue must be neutralized and removed to prevent tracking or functioning as a bond breaker when a sealer is applied. The residue is neutralized by scrubbing with a solution of 1 pound of baking soda with 5 gallons of clean water; soap should be avoided, since soap residue may act as a bond breaker when the surface is sealed. The surface should be rinsed and wet vacuumed until rinse water is clean and clear. If the surface is not thoroughly neutralized and rinsed, the longevity of the stained surface and sealer will be diminished.

Non-reactive stains or dyes

The concrete surface and joints must be thoroughly dry before application of non-reactive stains. Adjacent surfaces are covered for protection with plastic during mixing and application, as overspray and spills are difficult to remove. Application is done with a clean, high-volume, low-pressure (HVLP) sprayer, using a tip that produces a conical spray pattern. The stain is sprayed evenly over the prepared substrate in a circular or random motion.

For larger applications, an airless sprayer may be used, but a pump-up sprayer is the least desirable method of application, since it may not adequately atomize the material. During application, the product is periodically agitated in the mixing pail and sprayer reservoir, as settlement will occur. The stain may also be applied with a foam brush when coloring small designs or patterns.

A shallow saw cut is recommended for effectively separating different colors. More than one application may be required on very porous concrete to achieve the desired coloration, but over-application should be avoided.

A typical color chart for a chemically reactive stain product line. The color choices are somewhat limited for these types of stains, although applications can be modified with special finishing techniques. Certain colors are recommended for interior use only.

The material should not be allowed to puddle and dry on the surface or in joints. Excess material should be redistributed or wiped up with a clean cloth before it dries; otherwise, it will require a more thorough clean-up before sealer application. If the material appears wet for longer than one minute, more product should not be applied. Walking on the stained surface should be avoided for approximately eight hours after application, along with contact by water or other liquids.

Opaque stains

Application methods for opaque stains vary depending on their chemical composition and whether they are one- or multi-component products. Brush, roller or a powered sprayer can be used, although the product manufacturer should be consulted for particular product-application recommedations. Generally, surfaces should be clean and dry.

These products may also be subject to working time that is shortened at elevated ambient and surface temperatures, and may also be subject to specific recoat times.

Maintenance issues

Hardened concrete contains pores—it essentially is a rigid sponge that is susceptible to dirt accumulation by anything dripped or dropped onto it. Concrete surfaces can be cleaned, but it is more practical to seal out grime than scrub out dirt embedded in this porous surface. Some blemishes, such as oil stains, are difficult to remove completely, and certain cleaning procedures that may chemically etch (using acid-based cleaners) or abrade (using excessive scrubbing or grinding) the surface may mar the decorative surface. Sealing of a stained concrete surface, particularly interior floors, is highly recommended to prevent dirt buildup on the surface.

Typical concrete sealers are solvent- or water-based products based on acrylic resins. Regardless of the sealer used, however, none last forever, and most are prone to scratching and scuffing. Sealers eventually require reapplication with exposure to weathering and wear.

The initial application (and reapplication) of sealers must be factored into the budget and expectations for the decorative surface. Often, job callbacks occur when sealing and maintenance have been ignored, particularly for interior floors. There is no such thing as a maintenance-free concrete floor. If neglected, the sealer will eventually wear from the surface. At this point, reapplication can be costly and disruptive for a business.

A more proactive and cost-effective approach involves the periodic application of a maintenance wax over the sealer. Waxes, which are typically liquid emulsions, function as a sacrificial surface; if regularly reapplied, they protect and spare the underlying sealer from scratching, excessive wear, and eventual removal from the concrete. Waxes can be handled by in-house maintenance personnel and do not require the expertise, time, and cost associated with stripping and reapplying the original sealer.

Creative opportunities with concrete stains

Stained concrete flooring no longer lurks on the fringe of architectural and interior design. As materials and processes have evolved, concrete is no longer viewed as just a structural building material—it is also regarded as a creative medium suitable for many installations, such as residential and commercial hardscapes, natural-looking and artistic floors, and even custom countertops.

Greater awareness of the aesthetic and performance possibilities of concrete stains—and the methods involved in their application—will help to facilitate the effective selection, specification, and use of these materials.

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