Surface retarders are available in many grades or "etches" to produce multiple finishes of varying degrees with the same concrete mixture, depending on the manufacturer. The varying grades of surface retarder create differing textures and appearances.

Top-Surface Retarders

Top-surface retarders are generally comprised of water-based, low-viscosity liquids that are sprayed on the finished surface of freshly placed concrete after initial set has occurred. They differ from in-form, paint-type surface retarders by the level and type of ingredients. They also have the ability to be applied at varying thicknesses, yet maintain the required degree of penetration and uniformity of outcome.

Top-surface retarders ordinarily must be protected by plastic covering to remain active and to protect them from premature etch loss or crusting of the concrete surface. The plastic covering should not be placed on top of the surface retarder until it has cured to a fine film. This typically occurs 1 hour after applying the surface retarder, depending on the weather. In warmer weather, the surface retarder can be washed off the same day that it is applied if the concrete has gained sufficient strength.

The concrete matrix is allowed to harden normally while the surface is controlled by the surface retarder. The surface retarder inhibits the reactions that take place normally over 4 to 24 hours during the initial stages of concrete strength gain. When the bulk of the concrete has sufficiently hardened, the surface mortar can be washed with water and a broom, pressure washed, or sandblasted away, exposing the underlying aggregate (Fig. 6.2).

Fig. 6.2—This fine, nonslip finish for use at an aquatics water park was created by using a surface retarder

Guidelines for Use

Preparation

In preparation for using a surface retarder, consider the following:

- Determine the manufacturer and select the desired level of light, medium, or deep surface exposure for the concrete surface finish.
- Design a mixture that combines the materials, including the integral color if required, you want to see on the final surface of the concrete. Special aggregates can also be broadcast on the surface of the concrete and floated into the concrete per the project specifications. Refer to Chapter 8: "Seeding Special Aggregates." Seeded aggregates less than 3/8 in. (10 mm) diameter are not recommended for use with a surface retarder, as washout may occur and they may not adhere well over time. Consult with your local ready mixed concrete producer for the available aggregates, integral colors (if desired), or cement types available, as well as the appropriate concrete mixture to achieve the desired performance and finish outcome.
    - Light exposure surfaces may require that a greater proportion of the total aggregate in the mixture be sand (for example, 50% sand or greater), and deep exposure surfaces may require that a greater proportion be coarse aggregate (for example, between 60 and 70%).
- Ensure that you have both enough personnel and proper quality finishing tools to perform the finishing work required that will meet final expectations.
    - Review the project's placing and finishing techniques, and related application step timings, before commencing actual placing and finishing.
    - Review the surface retarder removal and containment plans before proceeding with placing and finishing.
- Confirm that a sufficient amount of surface retarder solution is available onsite to support the project's required surface area to be exposed, and in accordance the manufacturer's instructions.
- Always construct a mockup sample for the client or design professional's review and approval. Mockup samples are beneficial to the concrete contractor and

the client. They define the expectations of the finished product and this should not be discounted.

Applying the Surface Retarder

Following are the steps used to apply a surface retarder:

- Rod or screed the placed concrete in a sawing motion to remove excess material and leave the aggregate at the surface.
- Float sufficiently to bring cement paste to the surface, enabling proper closure of the surface.
- When producing micro-sand finishes, the use of a rolling tamper is most effective in developing a uniform mortar content that can be troweled smoother, thereby creating a tighter, denser sand finish. The use of a rolling tamper will allow the use of concrete mixtures containing less sand and more coarse aggregate. This may be necessary to produce the required water-cementitious materials ratio or meet a specified compressive strength, for example. The concrete mixture proportions must conform to the requirements of the soils report, structural drawings, or other project plans or specifications.

A saw cut is placed between two integral color concrete panels for cleanliness in design

- Avoid larger aggregate showing on the perimeter of micro-exposed (fine sand) surfaces. A small hand tamp can be used to slightly depress the coarse aggregate adjacent to the concrete forms prior to finishing the concrete. After edging the first time, floats should be used to swipe paste back over the edge of the form. This is done by placing the float onto the concrete surface approximately 6 to 10 in. (150 to 250 mm) out from the form at a 45-degree angle to the form, and swiping back to the edge. The float should be kept flat for this procedure.
- When producing a micro-sand finish, generally two or even three additional passes with steel fresno trowels or

hand trowels are necessary to ensure a dense, smooth, ridge-free surface from which the sand and additional fines can be exposed.

- Avoid kneeboard marks showing in the final surface. Only non-absorbent materials should be used. Absorbent materials such as wood can leave dark spots on the concrete. If impressions are left in fresh concrete by kneeboards, they should be removed prior to final finishing and before applying the surface retarder.
- If bleed water persists, wait until it dissipates prior to application, but be sure to apply the surface retarder when the concrete still has sufficient moisture remaining.
- In accordance with the manufacturer's recommended application coverage, apply the top surface retarder soon after the final finishing operation, using a low-pressure or garden-type sprayer (note: follow the manufacturer's canister and spray tip recommendations).
- Cover with plastic after the retarder has crusted over. Otherwise, staining from the plastic sheeting could occur. This will help achieve uniform results without crusting on the surface, allowing for easier removal of the retarded cement paste the following day, depending on the conditions and products used.
- Some surface retarder products may not require plastic covering. Consult the manufacturer's guidelines and recommendations and perform test panels prior to commencement of work whenever using surface retarders.

Surface retarder is washed off of the concrete surface after the concrete has sufficiently hardened

Removing the Surface Retarder

Remove the surface retarder in accordance with the manufacturer's instructions. In especially hot weather, it may be neces-

sary to remove the retarded material the same day. Late removal may result in difficult removal and affect the consistency of the final finish.

The surface material removed includes retarded hydrated cement paste, fine aggregate, and coarse aggregate that can result in alkali wash water and cement solids. This material should be handled carefully and disposed of according to local regulations. Sand dams, diversionary dikes, or a vacuum with sufficient storage capacity should be used to prevent alkali runoff during the removal and cleaning process.

Collect all solid particles and allow water to evaporate and dispose of the solid particles as normal construction waste.

Environmental Note:

Surface retarders are used to achieve a uniform sand finish or to expose larger aggregates in a concrete mixture without using acids or sandblasting. Both acid washing and sandblasting are environmentally unfriendly and pose defined health risks. Surface retarders produce a similar result without the use of caustic chemicals, dust, noise, or gasoline or diesel engines.

It is required to divert and collect all residues and washoff during the finishing process to eliminate potential environmental contamination. Refer to "Removing the Surface Retarder" for specific guidelines in this regard.

Removal timing depends on the specific surface retarder used, the environmental conditions and temperatures, and the mixture proportions. Removal could be as early as 2 to 3 hours and as late as 24 hours after applying the surface retarder. The key is that the underlying concrete must be hard enough so it is not damaged by whatever means is used for washing.

When the treated area has cured (usually overnight), high-pressure washing is the most effective means of removing the retarded material. If high-pressure washing is not available, street brooms or stiff bristle brooms and a garden hose can yield satisfactory results. Depending on the application, a commercial floor scrubber with a nylon bristle brush in

combination with a water hose may be used for removal and should be available on the project when washing begins.

Tools Required

Surface-retarded concrete requires the use of normal finishing practice tools, unless otherwise indicated herein. These include:

- Water supply
- Water hose
- Water pressure washer (1500 to 2500 psi [10.3 to 17.2 MPa])
- Standard low-pressure pump sprayer similar to the type used to spray curing agents
  - Sufficient quantity of sprayers should be on hand to support the required application rate and provide backup
- Sprayer tips for application coverage in accordance with manufacturer's recommendations
- Stiff bristle broom. Don't use metallic brush brooms on decorative concrete.
- Plastic sheeting to protect all adjacent surfaces and structures from overspray
- Materials to contain the runoff. Do not allow the washoff to be discharged to storm drain systems.

Curing and Sealing

To enhance the beauty and color of the aggregates and protect the surface, the use of a breathable acrylic sealer or a penetrating siloxane or silane sealer is recommended to protect the finished surface from damage. This is particularly important where salt damage from inclement weather is a concern.

A surface retarder finish can be cured with a moisture-retaining cover that does not cause discoloration. Curing compounds and wet curing methods are not options due to the application of the surface retarder. The curing method selected should be performed during the construction of the mockup sample and prior to commencement of the actual work.

Durability and Sustainability

Surface retarders create a concrete surface texture that is nonslip and requires limited maintenance. The concrete may use gray cement, white cement, or integral color; all three have different light reflectance values.

Light-colored concrete, with its high surface relectivity, reduces surface temperatures. This results in cooler pavements and roofs, where concrete could be used as a topping slab. This produces a reduced heat island effect. In addition, light-colored concrete could reduce the amount of lighting required due to its reflectance values.

Refer to the surface retarder manufacturers' MSDS information for safety requirements, and review them with field personnel prior to using. When working with surface retarders, avoid contact with skin and use eye and respiratory protection.

CHAPTER 7: STAMPED CONCRETE

Stamped concrete is a cast-in-place, monolithic slab that is colored and imprinted with a pattern, texture, or both (Fig. 7.1). Properly specified and installed, stamped concrete can resemble many materials such as cut stone, random stone, slate, brick, and tile. The tools can also create three-dimensional texture.

Fig. 7.1—Stamped concrete design achieved through the use of texturing tools

Stamped concrete is usually installed with color hardener or integral color and often uses contrasting release agent if a textured surface is required. The release agent remains in the low points of the texture to create color variations and highlights.

Stamped concrete can be placed indoors and outdoors and is often used for pool decks, walkways, plazas, patios, driveways, and steps.

Planning and Organization

In typical summer weather conditions, it takes about 3 to 5 hours to place, finish, and stamp concrete. During this time, at least 10 different steps must be completed, compared with four steps for exterior broom-finished concrete. Under hot weather conditions, the time available can be as little as 2 hours. When ready mixed concrete temperatures exceed 85°F (29°C), care and pre-planning are necessary to have an organized crew on hand to finish the work. It is best to place stamped concrete in the morning hours to reduce the problems with an accelerated set time.

In cold weather, 6 to 8 hours can pass before initial set. Contractors need accelerating admixtures to manage the placement and avoid excessive bleeding and poor impressions. If three workers are needed to place 1000 ft^2 (90 m^2) of plain gray concrete in a day, plan on five or more to place and stamp 1000 ft^2 (90 m^2) of stamped concrete. Some contractors will not exceed 100 to 125 ft^2 (9.3 to 11.6 m^2) per worker.

Subgrade Preparation

Subgrade preparation is critical for any slab-on-ground construction, but additional care should be exercised with decorative concrete applications. The subgrade must be

uniformly graded and compacted throughout. This helps ensure that the concrete will be of uniform thickness. It is recommended that the thickness of the fill match the thickness of the slab.

Well-drained, compacted fill, such as a 2 in. (50 mm) thick sand base, allows the concrete to set uniformly and cure with a more consistent color. There should be no soft spots in the subgrade, otherwise the concrete must bridge the soft spots, increasing the possibility of cracking. Before placing the concrete, make sure there is no standing water or muddy, frozen, or spongy spots. During hot-weather placement, the subbase may be moistened in advance, as long as the base is dry to the touch at time of placement. Excess moisture in the subgrade can also carry additional salts to the surface during hydration and curing. The additional salts can cause an increase in efflorescence, resulting in discoloration or spotting.

Concrete Mixture Proportions and Admixtures

The concrete mixture proportions should meet any and all requirements for a specific purpose and geographic area. For exterior paving, the concrete mixture could range from 2500 psi (17 MPa) for pedestrian paving in a mild (non-freezing) climate to 4500 psi (31 MPa) for a climate with frequent cycles of freezing and thawing. A typical integral color stamped concrete mixture will require 5-½ to 6-½ sacks of cement per cubic yard (307 to 362 kg/m^3). For concrete that will be stamped, a "fatty" or "rich" mixture is recommended; one with enough cement paste to provide a layer of cream on the surface that will take an imprint well. A 4 to 5 in. (100 to 125 mm) slump is recommended.

For impressions not deeper than ¼ in. (6 mm), a ¾ to 1 in. (19 to 25 mm) nominal maximum aggregate size works well. For deeper impressions you may need to go to a 3/8 to ½ in. (9.5 to 13 mm) nominal maximum aggregate size using aluminum or "cookie-cutter" tools.

Pozzolans and other supplementary cementitious materials (such as fly ash and slag cement) can have positive effects on concrete such as improved finishability, reduced permeability, reduced efflorescence, and minimized bleeding of color.

Admixtures can also be helpful. Retarding admixtures can slow the set of concrete in hot weather, buying additional stamping time. In cold weather, an accelerating admixture will speed setting time and minimize bleeding and segregation. Avoid using admixtures containing calcium chloride, as these produce additional efflorescence and can have an adverse effect on the final color.

Most water-reducing and retarding admixtures are compatible with color hardener applications. To improve durability without sacrificing workability, a water-reducing admixture may be used. These are designed to lower water requirements by approximately 10%, improving strength while reducing permeability and cracking.

Formwork

Sloppy forming can make stamping more difficult and can devalue the finished product. It is imperative that the formwork be properly squared to any adjacent structures or buildings. For jobs requiring repeating square or rectangular stamp patterns (such as brick or tile), the forms must be perfectly square at the corners. Most patterned texturing tools will fit together in a squared pattern, showing any variance if the formwork is not squared. Diagonal braces keep forms in alignment when the weight of fresh concrete pushes against them.

It is also critical to take precise elevation measurements. Proper slope must be established to ensure adequate drainage. The recommended slope for exterior paving is a minimum 2%. However, adhere to the ADA Guidelines as required. Maximum cross slope for a sidewalk is 2%, thus no tolerance.

Be sure to drive or cut form stakes flush or slightly below the top edge of the forms so as not to interfere with stamp mats.

Coloring Stamped Concrete

There are two primary ways to color concrete: 1) broadcasting color hardeners onto the surface of freshly placed, bull-floated concrete; and 2) mixing integral color into ready mixed concrete. Powdered or liquid release agents can be used to provide a highlighted or mottled appearance.

Color hardeners (made up of portland cement, iron oxide pigments, and finely graded silica sand) are used to color the surface of fresh concrete applications (Fig. 7.2). It is not a topping, but actually becomes part of the concrete surface. Color hardener also increases surface density and abrasion resistance, providing increased durability. These steps should be followed:

Fig. 7.2—Color hardener is worked into the concrete surface with a wood bullfloat; note the bright color.