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Feature Story

Hard Choice Made Easy

Polishing Makes the Concrete Sub-Floor Into an Aesthetic, Green, Economical Finish Option

By Steven H. Miller, CSI

Today's design and construction professionals find themselves juggling three balls: aesthetics, economics, and sustainability. When it comes to flooring, there is a solution that gives the juggler a firm footing to meet all three demands. It is beneath most of our feet most of the time, waiting to be uncovered: the concrete sub-floor.

During the past decade, the hidden concrete slab has finally started getting its day in the sun. Polished concrete is in fashion, for very practical reasons. It's an aesthetic and economic solution both for new construction and remodels. It offers a range of finish options to meet varied designs. Its first cost is highly competitive, and its life-cycle cost is even better. The new chemical technologies associated with polishing also impart low maintenance and high performance characteristics. Finally, it is one of the most sustainable flooring options available. The concrete slab or deck is almost always a basic, given element of construction, whereas any floor covering consumes additional materials in manufacture, some of them not highly sustainable.

A few years ago polished concrete may have been a fad, but it is now a major design option that makes sense and needs no apologies. This article defines where it can be used, and how to achieve the best results.

Why Choose A Polished Concrete Floor?

Both new and existing concrete floors can be polished. Both can be colored, or multi-colored, if desired. And both deliver the same high performance benefits.

The economics of polished concrete are highly favorable. In most commercial and institutional structures, the concrete sub-floor is either already present or, in new construction, is figured into the cost of the structure (as opposed to being itemized as a floor finish). In other words, as a flooring solution, the slab itself is essentially free. The expense that needs to be compared to other flooring options is the cost of polishing to give the concrete an attractive and practical finish.

The cost of polishing concrete is generally competitive with the least expensive covering options available, such as vinyl tile. The variables in polishing cost include regional labor differences, the condition of the original slab, and the colors (if any) selected. Even an expensive polished concrete floor is usually competitive or lower in cost than carpet, hardwood, terrazzo, or stone. Using next-generation polishing chemistry, such as Lythic™ Densifer with colloidal silica, tends to lower cost even further and speed up construction schedules.

Polished concrete – for reasons we shall see shortly – is easy to clean and maintain. Part of the polishing process is densification, which not only makes the concrete take a polish better, but increases the surface resistance to liquid penetration, so it does not stain easily. A polished slab can generally be cleaned with simple water-based materials, avoiding the use of harsh chemicals and solvents, or the emission of volatile organic compounds (VOCs). In most floors, it does not require sealing, however, sealant is recommended if the floor will be exposed to mild acids such as may be found in food processing areas.

The densified surface minimizes places for microbes or allergens to collect. The gloss of a polished floor also conveys an appearance of cleanliness, a beneficial psychological factor in many applications such as retail environments.

Concrete is so durable that the floor will probably last as long as the building. (There are extant concrete buildings that are literally thousands of years old.) This durability includes colored concrete; there are concrete coloring methods that are permanent, non-fading, and cannot wear off.

Polished concrete is also abrasion- and abuse-resistant, reportedly more so than a conventional concrete floor. Studies done by manufacturers of densifying chemistry claim increased abrasion-resistance. Owners of a variety of facilities including grocery retailers, car dealerships, schools, industrial facilities, food processors and others across the country have discovered the value of polished concrete flooring.

Many of the same properties that make concrete floors economical also make them sustainable. The material is already present, so it requires no additional materials-consumption. It is also unlikely to need replacement due to wear during the life of the building. Concrete is generally made from locally extracted raw materials. It is good for indoor air quality (IAQ): neither the basic material, nor the polishing process release VOCs; the slab surface does not tend to harbor IAQ hazards such as microbes, allergens or mold (in stark contrast to floor coverings like carpet); light reflectance from glossy, light-colored concrete may also reduce the need for artificial lighting and its associated energy consumption.

Aesthetic Choices

New concrete can be designed with polishing in mind, and a number of appearance options can be selected in the process. Existing concrete can also be polished, unless is it severely damaged. Light-to-moderate cracking does not

prevent polishing, although the cracks will probably remain evident as part of the visual character of the floor.

Both new and existing concrete surfaces are ground with diamond tools prior to polishing, to achieve a flatter and more uniform surface. Grinding can also achieve certain appearance options, such as exposing the aggregate – gravel or other chunky material that has been included in the concrete mix. Exposed aggregate can produce an effect reminiscent of certain types of natural stone, or unique effects obtainable only with concrete. If the slab is newly-made expressly to be polished, aggregate can be selected for size, color and pattern. Contrasting the aggregate colors with the color of the cement can create many unique looks. "Creative" aggregate can be added, for example seeding the surface with recycled crushed glass; when revealed by grinding, it becomes an interesting and unusual visual accent.

There is a wide range of coloring choices. New slabs may be integrally colored by adding a pigment to the concrete mix. Stains and dyes can be used on new or existing slabs, and tend to produce more variegated color. The versatility of the material has prompted the development of an entire subcategory of artisans specializing in creative concrete patterning.

What is Polished Concrete?

Concrete was originally called "artificial stone" and, like many stone materials, polishing it can reveal hidden beauty. To understand how concrete polishing is accomplished, it helps to review the nature of the material.

Concrete cures through a process called cement hydration, a chemical reaction that forms mineral crystals, chiefly calcium-silicate-hydrates (C-S-H). The process also has a by-product: calcium hydroxide (lime).

More water is used to make a concrete mix workable than is actually needed in the chemical reaction. Some of this excess water rises to the surface as the slab is setting (bleed water), bringing with it very fine, softer mineral particles that form the top of the slab. This soft cement "paste" is usually troweled smooth during concrete finishing.

The crystal matrix sets to moderate hardness within a few hours, although it continues to harden for weeks, and even years. Additional unused water is still trapped in the matrix, and evaporates out during the first few weeks, leaving behind empty spaces – pores.

The mechanical process of polishing concrete, or any other material, is actually a process of scratching it. A series of ever-finer abrasives are used until the scratch patterns become too fine to see. Finer abrasives flatten off the peaks left by coarse scratching, leaving the scratch-valleys shallow, creating the glossy, reflective effect we associate with polished surfaces.

To be polished effectively, a material must be hard enough not to give up micro-chunks under the stress of abrasion. The harder a material is, the better it will take a polish.

The Polishing Process

Concrete, in its native state, presents two problems to polishing. The surface is often not hard enough to polish well, especially since it is generally the softest layer of the material. In addition, the pore structure introduces random spaces into the scratch pattern.

Both these problems are solved by applying a chemical densifier to concrete before polishing. Densifiers are silica-based compounds that react with lime (calcium hydroxide) trapped in the concrete to form additional mineral compounds, filling in the pores and increasing surface hardness.

The first generation of densifiers were generally made from silicates such as sodium silicate. They performed the basic task of densifying, but they presented a number of drawbacks. Applying them was time-consuming and labor-intensive. They had to be scrubbed into the surface for an hour, required an overnight curing period, and left a gelatinous residue that had to be scrubbed off and disposed of before polishing could begin. Inadequate removal frequently resulted in an unsightly deposit known as "whiting" left on the concrete surface. Lithium silicates eliminated some of the time-consuming aspects of application and removal, but still presented a whiting hazard if excess material were applied, and it was difficult to judge how much was too much. Lithium silicates are also significantly more expensive than other silicates.

Silicates are highly caustic materials with a pH in the range of 11-12. Any material with such a high pH poses potential risks in handling, and places an ecological burden on the environment when disposed of.

The newest densification chemistry, Lythic Densifier, is made from colloidal silica, a much purer form of silica that is far lower in pH. It is faster-reacting, can be applied in about one quarter of the time, does not require overnight curing, and leaves no gelatinous residue to remove. It has virtually zero risk of whiting, a significant risk-reduction factor for contractors. These time savings enable applicators using Lythic Densifier to keep their costs down, and increase their productivity. The elimination of residue disposal is also more eco-friendly.

Some applicators report achieving equivalent polishing results with one less abrasive polishing step when they use colloidal silica, speeding up schedules and lowering costs further. Applicators also report that colloidal silica produces better results on concrete that is marginal in quality or condition.

Once the concrete has been densified, it is polished using diamond-tooled machines and a series of ever-finer abrasives. The amount of polishing needed to achieve a particular gloss level varies with mix design and quality of the concrete.

There are also many applications where an unpolished, exposed concrete floor may be desirable. In such instances, the use of Lythic Densifier can still have distinct advantages. The increased surface density has the same effect of improving impermeability to liquids, and thus stain-resistance, making the floor easier to clean and maintain. The increased hardness improves abrasion- and abuse-resistance, extending its durability and appearance.

Densified concrete floors, both polished and unpolished, can generally be maintained without sealants or waxes. For additional protection, a conditioner such as Lythic™ Protector can be applied after polishing to add more colloidal silica and a clear micro-layer of polymer protectant. Concrete can be cleaned with simple cleansers. A specialized cleaner such as Lythic™ Cleaner can be used to place additional colloidal silica into the floor as it is cleaned.

With all of the aesthetic options, practical benefits, and cost savings, polished concrete is the hard choice that's easy to make.

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