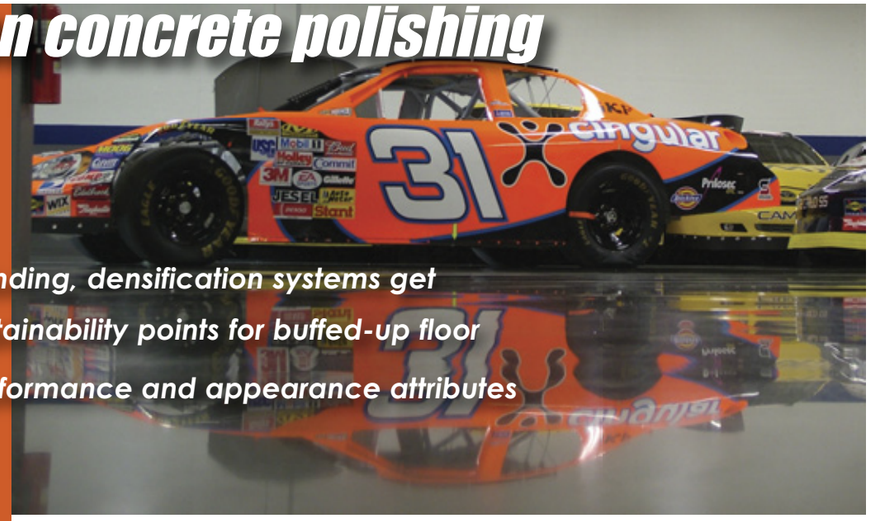
Getting Up to speed

on concrete polishing



Grinding, densification systems get sustainability points for buffed-up floor performance and appearance attributes

BY MARK B. VOGEL, W.R. MEADOWS INC.

The range of flooring options available in today's marketplace is vast, with each of these alternatives offering unique appearance and performance characteristics. As a result, owners and design professionals must evaluate many factors to determine the best flooring option for a structure's given needs and environment.

One flooring system or option currently gaining in popularity is polished concrete. Although polished concrete is relatively new in North America (approximately 15 years), the system offers many advantages.

Concrete is a durable material, and thus meets an important sustainable-design criterion. In addition, the polishing process enhances concrete's natural appeal. These attributes have contributed to the increased use of polished concrete in public and institutional buildings such as schools, hospitals, retail stores, restaurants, and other settings.

In this discussion, we will seek to provide a review of the polished-concrete process, which involves a sequence of steps that begins with initial grinding and preparation of the floor. Application of densifying agents and polishing with machines employing diamond-grit discs produce a surface that is durable, attractive, and highly reflective. A major factor in the integrity and performance of polished concrete is the use of high-quality liquid hardener and densifier materials.

Polished concrete: An overview

Polished concrete, because it does not involve a coating, is a breathable system—one that allows transmission of water vapor and thus is not subject to failure due to moisture migration from below.

When properly installed and maintained, polished concrete can last the life of the structure, avoiding the time and labor of installing subsequent flooring systems.

Polished concrete can be used in almost any interior area. In exterior settings, however, acid rain has a tendency to prematurely etch the surface and cause early deterioration of the shine. Polished concrete can be treated with integral concrete colors, color dyes, and edge-tinting products to produce an attractive floor surface.

Maintenance is relatively simple and economical, and involves cleaning the surface with an agent formulated for this purpose. A concentrated cleaning solution with a neutral pH is added to the cleaning water in an auto scrubber. The auto scrubber applies the cleaning solution, buffs, and vacuums any remaining solution and dirt particles, leaving no residue and a clean surface. Maintenance of polished concrete is quite low in cost, averaging 5 to 7 cents per square foot per year. No special waxes or strippers are required.

Dry or wet process

With dry polished concrete, vacuums are used to extract dust; with wet polished concrete, wet slurry is used to remove concrete particles. The wet-grinding process requires special disposal methods.

With dry polished concrete, pre-separators and vacuum systems are used to control airborne dust and contaminants. The dry powder or cement particles can be safely disposed of and can even be recycled. Incorporating a low- or zero-VOC (volatile organic compound) hardener/densifier completes a "green," environmentally friendly flooring system.

A densifier works by chemically converting weak calcium hydroxide [$Ca(OH)_2$] and calcium carbonate ($CaCo_3$) compounds in the concrete to form calcium silicate hydrate (CSH). CSH is insoluble in water and is highly resistant to water, acids, and other chemicals. The formation of the CSH is proportionate to increased concrete hardness and density due to the replacement of soluble lime [$CA(OH)_2$] with CSH. Once the concrete pores are filled with CSH, migration of moisture from the surface to the substrate will be inhibited, as the process produces a hard, dense, and sealed surface in which abrasion resistance is increased by approximately 50%.

Concrete densifiers are typically based on lithium silicate, sodium silicate, and potassium silicate.

The process steps

A true grinding and polishing system requires a process consisting of five to 10 steps, depending on the desired shine of the floor and its original condition. Assessing the condition of the concrete requires on-site analysis, general knowledge of concrete and mix design, and diagnosis of hardness, porosity, and aggregate types.

Polished concrete can be used in almost any interior area, and can be treated with integral concrete colors, color dyes, and edge-tinting products to produce an attractive floor surface. Photos courtesy of W.R. Meadows Inc.

Grinding and polishing techniques are divided into two categories: Those employing metal-bonded diamonds (16 to 150 grit) that are used in the initial grinding or preparation phase, and resin-bonded diamond segments (100 to 3000 grit) that are used in the subsequent polishing phases. Metal-bonded diamonds are more aggressive in their effect on the concrete substrate than resin-bonded diamond segments.

The initial grinding step removes high spots, imperfections, and contaminants such as cure and seal materials, mastics, or chemicals. This grinding phase may require one to three stages, but it will consume 60-65% of the total time required to complete the densification/polishing process. Grinding and prep work are critical, however, in achieving the ultimate result in the final floor finish.

Resin-bonded diamonds are used following application of the hardener/densifier to polish and remove the scratch pattern created by the initial grinding process.

The three primary degrees of shine are categorized based on the diamond grit of the final polishing step: 800, 1500, or 3000—which translate to semigloss, gloss, and high-gloss finishes. The cost increases incrementally by 10–15% when upgrading from a semigloss to a gloss range, and another 8–12% when upgrading from a gloss to high-gloss range, based on the total value of the project. The majority of the cost is related to the preliminary preparation stages, as labor intensity is greatest in the grinding stages.

A mock-up at the job site is always the best way to identify the capabilities of the designated slab and its affinity to the polishing process. In addition, the mock-up can help determine the polishing level needed to suit the building and achieve satisfaction of the customer and its occupants.

A final, optional step involves application of a type of topical or penetrating agent to immediately seal the surface until the densifier can fully develop to its potential. Because the densifier must fill all the voids in the concrete through a chemical reaction, sealing does not happen immediately and is highly dependent on the porosity of the concrete.

Densifying and hardening

Once the metal-bonded diamond phase and prep is complete, the densification process begins. This key step plays a central part in achieving longevity of the shine and a high level of performance of the finished floor. Densification results in a

Polishing revs up the performance of concrete floor at racecar art shop

They may be making a extended pit stop for cosmetic alterations, but the sleek racing cars at JKS Motorsports in the heart of North Carolina' s NASCAR country almost appear to float on the shimmering polished-concrete floor at the company' s new facility in Welcome, NC.

JKS Motorsports, which creates logos and other artistry that decorates stock-car racing vehicles, placed a bet on polished concrete as a practical, but eye-appealing, surface for the company' s new facility. The process transformed 34,000 square feet of plain gray concrete into a glistening, reflective surface courtesy of the INDUROSHINE system developed by W.R. Meadows Inc.

The facility was a design/build project by Samet Corp., Greensboro, NC. The concrete contractor was Triad Construction Services, High Point, NC. The concrete polishing contractor was Blair Duron, Raleigh, NC.

Casey Chandler, W.R. Meadows' sales representative in the Carolinas and Virginia, gives high marks to Triad for installation of a high-quality, hard-troweled, water-cured, 3,500-psi concrete mix design, providing a sound basis on which to work some polished-concrete magic.

Chandler says he was able to make a case for the polishing process, based on attributes that include light reflectivity, durability, slip resistance (impression of slickness to the contrary), and resistance to abrasion, oil, and chemicals. A key selling point was the relative permanence of the densified and polished concrete. The polishing process is without a doubt labor intensive, but should not have to be repeated if successfully executed.

"With polished concrete, it' s essentially a one-shot deal," Chandler says. "You are changing the composition of the concrete, and it' s a permanent solution."

The project began with initial grinding to prepare the surface for application of the liquid sodium silicate densifier, with 45-, 80-, and 150-grit discs used. W.R. Meadows' Liqui-Hard densifier was spray applied, then left in place for a dwell time of 45 minutes to an hour. Any excess densifier remaining on the surface was then removed with water and shop vacuum. The next day, the polishing was completed with increasingly finer diamond grits of 110, 400, and 1,500 sizes.

In some projects, the polishing stage can progress all the way to a 3,000-grit stage, but the hard-troweled concrete in this case didn' t require the finer-grit polishing, Chandler says.

Chandler concedes that the techniques are "something like an art. You have to evaluate the conditions and operate sophisticated machinery."

A final step was applying W.R. Meadows' Bellatrix, a propriety topical treatment that enhances reflectivity and resistance to staining from oil, grease, and other petroleum-based substances.

The owner opted to retain the inherent gray color of the concrete rather than introduce color by means of integral coloring of the concrete or field application of stains or dyes. A 10-inch-wide strip of solid-color epoxy coating was applied, however, to floor edges along walls that were not given the polishing treatment. A separate edge treatment of this type is often recommended due to the logistical limitations of the grinding and polishing equipment. The burgundy-colored coating provides contrast–an accent to the natural color of the concrete surface.

The resulting mirror-like, polished surface stands in marked contrast to the slate gray of a conventional concrete floor. For JKS Motorsports, it has the look of a winning entry.

Gentlemen, start your polishing-machine engines!

–Joe Maty, Editor, *JAC*

water-, stain-, and chemical-resistant surface.

After the initial grinding stage "opens" the concrete to facilitate the chemical reaction of the densifier and concrete, a sprayer or squeegee is used to apply the liquid densifier at a rate of 16 to 19 square meters per liter (175 to 200 square feet per gallon). The densifier is allowed to soak in for 10 minutes, and is then scrubbed into the surface for 15 to 20 minutes (or until gel formation) with a broom or, preferably, an auto scrubber for optimum penetration. This is followed by a light misting of water, and then a re-scrubbing and flushing of the remaining material from the surface, depending on heat and airflow conditions. Specific manufacturer directions should be referenced, as some application methods vary.

It is critical to not allow the densifier to dry on the surface, as this may leave a white residue or haze. Large quantities or concentrations of densifier left on the surface are difficult to remove and may actually stain the concrete a dark color. Water is used to help remove any remaining densifier.

The recommended temperature and humidity ranges for densifier application vary from manufacturer to manufacturer; product guidelines should be referenced. The installer can extend the application time by adding more densifier in the first 15 to 20 minutes, as the concrete can readily absorb the additional material. Water can be added after 20 minutes, as this will thin the densifier material as it gels to help facilitate deeper penetration and simplify the job of removing excess product.

The environmental profile of the densifier product also plays a primary role in the "green" credentials of the specific concrete-polishing process. This profile is determined by VOC content, the nature of the waste material generated, and disposal parameters.

The entire densification process takes approximately 30 to 45 minutes. The surface is then allowed to dry for 24 hours before the resin-bond diamond segments are used to polish to the desired level. The process produces a hard, dense, and sealed surface.

Adding color

If coloring of the concrete is part of the picture, numerous options are available, including integral coloring of the concrete, staining, and dyeing.

With integral coloring, an admixture is incorporated in the concrete mix to produce uniform color throughout the slab. With a dye or stain, the concrete surface is colored before applying the densifier, allowing unlimited color combinations and edge-tint options. Dyes or stains are typically applied after polishing at the 400-grit level. A second coat may be added later in the process or at the end to increase the effect or intensity of the color. Care should be taken to wash the surface of dyed or stained sections with water, followed by complete drying before the next polishing phase begins.

Attaining the desired level of shine in polished-concrete installations depends on the number of passes of the diamond disc grinder, as each step increasingly flattens the floor and enhances light reflectivity.

Levels of shine

Attaining the desired level of shine depends on the number of passes of the diamond disc grinder, as each step increasingly flattens the floor and enhances light reflectivity. Polishing systems that require minimal process steps—less than five—do not constitute a true grinding and polishing system, which involves a five- to ten-step process, including the hardening and densification application.

These less-complete (and lower-cost) types of systems are commonly referred to as topical, as their penetration of the surface is limited, leading to early wear and loss of gloss and reflectivity.

The safety issue: Polishing and slip

Contrary to a common perception, the degree of polish or shine is not directly related to slip resistance. A 400-grit finish can and usually is less slip-resistant than a 1500- or 3000-grit final finish.

It helps to think of it in this way: when a floor is wet and a person walks on it, the peaks and valleys in the landscape of the surface create a tendency for the person to "hydroplane." On a completely flat surface such as that produced by 1500 or 3000 grit, the water is pressed out from under the shoe, putting the sole directly in contact with the concrete surface—actually making the shoe stick to the surface.

A true grinding and polishing system with the highest levels of shine (using 3000-grit polishing) and gloss (gloss meter readings in the range of 45 to 65) exceeds OSHA (Occupational Safety and Health Administration) and Americans with Disabilities Act (ADA) standards for coefficient of friction and slip resistance, which are the two most widely accepted standards for these safety criteria. The process creates an attractive environment with increased light reflectivity, a desirable characteristic in today's safety-conscious marketplace.

Standard coefficient of friction (COF) numbers for an 800-grit or semigloss polished-concrete surface will range from .79 to .84, a 1500-grit or gloss finish will yield a COF of .84 to .87, and a 3000-grit or high-gloss finish will yield a COF of .87 to .89. These numbers all exceed the OSHA standard of .50 and the ADA standard of .60 on flat surfaces. The flatter the floor, the higher the standard of coefficient of friction.

Polished concrete: An effective solution on several counts

With the vast amount of flooring options available today, architects, specifiers, and owners are well advised to consider all available options to meet the needs of a structure and its occupants. Issues such as durability, safety, initial and ongoing maintenance costs, replacement needs, the service environment, and the environmental profile of the system should be weighed in determining the ideal flooring system for the given setting. Polished concrete can provide an answer to many of these needs by enhancing a common building component—concrete—that meets the definition of a sustainable building material in many ways.

In evaluating any flooring option, it is important that best practices and detailed specifications are employed. Effective choices regarding flooring systems can deliver safe, environmentally friendly solutions that are cost effective and contribute to the highly coveted goal of sustainability in design and construction.

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