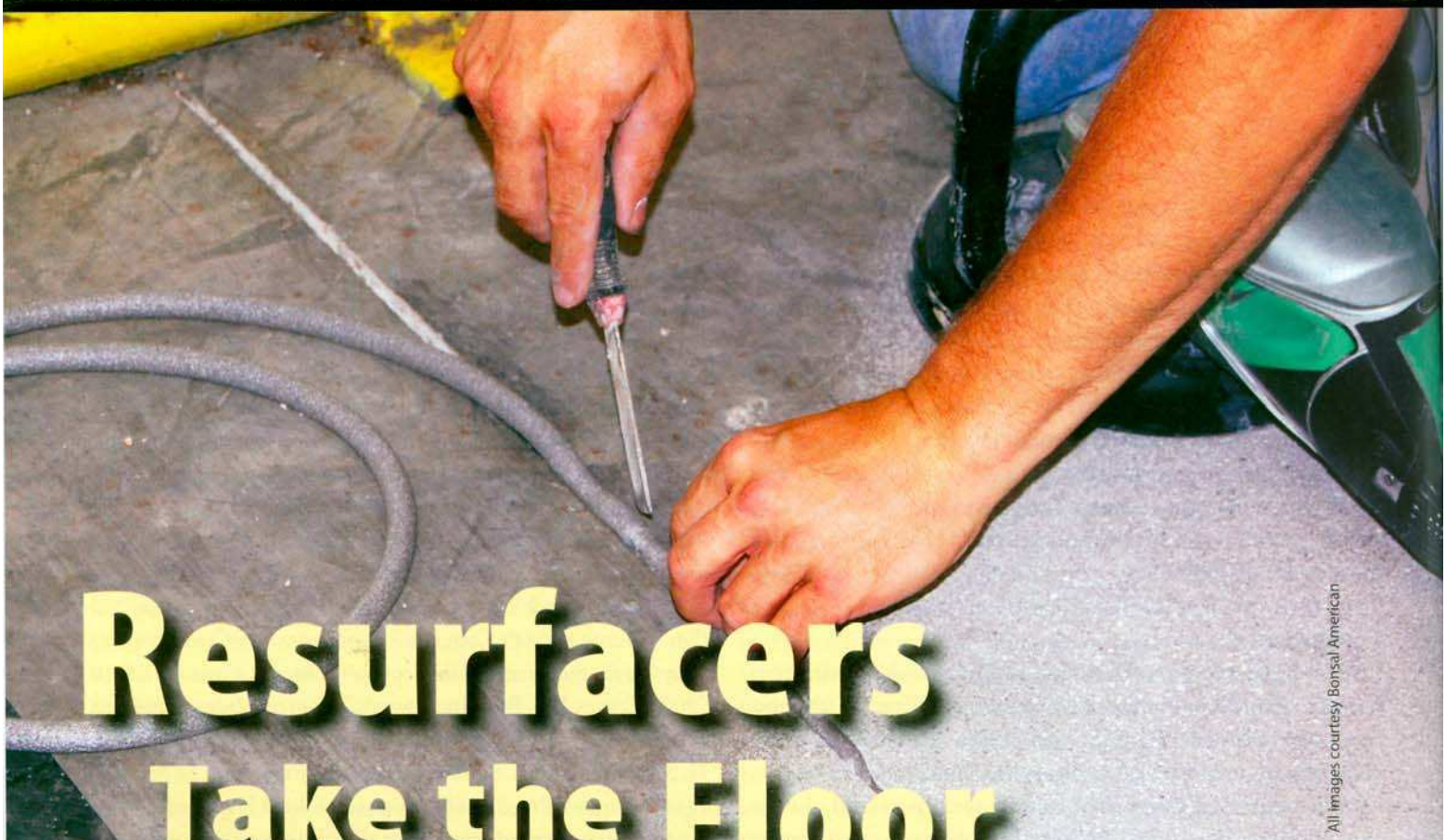

Resurfacers Take the Floor

Fixing floors for final finishes

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by H. Peter Golter, PE

Despite a contractor's best efforts, constructing a floor free of cracks, bumps, and other surface defects is unrealistic. Depending on placement procedures and finishing techniques, cast-in-place suspended slab or slab-on-grade floors are not typically ready to accept final floor finishes or coverings without remediation. Floor resurfacers can offer the right fix for existing site conditions such as correcting uneven or rough concrete, filling cracks, holes, or voids, and preparing a floor for the environmental conditions it will encounter during its service life.

Floor design 101

Both concrete and flooring manufacturers must meet tolerance requirements established by the American Concrete Institute (ACI) regarding the flatness (Ff), levelness (Fl), and abrasion resistance of a floor.

Flatness addresses overall floor bumpiness along sample measurement lines. Levelness refers to design grade conformance by limiting departures from design grade spanning distances of 3 m (10 ft), when measured over sample measurement lines. Concrete contractors must ensure floors are 6 mm (0.25 in.) within 3 m. Flooring manufacturers have to meet stricter standards that require floors are 1.5 mm (0.063 in.) within 3 m.

Abrasion resistance is achieved with the design mix and is based on the concrete's compressive strength. Most floor manufacturers require the substrate be a minimum of 21 to 24 MPa (3000 to 3500 psi) compressive

strength to warranty the performance of their product (*i.e.* the finished floor). Floors that have been compromised, such as rained on slabs, carbonation due to fossil fuel heating, or improper curing, can result in a punky or soft surface. Depending on severity, the compromised surface may need to be removed and replaced.

Floor class standards have also been established by ACI 302.IR-04, *Guide for Concrete Floor and Slab Construction*, and are dictated by location and usage. Classes one through three are designed for residential foot traffic. Classes four and five are required for light industrial or commercial situations that demand increased wear resistance. Class six and seven floors are industrial and must endure heavy wear such as hard- or steel-wheeled traffic. These standards aim to align expectations between the owner and contractor. However, the owner's budget ultimately influences how flat and level the floor will be.

Resurfacing benefits

Contractors can use floor resurfacers to achieve properties dictated by a specific project. In addition to helping create a smooth finish, resurfacers are engineered to improve a floor's longevity and durability under a variety of traffic conditions. Conventional concrete has a compressive strength of 21 to 28 MPa (3000 to 4000 psi). Engineered floor resurfacers may increase performance up to 69 MPa (10,000 psi), extending the floor's service life and reducing maintenance needs, which result in lower lifecycle costs.

Additionally, floor resurfacers can offer improved moisture resistance, which makes them suitable for floors in commercial and industrial environments, kitchen areas, dormitories, bathrooms, healthcare and assisted living facilities, and entranceways.

Types of resurfacers

Floor resurfacers take a variety of forms including skim coats, underlayments, screeds, and toppings.

Skim coats

A thin build of materials, typically featheredged to 13 mm (0.5 in.) in thickness, skim coats are used to spot repair, cover, and level defects in concrete, metal, and wood sub-floors. Skim coats can also re-profile existing vinyl and tile floors prior to installing a new floor covering.

At left, a continuous mixing rotostator pump, utilizing a dustless vacuum system, is used to prepare the floor. The photo on the right illustrates how the 'sock' at the end of the hose on this rotostator pump catches unwanted material such as small lumps and pieces of bag.

Typical costs of skim coating range from $0.50 to $2.50 per 0.09 m^2 (1 sf) for labor and material.

Underlayments

Underlayments cap existing concrete, wood, or primed metal floors, making the surface suitable for floor coverings or traffic-grade coatings. They can be pumped or troweled onto a floor surface to create a smooth, even finish. Due to their flow characteristics and self-healing properties, self-leveling underlayments require minimal labor.

For areas with a thickness of 3 mm (0.125 in.), costs are about $2/sf. Some underlayments are designed to be installed from 38 to 51 mm (1.5 to 2 in.) neat or up to 150 mm (5 in.) when extended with 10-mm (0.375-in.) washed pea-gravel. These deep pours can run as high as $13/sf. For a commercial floor of approximately 465 m^2 (5000 sf) at 6-mm (0.25-in.) thickness, typical costs range from $3 to $5/sf.

Steel shot (large) is in the rotostator pump and is projected onto the floor at high velocity to smooth it.

Screeds

A trowel-grade cementitious material, screeds tend to be 19 to 50 mm (0.75 to 2 in.) thick and fill in, level, or provide a desired slope for rough concrete surfaces.

Screeds vary in cost based on small areas (*e.g.* shower pans) to complete floors that receive dimensional stone and large body tiles. Costs start at $2 to $4/sf for large areas, and go up to $20/sf for small labor-intensive areas such as shower stalls.

Toppings

Toppings can be a thin or thick layer of mortar or concrete placed to create a finished floor surface on top of a concrete, primed metal, or wood substrate.

Most toppings are placed 6 to 13 mm (0.25 to 0.5 in.) thick, depending on anticipated traffic conditions. Once a topping has been placed, it will typically receive a surface treatment. Installed costs for toppings range from $4 to $9/sf, depending on the area and depth of application.

Floor resurfacing materials

Gypsum is one of the most common and inexpensive floor resurfacing materials. It accepts a wide range of floor coverings including vinyl composition tile (VCT), wood, carpeting, and, with special surface conditioners, ceramic tile. The material is lightweight, provides fire resistance, and serves as

a sound barrier. Although properties of gypsum-based materials have been enhanced in recent years, gypsum has a lower compressive strength than portland cement-based materials. It is more brittle and prone to flaking, dusting, chipping, cracking, and water intrusion.

Gypsum-based resurfacers come in the form of skim coats or underlayments and require floor covering as they will dust and abrade quickly under foot traffic.

Portland cement-based resurfacers can take any form including skim coats, underlayments, screeds, or toppings. While they are typically more expensive than gypsum-based underlayments, these products are suitable for a wide range of applications including:

- commercial, industrial, and decorative flooring;
- sidewalks;
- stairs;
- pedestrian ramps;
- parking garages; and
- bridge decks.

They can also be modified with polymers or pozzolans, which serve as densifiers and improve the bond, tensile, and compressive strengths.

Cementitious floor resurfacers do not degrade with water contact, whereas gypsum-based materials break down, causing substrate instability followed by floor topping failure. Indeed, gypsum is an inexpensive way to get a fire-rated floor when building wood-framed structures. As long as it is kept dry, it performs well. However, if gypsum-based materials get wet and foot traffic continues, they start to break down. Entrances, lobbies, kitchens, dining areas, bathrooms, and locker rooms are particularly susceptible as areas prone to getting wet.

Other types of resurfacing materials include self-drying cements that can be used when a quick return to service is particularly important. Polymer or resin-based resurfacers—typically screeds or toppings—can provide improved performance characteristics such as chemical and abrasion resistance. These materials can also be formulated as a moisture reduction vapor retarder for sensitive floor coverings or a finished wear surface that serves as a vapor retarder.

Polymer and resin-based resurfacers are more expensive than portland cement-based materials. However, initial costs may be offset by the labor savings, speedy return to service, and resistance performance offered by these resurfacers.

Why Water Causes Concrete Crises and Finish Failures

A cool moist floor in the presence of warm dry air will draw moisture from the concrete floor into the occupied space. When a non- or limited-breathable floor finish is placed on top of a concrete floor with excessive moisture, problems can arise. Over time, the covered concrete may become saturated, filling its pores with water. The soluble cement (calcium hydroxide) in the concrete floor dissolves, creating a saltwater solution with a pH as high as 14.

Most floor finishes are organic or use organic adhesives, which cannot endure high pH levels for long. Under these conditions, the materials will start to break down and the finish floor will fail. The outward liquid pressure exerted can exceed 1300 kPa (200 psi).

Temperature fluctuations can aggravate concrete containing trapped moisture under non- or limited-breathable floor coverings. As ambient temperatures rise and fall during the day, the entrapped vapor tries to move in and out of the concrete. As time passes, this pressure can cause the finish floor to blister or break down.

Encapsulating concrete in freeze–thaw environments is particularly damaging. As water expands by nine percent when it freezes, the water-filled pores will cause the concrete to rupture and possibly even disintegrate into rubble.

This author recently visited a parking structure in which the concrete had turned to pulp because it could not breathe. The author was able to insert a pocketknife more than one inch deep into the concrete deck.

Factors such as the use of a vapor barrier below the concrete floor, type of fill, and quality of concrete will further impact how the trapped moisture behaves.

The importance of testing

The key to a successful flooring project is testing. Validation of existing conditions provides a clearer picture of the unseen conditions within the substrate, including moisture vapor transmission, bond-inhibiting materials (*e.g.* oils and surface treatment chemicals), and quality (*e.g.* direct tensile and compressive strengths). Ideally, the area should be tested while it is operating as planned (*i.e.* while the space is being heated or air-conditioned). Knowing the concrete's condition in advance will reduce surprises and costly corrective actions later. (See "Why Water Causes Concrete Crises and Finish Failures.")

To begin, consider the location of the application. Exterior slab-on-grade applications should be designed to allow the passage of moisture vapor from the substrate to the atmosphere. If this is not the case, the floor's finish could be compromised.

Before applying the floor finish, interior slab-on-grade applications should be tested to determine the amount of moisture in the slab and rate of moisture vapor transmission. ASTM International F 2170-02, *Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In-situ Probes*, is used to test moisture content. ASTM F 1869-04, *Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride* can determine vapor transmission.

Exterior structural decks, such as precast or cast-in-place concrete, should be tested to verify the undersides do not have vapor retarder coatings on them. This is especially important if polymer- or resin-based traffic systems are to be applied to the top surface.

Interior structural decks can be built using various construction methods. The greatest concerns are non-vented metal pan decks with lightweight concrete fill. Lightweight concrete contains lightweight aggregates that are highly absorptive and retain water for long periods. Lightweight concrete decks with non-vented metal pans usually have high moisture levels six months after they have been poured.

A final consideration is the service conditions the floor must withstand. Environmental factors such as dust, dirt, oil, water, and chemical exposure degrade floors over time. A system approach to floor resurfacing can help mitigate these factors. No singular product can achieve everything—moisture mitigation treatments, primers, leveling materials, adhesives, and the finish floor treatment work together to create an effective system. A qualified subfloor contractor can provide expertise on testing substrates prior to installing flooring materials.

Preparing the floor

Once a resurfacer has been selected, the next step is to properly prepare the floor. Most resurfacers are designed to bond with the host substrate, becoming an integral part of the floor. Before installing any resurfacer, it is wise to involve a consultant or manufacturer's representative who has knowledge of the application in question.

Several methods can be used to achieve the proper floor profile prior to applying the resurfacer. The three most

commonly used methods are detergent scrubbing, steel shot blasting, and grinding. More aggressive floor preparation methods such as hydroblasting and scarifying are typically not used indoors.

Detergent scrubbing

This method uses a detergent solution to scrub off oil, grease, and other deposits on concrete, which could otherwise be driven into the material by subsequent mechanical preparation. Detergent scrubbing is limited to water-soluble or detergent-emulsifiable contaminants, and is often sufficient for preparing the surface to receive gypsum-based products.

Detergent scrubbing is the cheapest flooring preparation method at about $0.50/sf depending on area, depth of skim coat, and sanding and rewashing requirements prior to setting the finish floor (*i.e.* multi-step process). This type of preparation is typically used for floors that will be skimmed out.

Steel shot blasting

Steel shot blasting involves propelling steel shot onto the surface at high velocity. This process is confined to an enclosed blast chamber, which recovers and separates dust and reusable shot. Different profiles can be achieved depending on the size of shot used and the speed at which the blaster is moved across the floor. Steel shot blasting is also suitable for removal of polyurethane coatings up to 0.25 mm (10 mil) thick, tile mastics, and brittle epoxy or methyl methacrylate coatings.

Costs for shot blasting range from $0.25 to $3/sf. Setup, surface preparation, tear down, and cleanup changes can result in additional costs.

Grinding

Grinding entails the rotation of one or more abrading diamond discs applied, under pressure at right angles, to the concrete surface. Diamond grinding requires a hand-held instrument for edges and small areas, and large walk-behind units for open areas. Hand-held grinders are typically used for preparing around columns and difficult to access areas. Costs vary from $0.50 to $4/sf.

Scarifying

Scarifying uses rotary cutters that impact the surface at a right angle to fracture or pulverize concrete. This method can be used on bumpy areas to level slabs. Due to its extreme force, it may cause microcracking in the substrate. Scarification is not recommended in surface preparation for

A 'smoother' is used to provide the final touches to the nicely flat surface. A well-designed floor surface can improve longevity.

sealers or coatings less than 0.38 mm (15 mil) thick. Unlike scarification, hydroblasting, steel shot blasting, and sand blasting pose a low risk of microcracking in the substrate. Costs range from $4 to $8/sf.

Hydroblasting

Hydroblasting involves spraying water at pressures up to 276 MPa (40,000 psi). This method can also expose aggregate and embedded reinforced steel within concrete. Hydroblasting is fully contained and can be used to remove difficult substances such as glue and elastomeric membranes. Due to its destructiveness, this method is not used indoors.

Sand blasting

Sand blasting uses compressed air mixed with an abrasive medium to clean concrete surfaces. It generates large amounts of dust and can accidentally etch glass and architectural metals if the adjoining areas are insufficiently protected.

Sand blasting is not practical for interior applications; it is typically limited to open areas such as bridges, piers, and roads.

Post-profiling

Once the surface has been properly profiled and all surface contaminants have been removed, cracks or spalls must be addressed. Crack fillers and patching compounds provide a suitable method for resolving minor surface defects.

Floor joints such as control, construction, and expansion joints must also receive proper attention. If a rigid material is

Additional Information

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Abstract

Despite a contractor's best efforts, a floor free of cracks, bumps, or other surface defects is unrealistic. Depending on placement procedures and finishing techniques, cast-in-place suspended slab floors or slab-on-grade floors are not typically ready to accept final floor finishes or coverings without remediation. Floor resurfacers are used to correct or modify existing job-site conditions to prepare a floor for the environmental conditions it encounters during its service life.

applied over a moving joint, the result will be a cracked or delaminated finished floor. When selecting a floor finish, the designer should consider how the joints will be treated and the finished floor installed—as the building and floors move, the finished floor should not attempt to restrain this movement.

The final step prior to installation of a resurfacer is priming. Many resurfacers require priming to strengthen the bond between the floor and the resurfacing layer. Alternatively, cementitious resurfacers typically do not need priming on a properly prepared open porous concrete substrate, but do require a saturated surface dry (SSD) substrate. SSD is the condition where a surface's permeable voids fill with water, but water is not present on the exposed surface.

SSD is required for cement hydration to take place. If the bondline is deprived of water, the substrate sucks moisture out of the resurfacing material, leaving no water for the cement's hydration. Consequently, the material's performance and longevity is compromised. In extreme cases, complete failure can occur at the bondline, causing the resurfacing material to delaminate.

The underlayment material chosen affects the degree of floor preparation required. Gypsum-based underlayments can be installed with minimal surface preparation, whereas their cement-based counterparts typically require additional surface preparation, such as cleaning and priming.

Before a cement-based underlayment can be installed, the correct International Concrete Repair Institute (ICRI) Concrete Surface Profile (CSP) must be achieved. These profiles are used to align expectations between manufacturer and installation contractor, and play a role in the quality control process for the design professional and contractor.

Profiles range from CSP 1 to 9, with CSP 1 requiring only moderate roughening and CSP 9 needing heavy scarification. Sealers, for instance, require CSP 1 to 3. Self-leveling underlayments and toppings call for CSP 3 to 6 (light abrasive blast to moderate scarification). Bonded screeds and trowelable toppings require CSP 7 to 9 (heavy abrasive blast to heavy scarification).

Conclusion

Floor resurfacers are valuable because of the return on investment (ROI) they provide. While the initial outlay of materials and labor may appear costly, these processes and products are ultimately an asset when considering their long-term value. Resurfacers allow the contractor to extend the life of a structure and reduce its lifecycle costs. Proper floor preparation and resurfacing helps boost property value, protect brand equity, improve service and longevity, and increase overall customer satisfaction.