ITRC Technology Information Sheet

Vapor Intrusion Mitigation Team | December 2020

Epoxy Floor Coatings (EFCs)

This ITRC Technology Information Sheet provides an overview of EFCs. EFCs are chemically resistant coatings that form a seal over existing concrete. EFCs can serve as a vapor intrusion mitigation system (VIMS) for existing structures. This technology information sheet will help you better understand the various components of EFCs.

Overview

Epoxy products can be used for a variety of industrial, commercial, and residential applications. EFCs can be applied to concrete foundations in existing buildings and new construction. EFCs are most often used to protect existing concrete surfaces or provide a decorative finish, but they can also be applied to existing concrete slabs as a passive vapor intrusion (VI) barrier.

Epoxy is an organic compound derived from petroleum. The name refers to the epoxide functional group of thermosetting polymer resins. Most EFCs for VIMS are created using two components: a resin and a curing or hardening agent, which are mixed before application. When applied, the epoxy cures by an exothermic chemical reaction that changes the material from liquid to solid. After the two components are mixed, the application becomes time-sensitive before the product hardens. The rigidity and strength of the epoxy coatings are created during the curing process. The curing agent can be adjusted to address project objectives and performance requirements. Curing is significantly affected by temperature, and cold temperatures can impede the curing process.

During the conversion from a liquid to a solid state, EFCs become highly adhesive, which allows them to bond with the concrete floor and seal porous concrete. As a result, EFCs can be strong, durable, and chemically resistant, but performance will vary based on the type of epoxy resin selected. When evaluating epoxies, the following properties should also be considered:

- adhesion of the epoxy bond to the floor material
- resistance to abrasion, to determine how durable the EFC will be for the anticipated wear
- impact resistance
- compatibility and resistance to chemicals that may come into contact with the EFC

EFCs are commonly applied in one or two coats using a roller or squeegee to obtain the proper thickness. Application thickness can vary, but thicker coatings reduce the potential for defect and typically increase the durability of the finished surface. Many EFCs require a 24- to 48-hour curing time between coat applications. The curing time will vary between manufacturers; be sure to consult the manufacturer's instructions and recommendations regarding cure time and foot traffic during the curing process.

An EFC may fail if applied to damp concrete or other surfaces with high moisture vapor emission rates. This type of failure is known as delamination. Removal of moisture within the concrete slab is typically achieved through ventilation, heating, and dehumidification. The primary aesthetic disadvantage of some EFCs is discoloration over time due to exposure to sunlight.

The use of EFCs as a vapor barrier requires the concrete surface to be clean, free of debris, and slightly porous. Before application, shot/sandblasting, diamond grinding, or chemical etching (muriatic acid or buffered phosphoric acid) may need to be used for an existing concrete slab in poor condition. All major cracks, patches, and chips in the concrete slab surface must be repaired before the application of an EFC. Newly poured concrete must be cured sufficiently before application of an EFC. Generally, a 30-day cure time for the concrete is recommended prior to the application of the EFC, but much faster cure times can be achieved if required. To prevent delamination post-installation, measuring relative humidity (RH) prior to EFC application to determine the moisture condition of the concrete slab is recommended. Each RH test has advantages and disadvantages; consult the epoxy coating manufacturer's instructions to determine the most appropriate RH test for the application. Three standard methods for testing RH are:

- ASTM F2170—Relative Humidity Test
- ASTM F1869—Calcium Chloride Test
- Hand-held Concrete Moisture Meters

The application approach should include quality assurance procedures to ensure the proper installation of the EFC. It is recommended that manufacturer-certified installers be used to install EFC for VI mitigation. Surface preparation is one of the most critical factors to ensure proper bond strength. Certified installers are experienced at creating the correct concrete surface profile (CSP) necessary to provide a robust mechanical bond between the EFC applied and the concrete substrate. Most EFC manufacturers will specify the CSP required for the installation.

To ensure the specified EFC thickness is achieved, installers must compare the published manufacturer coverage rates to the desired application area. For example, 1 gallon of resin may be specified to cover 1,600 square feet to achieve a 1-mil-thick coating. If the specification calls for a 10-mil thick EFC, 1 gallon of resin will cover 160 square feet. Installers should use a wet mil gauge to verify applied mil thickness throughout the application. Please note that concrete substrates are not perfectly flat; therefore, periodic inspection of the installation is necessary to ensure appropriate application rates.

Components

EFCs consist of two components, typically described as a part A resin and a part B hardener. The part A resin can be either a clear or pigmented solid-containing material. The hardener is compatible and added to the resin. Together, they cure to form a solid material. Once cured and bonded to the substrate, it will function as prescribed by the manufacturer's technical data sheet. For VI applications, it is essential to select materials that have very low to no VOCs. No VOCs is preferred. Additional materials such as expansion joints, moisture mitigation primers, backer rods, and decorative elements may also be required based on the application.

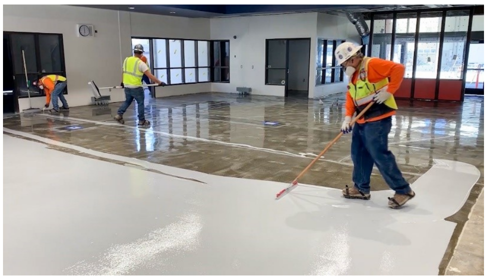

Figure 1. Application of EFC to a concrete substrate.
Source: Land Science, a Division of Regenesis, used with permission.

Advantages

Advantages of using EFCs as a passive mitigation strategy include:

- They are broadly applicable to industrial, commercial, and residential settings.
- They are quick curing for time-sensitive projects.
- EFCs produce a strong and durable product.
- They provide a chemically resistant surface.
- EFCs protect the concrete foundation.
- EFCS are easy to clean and require little maintenance.
- The aesthetics of EFCs are easily manipulated through the use of colors, patterns, and finishes.

Limitations

The effectiveness and reliability of EFCs for VI mitigation can be significantly improved with passive venting. Other limitations of using EFCs as a passive mitigation strategy include:

- EFCs are susceptible to delamination in settings where concrete slabs retain high moisture content.

- Several days may be needed before EFCs can accept traffic.
- Scarification of concrete will almost always be required to prepare the substrate properly.
- Routine maintenance is required to ensure the epoxy coating remains intact, especially if the building experiences differential settling.
- Removal of all building contents is necessary to achieve a complete seal of the concrete surface. This may require substantial coordination with the building occupants.
- Measurements of performance are limited to periodic indoor air sampling.

Cost Considerations

Several factors affect the cost of installing EFCs. Labor represents a large portion of the total project cost. Proper installation typically requires a professional contractor, especially when retrofitting an existing building. Labor costs to install EFCs for new concrete slabs may be less than retrofitting an older concrete slab with an EFC. The condition of an existing concrete slab can affect the amount of preparation required (e.g., physical or chemical scarification, removing stains, repairing damaged concrete, RH testing). Product lifetime should be considered as part of the overall cost and will vary by manufacturer. Charges for labor, materials, and installation of EFCs range from approximately $3 to $12 per square foot.

Industrial and commercial buildings may also have higher costs due to a need for an EFC with greater durability and traction properties. EFCs with these properties may significantly increase material costs. Aesthetic design considerations such as color and pattern, especially for commercial buildings, will also increase costs.

Special Circumstances

Special circumstances associated with the application of EFCs as a passive mitigation strategy are described below:

- Design for function—Epoxies can be readily modified to enhance specific attributes in addition to the primary performance objective as a sealant. End-use and site conditions will dictate the materials and tools needed for installation.
- Weather—Extreme temperatures may affect the curing of the epoxy. Hot temperatures will limit the time available for application; cold temperatures may lengthen curing time.
- Relative humidity of concrete—The project scope should include measuring RH, especially in conditions where excessive moisture is encountered. Additional tasks may need to be performed to dry the concrete to prevent the delamination of the EFC.
- The surface condition of the existing concrete slab—The surface of the concrete must be clean, dry, and free of cracks, chips, and stains. Poor surface conditions detrimentally affect the adhesion of the epoxy.
- Newly installed concrete—New concrete slabs must be allowed to cure before the application of EFCs. Curing times depend on materials and site conditions and should be evaluated before implementation.
- Vertical surfaces—Concrete masonry unit (CMU) block, cast-in-place concrete, or other vertical wall materials specifically designed for wet adhesion would follow similar application approaches to horizontal concrete slabs.

Occupant, Community, and Stakeholder Considerations

- Buildings should not be occupied during EFC installation. If vacating the building is not possible, occupation should be relocated to areas of the building away from the work area, which must be well ventilated until the product has fully cured (typically 24–48 hours following application).
- The materials, equipment, and traffic control measures needed by the professional firm contracted to install EFCs may temporarily disrupt residential neighborhoods.
- It is essential to develop and implement a site-specific community involvement plan that addresses, among other things, how to win the trust and gain access to properties, communicate risk to potentially exposed individuals, and minimize the disruption of people’s lives and businesses. For more details, see ITRC’s ***Public Outreach During Vapor Intrusion Mitigation Fact Sheet***.

Resources

- ITRC. 2014. Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management, Washington, D.C.: Interstate Technology & Regulatory Council, Vapor Intrusion Team.
- ASTM. 2016. Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride. ASTM F1869-16a
- ASTM. 2019. Standard Test Method For determining Relative Humidity in Concrete Floor Slabs Using in situ Probes. 2019. ASTM F2170-19a

For more information and useful links about VI pathways and mitigation technologies, go to http://www.itrcweb.org .

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