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Core Before You Coat: Pre-Project Evaluation and Coating Mockups

*By **Brian J. Wolfe, PE, Principal Engineer-Petrographer for SGS TEC Services, Inc.***
*Photos courtesy of the **author***

The number of times we are hired to investigate a coating failure far outweighs the number of times we are hired before the project starts. This is an unfortunate truth because, more often than not, the investigation determines that the failure could have been prevented.

Almost all parties involved in the coatings industry are well aware of moisture vapor transmission and the havoc it can cause with impermeable coatings. Today, it is standard operating procedure to perform slab moisture testing upfront before a project begins, but there are other obstacles that can derail a coating project — and these obstacles can typically be identified in pre-project core samples.

What's in a Core?

The sampling area is determined on a project-to-project basis. A new concrete slab where a coating is specified is a completely different animal than the slab coating project of a 30-year-old industrial facility that previously served as a steel mill. However, in all cases, it is recommended to perform an initial visual condition assessment of the slab surface to determine the typical (>75 percent of the square footage), occasional (5–25 percent), and rare (<5 percent) slab surface conditions.

Generally, for new concrete projects, significant preexisting slab issues are not expected, but if curing compounds or tilt-up wall bond breakers were used on the slab, cores of the preexisting condition would be recommended to determine the depth of penetration. Core sampling of a mockup performed in a typical slab location often provides the most useful information for a new slab coating project. This information can assist in determining if the surface preparation depth is adequate, if the surface preparation is inducing microcracks, and if the coating methods are resulting in adequate dry film thickness.

Figure 1. Typical coring setup

Figure 2. Core samples

Areas with substantial surface stains, cracks, exposed aggregate, and delaminations are of particular interest, but it is also important to sample areas that appear in good condition for comparison. These cores can determine an abundance of important information prior to coating, including but not limited to carbonation depth, crack depth, alkali-aggregate deterioration, laminar cracks, chemical penetration, concrete quality, and expected service life. This information can be used to determine the required depth of surface preparation, the surface preparation methods, and the most suitable coating material needed for that particular slab.

Drilling Tips and Tricks

Whether you are evaluating an undisturbed slab, a mechanically prepared surface, or a coating mockup area, core drilling is the most effective and efficient method for sampling the existing slab conditions without compromising or manipulating the concrete within the sample. This is extremely important because cracks and defects caused during sampling can be misinterpreted as preexisting.

A core barrel designed for concrete coring cuts smoothly through the concrete and coating materials because the end

of the core barrel is impregnated with fine diamond particles and the tip of the barrel is cooled with water during drilling. The core barrel threads into the gearbox, which is connected to the electric motor. Most core drills are freestanding, but handheld coring is strongly discouraged. Even this year's winner of the World's Strongest Man competition would be hard pressed to prevent barrel movement during coring by hand. Instead, the core drill should be securely fastened to a rigid stand that can be fixed/anchored to the slab surface (Figure 1). Only with this setup can proper core sampling be performed. Remember: We are not just trying to make a hole; we are obtaining a sample for examination.

Prior to coring, it is standard practice to perform nondestructive testing (NDT) to locate the embedded objects in the slab. This is just as important as "calling before you dig" in your front yard, because coring through wire mesh, rebar, post tension cables, or conduit is a life safety issue. And it can damage the core sample, which will render the core useless and potentially misleading.

If possible, it is best to obtain cores through the full thickness of the slab and extract them without applying force to the top of the core. Breaking off cores in the slab is not recommended unless absolutely necessary. This is because the prying force applied to the top of the core can cause microcracks or exacerbate existing cracks.

After the core is obtained and numbered, it is ready for examination (Figure 2), but it still needs to be shipped to an accredited laboratory for evaluation and testing. Although concrete is an incredibly strong building material capable of supporting skyscrapers, it is best to think of the cores as eggs when they are shipped. (More times than I care to remember, I've received a box containing a core that broke in transit.) Broken cores can be prevented if all the core surfaces are protected with bubble wrap and the cores are secured from movement and side impact inside the box.

Core Evaluation

Obtaining a core sample is a destructive act, but without a core, you won't be able to see what is hiding beneath the top

Figure 3. Segregated aggregate polished section

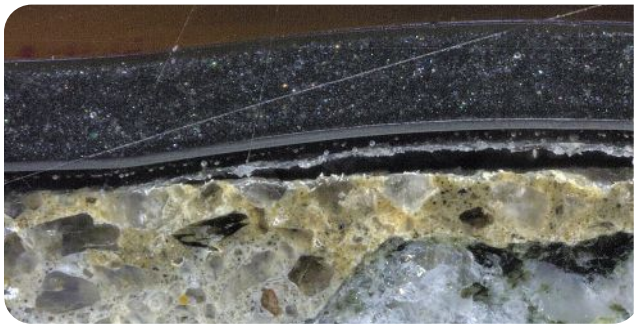
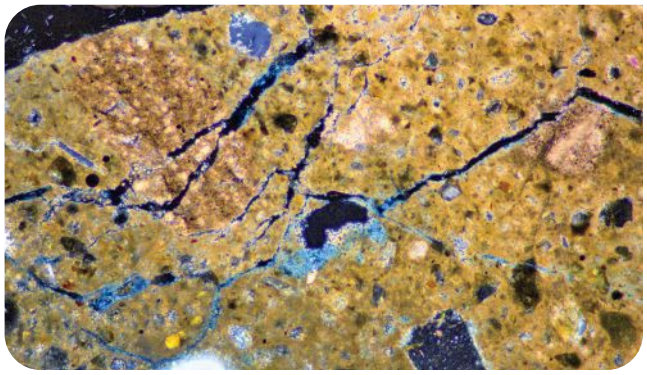


Figure 4. Delamination at carbonation

surface of the slab. Occasionally, these secrets are evident to the naked eye the moment the core is removed (Figure 3); however, typically, a more advanced laboratory analysis is required to reveal all the secrets of the concrete. A plethora of tests can be performed on concrete cores, but the two most commonly used techniques for coating projects are:

1. Microscopic (Petrographic) Evaluation: This is performed by an experienced petrographer on polished sawn cross sections and thin sections of concrete cores in accordance with the applicable sections of ASTM C856, "Standard Practice for Petrographic Examination of Hardened Concrete." For coating projects, the petrography is typically focused on identifying issues that will be detrimental to the bond strength of a coating, such as sub-surface microcracks, trapped bleed water voids, surface popouts, carbonation (Figure 4), poor quality concrete, and alkali-silica reactions. The most common defect in concrete slabs that promotes surface delaminations is the presence of sub-surface microcracks (Figure 5), and these microcracks can be caused by aggressive surface preparation methods. This is why it is so important to obtain cores for evaluation initially from surface preparation mockup areas. Bottom line: Before you apply thousands of square feet of coating to a concrete slab, it is a good idea to determine if it is a slab worth coating.
2. Chemical Analyses: The most common and useful forms of chemical analysis on coating projects are ion

Figure 5. Microcracks in carbonated paste



chromatography and infrared (IR) spectroscopy. These tests are used to determine the depth of organic and inorganic contaminants. Typically, the ion chromatography is searching for elevated concentrations of sodium, potassium, chloride, and sulfate ions in the upper zone of the concrete slab. The IR spectroscopy is used to identify the organic contaminants. Many coatings manufacturers require the contaminant testing to be performed to obtain their warranty. This is because these contaminants are detrimental to the integrity and bond of coatings. The chemical analyses are performed on progressively deeper core depth sections to determine the depth at which no contaminants are present. Typically, the depths from the top surface are 0–3 mm (0.12 inch), 3–6 mm (0.24 inch), and 6–9 mm (0.35 inch). These tests are effective at determining the depth with concerning concentrations, which can then determine the required depth of removal.

Summary

Pre-project core sampling and analysis of preexisting conditions and mockup areas are effective tools for preventing flooring failures. This is because core sampling and analysis can identify preexisting issues and determine if the proposed coating application will have a long service life or if delaminations can be anticipated. Sadly, pre-project core sampling and analysis is still greatly underutilized, but hopefully, this article will help to prompt more people in the coatings industry to think, "Core before you coat." ***CP***

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