A Program on Stucco and EIFS

The Stucco and Exterior Finish Cladding Systems course is the second specific exterior wall course that builds on the fundamentals presented in RCI's Exterior Walls and Science educational program. This shortened one-day course will provide essential information on material properties, design principles, evaluation techniques, and repair methods for stucco and EIFS. Topics covered in this course include the various codes and standards that influence design, installation of stucco and EIFS systems, serviceability requirements, performance test methods, and case histories relative to stucco and EIFS assemblies.

This abbreviated course is recommended for those who have taken Exterior Walls Technology and Science and want to further expand their knowledge of exterior wall systems. It will also serve as a good review course for those interested in taking the Registered Exterior Wall Consultant (REWC) exam.

Presentation Speakers

James I. Daniel, REWC, PE | Daniel Building Investigations, Inc., Lemont, IL
Richard L. Cook, Jr., FRCI, RBEC, RRC, REWC, RWC, RRO, CCS & LEED® AP, CSRP, SC ACEM | ADC Engineering, Hanahan, SC
Patricia M. Aguirre, REWC, PE, CDT | Bristow, VA

Stucco And Exterior Finish Cladding Systems

12 CEHs in six hours | 6 AIA LUs/HSW                 $275 RCI members and Nonmembers

March 23, 2018
Houston, Texas

RCI, Inc. International Convention and Trade Show: Auxiliary Educational Program

Accelerated Learning Edition

Figure 1 – Traffic-bearing membranes look appealing. But are they worth the price?

Elastomeric traffic-bearing membranes are showing up on garages old and new, and their popularity has soared in the past decade. A beautiful coating that locks out harmful moisture and chlorides must be a reasonable long-term investment, right? Not only is this not necessarily true, in some cases, applying such coatings can be a costly mistake. It is true that parking decks must be cared for to ensure that they will be here after we are not, but there is a growing preconception that installing a traffic-bearing membrane is a one-way ticket to the garage equivalent of immortality. While a traffic-bearing membrane may, in fact, be the best solution for many situations, this is a big-ticket item, and thorough consideration is necessary to determine if this costly investment is the correct solution for your garage’s needs (Figure 1).

Traffic-bearing membranes are not perfect. In order to withstand the punishing abrasion that a parking deck must endure, the membrane must be hard and durable; however, the membrane must, at the same time, be soft and flexible to bridge over moving cracks and joints without failure. Since very hard membranes are generally inflexible, and more pliable membranes don’t hold up well to abrasion, choosing the right membrane is a balancing act. In addition, there are locations where no membrane performs well, such as those areas requiring a flexible membrane that are subject to snow plows.

So...what is the best solution? It’s helpful to begin by looking at the reasons why deck protection is necessary.

THE PROBLEM

In northern climates, parking decks are subjected to extreme corrosive and deteriorating environments. Moisture, laden with chlorides from deicing chemicals, tracks into garages or hitchs a ride as ice formations behind the wheels of vehicles (tenderly referred to as “fenderbergs” by those in the repair industry) and ultimately soaks into the concrete surface. The dissolved chlorides

Figure 1 – Traffic-bearing membranes look appealing. But are they worth the price?
then migrate to embedded steel reinforcement through the pores in the concrete or penetrate through cracks. Once they reach the steel, the salts cause expansive corrosion, ultimately resulting in unsightly, destructive, and costly deterioration of the structure.

Moisture’s ability to transport corrosive chlorides is not its only damaging property. Coupled with cold weather, water can damage concrete decks as it expands and contracts during freeze/thaw cycles. Air entrainment—the deliberate incorporation of microscopic air bubbles in concrete—releases the internal pressure created by freezing water by permitting moisture to flow from bubble to bubble. Still, although this solution to freeze/thaw degradation has been known for years, garages continue to be constructed with insufficient air entrainment, leading to premature breakdown of the concrete as freezing water destroys it from the inside out.

Water is at the heart of most parking deck deterioration. Moisture can facilitate reactions between certain aggregates and alkali hydroxides in the concrete, creating a cycle of expansion, cracking, and further moisture intrusion. This alkali-silica reaction, or ASR, is very difficult to stop once it has begun. Other minerals—notably sulfates and ettringite—migrate via penetrating moisture and can crystallize and lead to spalling, cracking, delamination, and even loss of integrity of the concrete.

Because parking structures are exposed to the elements inside and out, they are more susceptible than other building types to deterioration due to moisture, temperature cycles, and contaminants. Even the best-designed and constructed garages need some help to survive this onslaught of corrosive forces.

**THE OBJECTIVE**

Ultimately, the goal of all deck protection is to stop water from getting into the deck. Perhaps this is an oversimplification, but not by much. No water, no deterioration. The tricky part is that water comes in more than one form. Liquid water is an obvious villain, as is the expansive force of ice and snow, but water vapor can be just as damaging.

For example, a chloride-laden deck can actually draw moisture from the air and continue to deteriorate even after one’s best efforts to keep it dry. In fact, calcium chloride, the most popular and effective of all deicing chemicals, is commonly used on construction sites for dust control. It is sprinkled onto the dry earth and wets the surface by pulling moisture from the air. Unfortunately, it works equally well at saturating a parking deck.

Remediating the effects of chloride ion attack, freeze/thaw damage, or moisture-driven chemical reactions is both difficult and costly, so preventing water infiltration—whether liquid, solid, or vapor—is top priority. While keeping a garage perfectly dry is an impossible task, through thoughtful product selection, the degree to which moisture can penetrate the parking deck can be limited. As such, there are a variety of products on the market that showcase the best protection chemistry can currently achieve.

**THE OPTIONS**

Technological advances in the chemical industry in the past 30 years have brought concrete sealers a long way from the boiled linseed oil that was previously used. Today, an industry dedicated solely to concrete protection offers a dizzying array of products to treat concrete before, during, and after production, both inside and out. For existing parking structures, a number of waterproofing agents are available that can be applied to the surface of the deck; the following is a look at some of these product types and their properties.

**Penetrating Sealers**

These liquid-applied treatments, which include silane, siloxane, and silicates, stop water entry by penetrating deep into concrete and forming a barrier that prevents liquid water from entering, limiting chloride ion migration and freeze-thaw damage. These treatments are also vapor-permeable, allowing them to be used at locations where other coatings may not be appropriate, such as slabs-on-grade. Because they are inexpensive and quickly applied, with little or no down time, penetrating sealers offer a good first line of defense for a parking structure that is in good overall repair. As invisible penetrants working below the surface of the concrete, these sealers do not affect deck line striping, saving on project duration and cost.

However, these coatings can be short-lived solutions, requiring reapplication every five years or less. They also do not bridge cracks, so they only limit moisture and chloride penetration in intact concrete. Because cracking can be an ongoing process, the ability to bridge new cracks as they form may be important in parking decks that already have evidence of concrete distress (Figure 2).

**Methacrylate and Epoxy Healer/Sealers**

As the name implies, these coatings both repair cracks and seal pores, so they can be used to restore a deck that has already undergone some deterioration. Like
WHEN COATINGS GO BAD

A coating applied successfully to an elevated deck may have disastrous effects in the same garage when applied to a slab-on-grade. Why?

As water levels and humidity change, ground moisture seeps up into the concrete slab. Vapor barriers, often installed under slabs-on-grade, are designed to block this moisture from entering the slab; but, in reality, breaches in that barrier or cracks in the slab can still permit water entry. If an impermeable coating is applied to the top surface of the deck, that moisture becomes trapped between two impenetrable surfaces. Unable to escape, the water sits in the slab, leading to chloride and freeze-thaw degradation. Even with no vapor barrier present, moisture in the ground rises within the slab and becomes trapped within the deck. Therefore, leaving the slab-on-grade uncoated is the best course of action.

On an elevated deck, that permeability gradient is reversed. Moisture enters the deck from above and migrates through the slab to the underside, where it evaporates. Even with a waterproofing membrane protecting the top surface, the deck is still susceptible to water entering at cracks, joints, and failed coating sections. Coating the bottom of the deck with an impermeable coating invariably leads to trapped moisture and accelerated deterioration. For this reason, the underside of an elevated deck should be treated similarly to a slab-on-grade: leave it uncoated.

One often-overlooked fact is that paint is also a coating. Many of the concrete paints on the market are epoxy-based and relatively impervious to moisture. Even if a vapor-permeable paint is used, successive reapplications increase the coating thickness and so decrease its permeability. Over time, what was once a high-permeability surface can become surprisingly resistant to moisture migration. With the eventualty of peeling paint, spalls, rust, and cracks taken into account, a deck underside that’s been painted for appearance’s sake begins to lose its appeal, as compared with a simple, uncoated one that’s still intact.

As the adage goes, location is everything. Knowing which surfaces in a parking structure can accept an impermeable coating and which are best left bare is critical to prolonging the life of your garage.
the penetrating sealers, low-viscosity methacrylates and epoxies fill the pores in concrete to create a barrier to liquid-water-driven chloride intrusion (Figure 3). They can also be injected or gravity-fed into cracks to structurally heal them (Figures 4 and 5). Where desirable, the healer/sealers can also limit vapor transmission, although care must be taken not to lock moisture within the deck. With a moderate price tag, this class of surface treatments offers a good solution for parking structures that are starting to show some signs of distress, both to treat deterioration that has already occurred and to prevent continued water-related damage.

Where methacrylate and epoxy healer/sealers fall short is in wet or soiled fractures, to which the materials won’t adhere, and in moving cracks, which are likely to refracture. On parking decks exposed to continuous sunlight, epoxies can degrade quickly under UV radiation, so consider methacrylates for these areas. For enclosed parking structures or other areas where fumes might be a problem, offensive odors from methacrylates might prove prohibitive. Unlike the penetrating sealers, healer/sealers...
aren’t just coat-and-go; surface preparation necessitates shot blasting, which means increased down time and cost. Also, pavement markings must be reapplied.

**Traffic-Bearing Membranes (Elastomeric)**

In parking structures with dynamic cracking, shrinkage, or more advanced damage, a traffic-bearing membrane may be the only option to address the ongoing deterioration. Unlike the sealers, these do not penetrate the concrete, but remain on the surface to create a barrier that locks out moisture and chlorides. Most elastomeric membranes have two layers: a base coat that provides the waterproofing protection, and a top coat, which protects the base membrane and provides skid resistance. Together, these yield an attractive, easy-to-clean surface that can give a “face lift” to older, crack-riddled parking decks.

However, a traffic-bearing membrane’s assets are also its downsides. Flexible varieties offer superior crack-bridging, even for moving cracks, but they don’t hold up well to abrasion because they are soft and yielding. More rigid varieties, designed to better withstand abrasive forces of heavy traffic, are too stiff to bridge these moving cracks. So while traffic-bearing membranes, as a class of surface treatments, may seem to have all the right stuff, no one membrane, in practice, actually does. Before opting for one of these very expensive coatings, consider, too, that they require lengthy down time (preparation and application takes several days) and considerable ongoing maintenance (recoating, or at least top-coating, every five to ten years) for the life of the garage. Once a traffic-bearing membrane has been installed, it’s nearly impossible to return to an uncoated surface in the future.

**Super-Rigid Elasto-Epoxythane Traffic-Resisting Armor**

This surface treatment combines the best of all of the above. Although abrasion-defiant, it is flexible enough to bridge moving cracks, locking out all moisture and chlorides. It is environmentally friendly, low odor, and available in a wide variety of colors to match any decor. Unfortunately, it also, as yet, does not exist.

**THE CRITERIA**

Until such time as the super-rigid elasto-epoxythane traffic-resisting armor is developed, we will have to settle for the solution of selecting the best of the available surface treatments for the parking structure’s characteristics, condition, and situation. To that end, there are a number of criteria we can use to determine which products would offer the best-performing option for the cost, in terms of both initial investment and long-term maintenance expense.

**Deck Type**

Over the years, many different types of parking decks have been developed. For the purpose of investigating surface treatment options, however, deck types can be simplified into two basic categories: cast-in-place and pre-cast concrete.

- **Cast-in-place decks.** Usually composed of a single, contiguous, reinforced slab of concrete spanning a concrete or steel frame, cast-in-place decks are constructed onsite.

  Due to its nature, concrete shrinks as it cures, which, coupled with the external restraint stress from the structure to which it’s attached, can lead to crack formation. Cracks, as we’ve seen, are water-borne chlorides’ direct route to reinforcing steel. Once established, these cracks form natural expansion joints that open and close with changing temperature and humidity.

  Consequently, protective techniques tend to focus on these moving cracks. If cracks are few and the deck is chloride-free, then routing and sealing cracks and applying...
a low-cost sealer may be appropriate. If the
deck is riddled with cracks that can’t be
adequately sealed, then elastomeric mem-
branes begin to look like a good option.

**Pre-cast decks.** Cast off-site under con-
trolled conditions, pre-cast decks are lifted
and welded into place after they have cured
and—to some extent—dried out. Because
the concrete used for this type of construc-
tion is typically high-strength and more
dense than its cast-in-place counterpart,
pre-cast decks should rarely experience
fracturing. However, this manner of con-
struction is favored for fast-track projects,
and the end result is rarely defect-free.

Because they are factory-made and
must be lifted into place, pre-cast units do
not create a single, contiguous, monolithic
structure. Instead, the individual members
meet at sealant joints. Extending around
each pre-cast unit, these joints add up to
miles of sealant that must be maintained
and periodically replaced. Even if cracking
isn’t an issue, water migration through
failed joints can be just as damaging.

Aside from routine sealant maintenance,
surface protection requirements are typically
minimal and usually can be addressed with
simple low-cost penetrating sealers. Heavily
fractured decks may be routed and sealed
or treated with rigid epoxies or healer/
sealers, since these cracks are typically
non-moving. However, the irregular surface
of the pre-cast deck does not readily lend
itself to flexible membrane-type coatings.
The leading edge of each panel quickly
becomes a wear point, bumping against
automobile tires or catching the tip of a
snowplow. Protection techniques that soak
into the deck and keep the concrete as the
wearing surface are preferred.

**Concrete Quality**

Knowing the quality of the concrete
offers insight into the type of deterioration
to which it would be most susceptible. This
is most often achieved by ordering a petro-
graphic analysis of a test sample. A petro-
graphic analysis is an extraordinarily useful
tool in determining what is wrong with
concrete or predicting what will be wrong
with concrete in the future. This analysis
can detect most durability issues, such that
the most appropriate level of protection can
be selected.

**Chloride Content**

Chlorides are detected by removing con-
crete samples from varying depths and
analyzing them in a laboratory. If chlorides
are moving through the concrete quickly,
the deck protection system must be aggres-
sively enhanced to stop further migration. If
the chlorides have reached the level of the reinforcement, chances are deterioration has already begun. Low-cost sealers are no longer an option. Deck protection that retards water vapor intrusion or effectively inhibits corrosion is now necessary.

Age and Deterioration

While there is nothing inherently wrong with old concrete, the life of a deck does tend to follow a natural progression. Unless design or installation defects are at issue, a new deck can be effectively treated with low-cost sealers that limit the intrusion of chlorides through the concrete.

Further in the life of the deck, a more positive barrier, such as a moderately priced epoxy sealer, may be necessary to retard moisture entry. Unfortunately, this option is often overlooked or skipped.

Ultimately, if not properly protected, a deck may require a traffic-bearing membrane to provide the best defense. However, as these membranes are costly and require maintenance and periodic reapplication, waiting to address signs of trouble until there are no other options is not the best course of action. Remember, once a deck has begun to deteriorate, the coating can only retard further deterioration, not stop it.

Exposure

Whatever the protection system that is employed, it must withstand the rigors of its environment. UV degradation may be a problem for some coatings on a top deck. Epoxies, in particular, have difficulties when exposed to direct sunlight. Soft, flexible membranes may not withstand abrasion in high-traffic garages or on a typical turning radius and will fare poorly against snowplows. A coating that looks like new after many years in an apartment garage may not withstand a year at an airport or shopping mall.

Snow Removal

Do not underestimate the damage that can be inflicted by the average snowplow. Most coating warranties require that snow removal equipment have rubber tips; others do not cover snowplow damage outright. The truth is, most snowplow companies have never heard of rubber snowplow tips, let alone know where to buy one. Unless the garage management operates its own snow removal equipment, it’s a given that steel will touch pavement at some point in the life of the garage. Therefore, coatings at exposed decks must be armored against such an onslaught (Figure 6). There are coating systems tough enough to repel the steel tips and let sparks fly, but these super-rigid coatings do not bridge cracks. The best solution, therefore, depends on finding the right compromise between rigidity and flexibility for a specific situation.

Cost

While the saying, “You get what you pay for,” can be applied just as well to surface protection as it can to anything else, in terms of quality materials selection and skilled application, it’s also true that lower-cost systems are usually lower-maintenance alternatives. Don’t overspend. If an inexpensive sealer would suffice, installing a traffic-bearing membrane because it is the high-end option may mean investing in a costly system that doesn’t perform any better in that situation—and may even perform worse. Plus, once the membrane is in place, it must be maintained and, eventually, replaced. More moderately priced treatments, such as penetrating sealers and epoxy healer/sealers, will no longer be options. (See sidebar below, “Don’t Seal Your Fate.”)

Aesthetics

While a simple sealer can help prevent water infiltration, it won’t change the parking deck’s appearance. An elastomeric membrane, on the other hand, will change the look of the garage and provide a uniform, fresh-looking surface that’s easily cleaned of dirt and stains. For a crack-riddled older garage, this can be a welcome change. In a newer garage, however, the existing concrete surface probably looks fine as is. Using paint on a deck to improve its appearance can have problematic effects, as paint, too, is a type of coating. (See sidebar, “When Coatings Go Bad,” page 43.)

DON’T SEAL YOUR FATE

Not all surface treatments are compatible. The parking deck protection you choose now may limit your options in the future, so consider both immediate performance goals as well as long-range planning before committing to a coating. Investigate, too, any applications that may already be in place.

For example, if you are looking for a “quick fix” to get you through the winter, a less-restrictive sealer that penetrates the slab—rather than one that coats the surface—might be a good option, because a wide variety of surface treatments can be applied over it in the future. Epoxy healer/sealers can cover such penetrants, and they provide a good base for membrane systems, should you choose to install one down the road. However, once you opt for a traffic-bearing membrane, you must stick with a traffic-bearing membrane, as there is no way to effectively remove it without severely damaging the slab.

To determine which coating types can generally cover an existing application, as well as which options remain following a proposed treatment, check the accompanying table.

### Compatibility of Existing and Overlaid Garage Surface Treatments

<table>
<thead>
<tr>
<th>Current Sealer</th>
<th>Migrating Corrosion Inhibitor</th>
<th>Penetrating Sealer</th>
<th>Epoxy Healer/Sealer</th>
<th>Traffic-Bearing Membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migrating Corrosion Inhibitor</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Penetrating Sealer</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epoxy Healer Sealer</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Bearing Membrane</td>
<td></td>
<td></td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>

* Compatibility of penetrating sealers should be taken into consideration.
THE SOLUTION

The preferred protection techniques stop deterioration before it begins. If a parking deck is well maintained from the start, with sealers applied early and cracks promptly addressed, then surface treatment choices can evolve over time as the garage ages and its needs change. If, on the other hand, conditions are such that distress is advanced and progressing rapidly, more immediate and aggressive action must be taken to slow deterioration and minimize its impact.

Should you follow the trend and apply that traffic-bearing membrane? Look first at the parking deck type, concrete age and quality, and level of exposure to traffic and weather. Don’t invest in a surface treatment until you’ve assessed your garage’s condition. Through investigation, testing, and evaluation, a qualified architect or engineer can help to navigate the array of available coating options. If that means shunning the coating of the moment in favor of a low-cost, low-upkeep alternative, so be it. The right parking structure protection program should not only protect the deck today, but anticipate the maintenance needs of tomorrow. Now that’s a bandwagon to jump on.

Lawrence E. Keenan, PE, AIA, is director of engineering with Hoffmann Architects, Inc., an architecture and engineering firm specializing in the rehabilitation of building exteriors. As manager of technical staff for the Connecticut office and one of the owners of the firm, he has extensive experience in parking structure rehabilitation, including investigation, repair, and surface treatment consultation. He holds multiple U.S. patents for precast concrete parking garage structural connection design.

Robert A. Marsoli, Jr., PE, is a senior engineer with Hoffmann Architects, Inc. (www.hoffarch.com) and part owner of the firm. With specialized expertise in building enclosure and parking structure evaluation, problem analysis, and rehabilitation, he oversees garage remediation projects, from design through administration, for a variety of construction types.


www.rci-e-learning.org