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THE SNAIL ISSUE . . .

Architechnics is the architectural journal of McGinnis Chen Associates, Inc.

Architechnics is published to inform our clients and colleagues of issues and problems addressed in our practice. By publication of technical articles and case studies, we hope to circulate information that will be helpful to practicing architects, building managers and others in the building trade and related professions.

Due to the unique nature of our practice, McGinnis Chen Associates is often the beneficiary of hindsight. That is, we are often asked to examine, analyze and repair failed building systems principally regarding the building envelope.

Having done this type of work for over forty years, our office has accumulated a wealth of insight into the causes of many different types of building failures and how they might be rectified or avoided. We routinely work on buildings ranging from residences to high-rises, commercial to governmental, and old to new.

COFFEE, TEA, OR...SEALANT?
Adaptive Strategies for Today's Metropolitan Snail
by Tracy Yang

In mid-June 2008, McGinnis Chen Associates welcomed some new additions to its staff in the form of 18 *helix aspersa*, more commonly known as the brown garden snail. Unfortunately (or fortunately, from the snail's perspective), despite several arguments over the delectability of escargots, MCA's newest pets were not for eating. The new inhabitants of 10 Nottingham were collected off a current building project, where staff observed them gathering in large numbers around window and door openings. Such odd behavior triggered questions previously raised in an older Architechnics article (R. Shoemaker, Summer 2004) documenting the discovery of snails' evolved affinity for building sealants.

Though some time has passed, there has not been any progress towards answering the question of why these gastropods regularly gorge themselves on building sealant. Due to the previous reactions from various product representatives (namely laughter), MCA decided to try a different approach to this query. The subsequent set of in-house experiments was tailored to our specific curiosities, and the results have been intriguing, to say the least.

Tip #1: Eat Locally

MCA's first test intended to verify the snails were actually eating the sealant. Merely noting their presence at building edge conditions will not suffice in our arguments. Helping to investigate this claim, several Bay Area waterproofing contractors graciously donated various tubes of sealant for our experimentation. The snails were put on a diet of normal organic foods—spinach leaves, plums, flower leaves and the like—for a period of 7 days as the newly caulked sealant cured. Discussions with other professionals in the field have led to a general consensus to the snails' preference of silicone sealants. However, to be as inclusive as possible, MCA tested both silicone and urethane sealants.

The first independent test consisted of four sealant materials—three silicones and one urethane—caulked against perpendicular construction scrap pieces to mimic a building edge condition. Once cured, the sealants were inserted into the snails' terrarium while all other edibles were removed.

A mere two days after introducing the sealants, the damage had been done. The snails devoured two of the three silicones completely (photos page 2). While the urethane had been sampled, it was abandoned for tastier delicacies not far away. Intriguingly, one silicone had remained completely untouched despite two additional days in the terrarium.

The test was then repeated with snails collected from a natural habitat (on permanent loan from a coworker's garden) with identical results. Again, the silicone ignored in the first test was disregarded in favor of the other two.

The outcome of these initial tests produced two very important questions. First, why did the snails so obviously prefer the silicones over the urethane when it was clear both were edible? Furthermore, why did they favor two of the silicones over the third?

Tip #2: Eat Right to Build Strong Bodies

This author's personal rendition of two years of high school chemistry: you are what you eat. Not surprisingly, the answers to these silicone based questions lie in the snails' dietary habits. While it is common knowledge that most land snails are herbivores—dining on leaves, rotting fruits, and some types of barks, these gastropods also require substantial amounts of calcium (Ca) to produce healthy shells, promote growth, and reproduce[1]. In fact, it is so important to the gastropod diet that studies show a direct correlation between Ca concentration and snail population in a given environment[2]. Wild terrestrial snails obtain calcium from various plants and rocks in the form of calcium carbonate, otherwise known as limestone.

Further study of the sealants' Material Safety Data Sheets (MSDS) made it clear what these snails find so enticing: calcium carbonate is a prominent component by percent weight in silicones but not in urethanes. It serves as an inert filler material in the sealants.

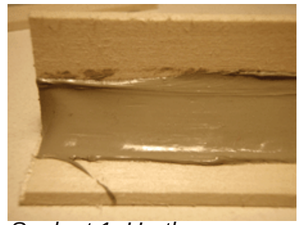
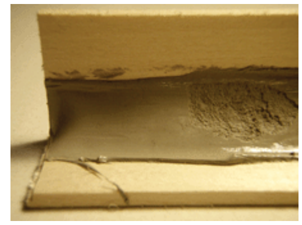
To test this hypothesis, MCA staff formulated a second round of experiments. Using the same urethane sealant, staff shot two beads against opposing corners of a piece of scrap metal. Pure calcium carbonate powder was then added to one bead, fully integrating it into the material and then tooling it as smoothly as possible. Upon curing, the sealant was added into the aquarium as the only available source of food.

The snails were reluctant to eat the sealant, consuming the urethane only as a last resort after several days of fasting. Though they consumed only a portion, the gastropods favored the urethane bead containing the calcium carbonate (photos page 3). This preference for the mineral infused sealant supports the theory that the snails utilize it as a primary source of calcium.

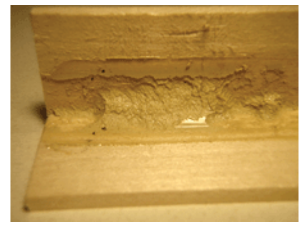
Yet this does not explain why the snails preferred two of the silicones over the third. According to the MSDS reports, all three had similar percent weights of calcium carbonate in their compositions. This indicates that another factor is at play in the snails' dietary preferences.

Test 1: Are the snails eating the sealant?

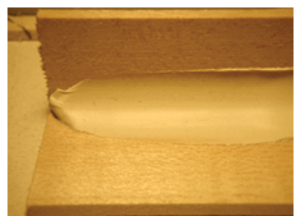
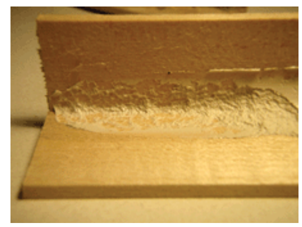
Before *After*

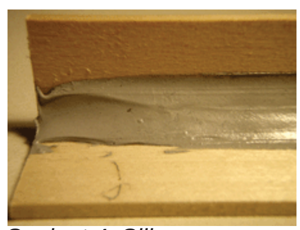
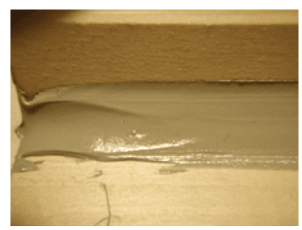
Sealant 1: Urethane

Sealant 2: Silicone

Sealant 3: Silicone

Sealant 4: Silicone

The initial test results confirm the snails were eating the sealants. The urethane, while obviously edible, was abandoned in favor of silicones 2 and 3. However, though Sealant 4 is also silicone, it remained untouched.

Surprisingly, the gastropods are seemingly unaffected by the various toxic materials that would otherwise cause severe sickness or injury to humans if ingested. Conceivably, the contaminants may move through their bodies too quickly to cause harm.

Tip #3: If It Smells Bad, It Probably Tastes Bad
Further discussions with MCA's Rodney Shoemaker (original discoverer of such behavior) redirected the experiment's attentions to the *type* of silicone sealant, rather than their chemical composition. In particular, technological innovations now allow for a variety of cure methods and chemical compositions in silicone sealants.

First generation silicone sealants are known to produce an acid byproduct as they set. Silicone molecules react with atmospheric moisture, causing a catalyzed reaction in which a three-dimensional silicone polymer network forms along with acetic acid. Specifically, the compound *polydimethylsiloxane* is a known contributor to this particular reaction. Today, sealants are new generation silicones which release an alcohol (methyl or ethyl) as they cure. They generally contain a titanium compound acting as a catalyst in a cure process separating alcohol molecules from the silicone polymers.

Such information provides additional clues explaining why these snails prefer specific silicones over others. Naturally occurring forms of acetic acid—most commonly indole-3-acetic acid (IAA)—are found in leaves of most plants. This acid acts as a plant hormone playing an important role in leaf growth and development. Though scientists do not fully understand how plants regulate this hormone, studies show an indirect relationship between the youth of plant leaves and their respective IAA levels[3]. In other words, younger shoots and leaves have higher levels of acetic acid than more mature ones.

Intriguingly, Sealants 2 and 3 (see photos, page 2) contained the aforementioned compound—polydimethylsiloxane—suggesting the presence of acetic acid. Perhaps the acid byproduct is an olfactory trigger for the gastropods, in which they are duped into believing the silicone sealant is actually their favorite meal of young leaves. To them, it is the perfect food—natural leaves high in calcium to help their developing shells and hormones. In addition, these leaves are never out of season and exist year-round!

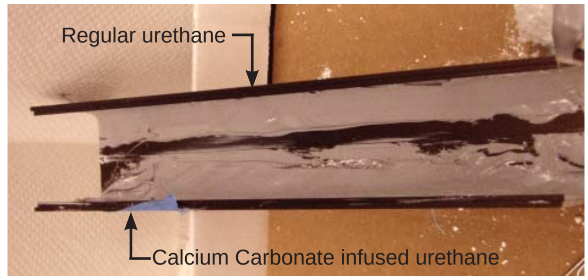
Sealant 4 also contained the siloxane compound, but was combined with additional methyl-containing silicone polymers. It is possible the alcohol molecules acted as a primary deterrant for the snails, despite the presence of acetic acid.

Having made this discovery, MCA staff sought out two additional silicones, one containing the polydimethylsiloxane and the other with the titanium catalyst. As predicted, the snails concentrated their dining efforts on the former, disregarding the newer-age silicone. (photos page 3)

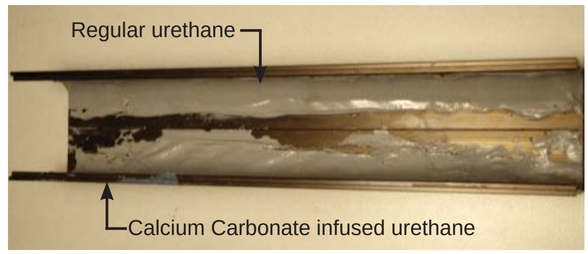
Counteraction to Adaptation
The final question remains as to what can be done about this pesky problem. Remedies such as beer and tile traps work in local gardens quite nicely, but due to maintenance issues they do not provide a feasible answer

Test 2: Are the snails eating the Calcium Carbonate?

Before



After



The second test's results supported the theory that the snails were eating the sealant primarily as a source of calcium. For this test, urethane sealant was chosen specifically for its composition, in that it does not contain calcium. The bead aligned with the blue tape contains the calcium carbonate (white powder), while the other sealant is as sold by the manufacturer.

Though the snails did not devour the urethane, they displayed a stronger preference for the sealant containing the calcium.

Test 3: Acetic Acid vs. Alcohol byproducts

As a final test, two new silicones were selected based on their chemical composition. Both from the same manufacturer, the upper sealant contains the siloxane compound, while the lower bead contains the titanium catalyst. The snails' preference is clear.

in large scale building scenarios. To date, copper has provided a consistent solution in combating the ravenous gastropods in existing buildings.

It has been a common gardener's rule of thumb that snails cannot cross copper. A chemical explanation of this peculiar truth is that the acidity in the snail slime causes the copper to oxidize, similar to the reaction which turned the Statue of Liberty green. Such a reaction can be further simplified as a transfer of electrons between materials, otherwise called an electric current. In regards to this situation, a snail in contact with copper experiences a significant and often fatal electric charge. No wonder they are deterred. To date, copper banding provides the most realistic, though expensive, solution to this issue. Yet considering the several hundred thousand dollars' worth of damage snails eat away, perhaps this is an acceptable cost measure to take.

In new construction, the obvious means of prevention would involve avoiding specifying sealants which contain these chemical triggers. Additionally, wrapping buildings in vegetation often promotes snail survival and reproduction; the soil provides a safe place to lay eggs while the vegetation itself simultaneously provides food and shelter from predators.

Nature's ability for adaptation never ceases to impress. Animal life has been found in even the most extreme environments: at thermal vents on the ocean floor, on the tallest mountain peaks, and in the deepest caves of the world. In this case, snails' discovery of this convenient food source has allowed for their existence in major cities where plants and leaves are scarce. MCA staff members have found snails in the least expected places: plazas, office buildings, and housing complexes in the middle of downtown San Francisco and Sacramento. While this research by no means claims to identify the exact reasons why the snails are eating silicone sealants, it has at least uncovered several probable triggers to their behavior. The next step is how we in the building industry will adapt to this phenomenon.

[1] Skeldon, Monica A., Matthew A. Vadeboncoeur, Steven P. Hamburg, and Joel D. Blum. "Terrestrial gastropod responses to an ecosystem-level calcium manipulation in a northern hardwood forest.(Report)." Canadian Journal of Zoology 85.9, (Sept 2007): 994(14). General OneFile. Gale. San Francisco Public Library.18 August 2008 http://find.galegroup.com.ezproxysfpl.org/itx/start.do?prodId=ITOF.
[2] Skeldon, 1003.
[3] Allen, J.R.F. and D.A. Baker, "Free Tryptophanand Indole-3-acetic Acid Levels in the Leaves of Vascular Pathways of Ricinus communis L." Planta, vol. 148 (1980): 69(5). 3 October 2008 <http://resources.metapress.com/pdf-preview.axd?code=g5112m7283123736&size=largest>.

Above: Silicone tape flashing on a condominium in San Francisco.

Snail Comments? Snail Questions?
Contact Tracy Yang
tyang@mcaia.com
What would you like to see in future issues of this newsletter?
Contact Jessica Walitt
jwalitt@mcaia.com
(415) 986-3873

McGinnis Chen Associates, Inc. has been providing specialized architectural and engineering consulting to private, institutional and public property owners since 1963. Over this period we have provided pre-construction, diagnostic and remedial design for many of the San Francisco Bay Area's most prestigious commercial and civic properties as well as hundreds of residential properties. Our clients have included the most experienced property owners, developers, builders, architects, and attorneys as well as single-family and multi-family residential property owners and homeowner associations.