Performance Requirements of Wall Coatings: The Facts and the Fiction

By Marthe Brock

How do you compare products? In the construction industry, we read manufacturers' literature, analyze test results, compare performance properties, and review case studies. This works, but how well? An excellent example is elastomeric coatings for exterior above-grade concrete and masonry walls. There are hundreds to choose from—how do you select the best one? All of the necessary information is out there, but what does it mean? If a coating is applied to one building, will it perform the same way on the next? Breathability is important, but is it critical? Elongation is integral, but how much is enough? This article discusses the balance between test methods and product reality, between test results and overall product performance.

Elongation

Elongation appears to be a very basic concept on the surface. The ability to stretch is not new—just think of a rubber band. In reality, it is not that simple. When looking at elasticity, manufacturers tend to emphasize ultimate elongation, which is just one part of ASTM D 412. The basic procedure for ultimate elongation is to cast a bone-shaped sample of a coating and stretch it until it snaps. How far the coating stretches is recorded as percent of elongation. It is not unusual to see test results in the 500% range. However, is ultimate elongation sufficient to evaluate the ability of an elastomeric coating? Some manufacturers report both ultimate elongation and elongation recovery, which is part of ASTM D 412 as well. Whereas ultimate elongation measures the plastic behavior of a material, which is a typical property for chewing gum, elongation recovery measures the elastic behavior, which is typical of a rubber band.

The procedure for recovery is similar to ultimate elongation; the difference is the coating sample is not stretched to the breaking point but to 100% over its initial length. The sample length is measured before it is stretched; once the tension is released, the sample is measured again. The desired result is for the material to return to its original shape, which corresponds to an elongation recovery value equal to 100%. This represents a perfect elastic behavior. Any value less than 100% shows that the material has some degree of permanent deformation, which affects its ability to perform over time. No elastomeric coatings report 100% recovery. An excellent elastomeric coating has >95% elongation recovery. This value is affected by the timing of the test because elasticity tends to be at its peak just after the sample is cast.

Recovery is a more important test than ultimate elongation because it represents the ability of a coating to perform over time, withstanding the daily and seasonal temperature cycles. It may seem that 100% elongation is a limited movement range. The range is necessary because crack movement caused by thermal cycling can go from 2 to 7 mils. Movement greater than that should not be concealed by the coating because it could be a sign of structural movement.

Both elongation and elongation recovery are lab test procedures that provide a good insight about the material behavior but do not represent real-life conditions when the elastomeric coatings are bonded to concrete or masonry. It is the crack bridging test that provides this real-life information. The U.S. standard for this test (ASTM C 1305), however, is designed for liquid membranes applied at 60 mils dry film thickness. Because 60 mils is five times greater than the average thickness of an elastomeric coating, one may question whether it makes any sense to use this test for elastomeric coatings. The argument has some validity. Some manufacturers report the EU for crack bridging of elastomeric coatings. This test measures the ability of the material to withstand a number of crack movement cycles without being damaged. The test is conducted at different levels of temperatures because it is commonly accepted that the elasticity of a material is affected by cold temperatures. Overall, it is a lot of information to be interpreted and evaluated to make the correct product choice!

In thinking about cracks, it is important to properly detail and prepare a concrete substrate before the application of elastomeric coatings.

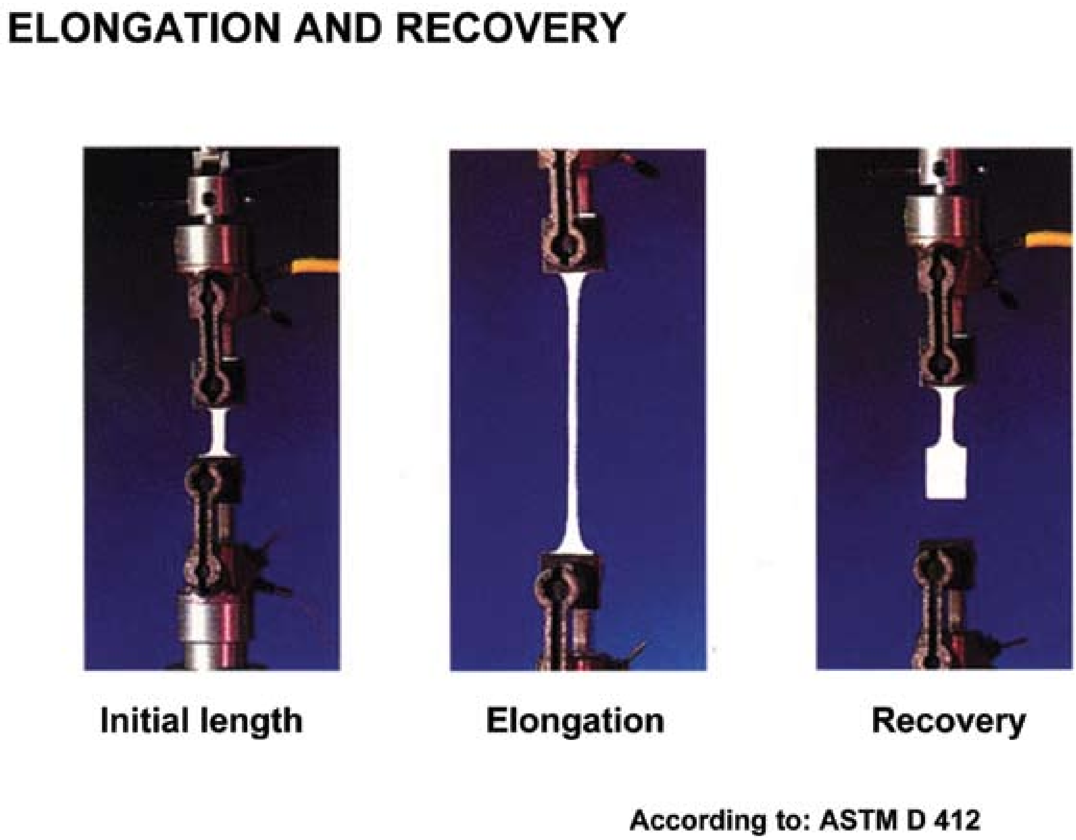

Fig. 1

Nonmoving cracks should be filled with elastomeric crack filler. Moving cracks should be routed and caulked. Elastomerics bond well to polyurethane sealants, but remember that sealants almost always have more flexibility than coatings, so it is important to use compatible materials in the same color.

Another important detail to consider is bond to concrete. Elastomeric coatings do not have the same bond characteristics as non-elastomeric coatings, which makes surface preparation critical. If the substrate is very smooth, a light brush blast may be required. It is always a good idea to perform a field adhesion test, such as ASTM D 3359. It may show that the substrate requires a primer, or that additional preparation is needed before the coating application. For elastomeric coatings to really perform properly, a continuous pinhole-free film must be applied to the substrate. The reality is a coating's ability to span cracks is directly proportional to the film thickness. That being said, then is more better? Not necessarily.

Breathability

It seems rather intuitive that the thicker something is, the less breathable it would be. As mentioned previously, breathability is important because a coating is applied to a wall system that must allow for moisture vapor transmission. There is an enormous amount of data available on this topic. One of the challenges is sorting through all this information and making sense of it.

There are three common terms used in defining breathability: water vapor permeance, permeability, and water vapor transmission. Permeance tells us how much water passes through a film during a specific period of time as induced by a change in pressure. This is expressed in perms. What permeance does not tell us is how thick the film is.

Permeance is a performance evaluation, not a property of a material, as stated in ASTM E 96, Section 3.1. Permeability is permeance multiplied by film thickness. This definition is typically only applied to thicker specimens, generally greater than 1/2 in. (13 mm), as stated in ASTM E 96, Section 13.3.

Water vapor transmission tells us how much water passes through a film during a specific period of time. What is does not tell us is how much force (change in vapor pressure) drives the vapor or how thick the film is. ASTM D 1653 states "values of water vapor transmission rate (WVT) and water vapor permeance (WVP) can be used in the relative rating of coatings only if the coatings are tested under the same closely controlled conditions of temperature and relative humidity, and their thicknesses are equal." So film thickness is important but it is not part of the definition used to analyze thin film coatings.

ASTM E 96 and D 1653 are the two tests used to measure these properties. Both methods follow the same basic procedure; however, D 1653 does not account for permeability that again relates to film thickness. Why is that important? Say one manufacturer performs D 1653 using a 3 mil sample that results in a perm rating of 35. Is that a relevant result? Three mils would not provide any crack bridging ability, so would the coating perform in the field as expected? Probably not. On the other hand, say a 10 mil sample is tested that results in a perm rating of 10. Is that enough? How much is enough? There is no criterion in the U.S., thus it is left to interpretation. (Interestingly, German norms provide a value).

To muddy the water even more, let's consider what the U.S. Department of Energy says: "water can move through and into building components in three ways: liquid water leakage and wicking, air currents caused by air pressure differences, and diffusion of water vapor through materials." The first two account for most moisture ingress. In fact, a 1/2 in. (13 mm) hole in a substrate can allow 50 pints (24 L) of water into a wall system per a single heating season. On the other hand, vapor diffusion only allows 2/3 of a pint of water (0.3 L) per heating season. Clearly, a void in the substrate is a larger problem than a film on the surface—again, getting back to the notion that proper preparation can make all the difference. Regardless of how the water is getting into a wall system, it has to get out and breathable films will allow that to happen. Figure 2 illustrates what happens when a coating is too thick and is not breathable enough to accommodate vapor drive. This is a problem we all want to avoid.

Fig. 2

There is much to consider when selecting coatings for above-grade concrete and masonry. While we have addressed some of the challenging issues here, it is important to remember that comparing products is an inexact science. The process starts with the development of a standard. A scientist in an R&D lab performs the test based on the standard. The scientist provides results to a marketing person who incorporates the information into a technical data guide. A salesperson takes the guide and gives it to an engineer or architect who uses it to compare products. Anywhere along that process, misinterpretation is possible. So what is the answer? Continue to ask questions, provide factual information, and get involved with organizations like ICRI so the dialogue does not stop and the industry continues to improve.

For more information on moisture vapor transmission, check out the following websites:

- **www.buildingscience.com/resources/walls/insulation_sheathings.pdf**
- **www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11760**
- **www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11810**

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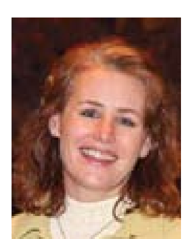

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