

ASTM D-6083 “Standard Specification For Liquid Applied Acrylic Coating Used in Roofing” What it Says, what it Means, and How It Came to Be

Introduction

ASTM D-6083 is entitled *Standard Specification for Liquid Applied Acrylic Coating in Roofing*. It was developed in 1995 under the Roofing and Waterproofing Committee, D-08. More specifically, it was developed in the Non-Bituminous Organic Roof Covering Subcommittee. While other authors have written articles describing the test methods in more detail 1, this paper endeavours to assist the reader in understanding how the specification came into existence, why it includes the tests listed in the specification, and what the test results really mean from a “real world” perspective.

Background

First some background about the American Society for Testing and Materials as an organization; ASTM is a consensus standards organization. It is composed of individuals who wish to further the understanding and development of methodology, specifications, and standard for a particular technical issue or discipline. In the case of the ASTM D-08 Committee (Roofing, Waterproofing and Bituminous Materials), it is comprised of raw material manufacturers, roofing material manufacturers, contractors, specifiers, consultants, architects, testing organizations, code officials, insurance companies, and other interested parties. Herein lies the strength of this organization. The broad diversity of perspectives from these individuals representing all points in the value chain creates a comprehensive oversight on the entire committee’s activities. From a roofing perspective, all facets of the roofing industry are fully represented. The Non-Bituminous Organic Roof Covering Subcommittee as the name implies is composed of representatives who are primarily interested in synthetic roofing materials versus those composed of natural products such as asphalt and coal tar.

As a consensus organization, the ASTM committee allows for the viewpoint of the minority in all phases of the balloting process. This ensures that the voice of the dissenting voter is clearly heard and understood during the entire standards process.

Purpose of ASTM D-6083, was developed as a specification for acrylic roof coatings employing previously developed standard test methods found in roof and coatings disciplines. The underlying purpose of the development of this specification was borne from concerns among the various stakeholders in the roofing industry to establish a minimum level of quality for acrylic roof coatings. It had become increasingly difficult for an architect, consultants, specifiers, and contractors to distinguish among acrylic roof coating products. Product data sheets would list values based on a range of different test methods or methods run under different conditions. The reported values could not be compared from one product’s data sheet to another. Moreover, coating manufacturers were unable to educate their customers in differentiating the value of their product versus that of another product. Thus, manufacturers were destined to sell in a price-quality arena only, without any ability to communicate the superior technical performance of their product versus that of a competitor. Ultimately, the purchaser (user or installer) of these roof coatings lacked the necessary information to determine the true value of a particular coating and could not make an educated buying decision.

The Tests, What They Mean, and How the Values Were Established

Each ASTM test method and the minimum value required to meet the ASTM D-6083 standard has been derived after lengthy discussions between all interested parties at the task group level. We shall consider each test independently.

The first requirement in the specification is not a numeric performance requirement but is described in the scope of the document. This specification pertains only to waterborne 100% acrylic roof coatings. Thus, it is intended to define the laboratory properties of a successfully performing roof coating, where the coating uses an "all-acrylic polymer" as the binder. The specification does not apply to styrenated, urethane, silicone, butyl, or vinyl acetate (or other) polymers used for roof coatings.

Viscosity, weight, and Volume Solids

The product viscosity is specified merely as a method for providing information for the user regarding the relative thickness of the coating in the can. Typically, coatings having viscosities on the higher end of the range are more ideally suited for applications on vertical surfaces such as parapets and penetration flashings. Viscosities in the lower range are better suited for rolling or brushing into irregular surfaces or applying over reinforcing scrims where it is desirable for the coating to penetrate and "wick into" the scrim.

The weight and volume solids specifications provide some very valuable information about the coating. All coatings are typically sold on a volume basis. A one-gallon can of paint costs \$X. However, there is no accounting for the amount of solvent (water being the solvent for a latex coating). Thus, the user has no way of really knowing how much of the coating in the can is actually "Usable Stuff" and how much is merely solvent. Two coatings may vary widely in cost, simply because one has more water in it than the other. ASTM D-6083 has minimum values for both weight and volume solids. While weight solids is easier to measure, volume solids is the best measure of the useable material in the coating. From a simple calculation, if a product has 50% volume solids, a 20 mil-thick wet film will yield a 10 mil dry film. The minimum value which meets ASTM D-6083 is 60% weight solids and 50% volume solids.

Mechanical Properties

The mechanical property specification, Elongation and Tensile strength, is one of the most important in this standard. The ability of a coating to tolerate movement or dimensional instability is what clearly distinguishes an elastomeric roof coating from a architectural house paint. It is well known that roofs are dimensionally unstable and expand and contract due to thermal and load-induced movement factors. Thus, a fully adhered coating must be able to tolerate the movement of the roofing membrane substrate to which it is applied, or it will crack and disband. The test method employed here is ASTM D-2370, which was specifically developed for measuring this property in coatings. Figure 1 and 2 shows a test specimen in the tester before and after it is elongated. Another method, ASTM D-41, has sometimes been cited. However it is actually intended to measure prefabricated rubber membranes. The mechanical property test measures two parameters, elongation and tensile strength. Elongation is simply how far a material can be stretched until it breaks, and tensile strength is how much force per unit area is required to pull the sample apart. Ideally, a roof coating must have both elongation and tensile strength to be serviceable. If it merely has high elongation but no tensile strength, the membrane behaves like chewing gum and deforms too easily without recovering to its original shape. If it has high tensile strength but poor elongation, it is brittle and glass-like and will crack when applied to a dynamic roof. The minimum values here are 100% elongation and 200 psi tensile strength.

Professional Presentation

These values were adopted with the help of numerous roof coating manufacturers and contractors who provided empirical data on the performance of acrylic roof coatings applied over a wide range of substrates, roof designs, and climatic conditions. These data were compiled, and the laboratory mechanical property profiles were used as proxy for actual, in service, successful performance. Simply restated, successfully performing roof coatings were identified from field experience, and their laboratory mechanical properties were measured to identify a minimum performance standard. Products that did not demonstrate successful field performance were also identified, and their mechanical properties were used to identify the specific value or profile which would not meet the laboratory standard.

The second part of this requirement involves the use of an accelerated weathering device, commonly called a Weather-Ometer. The actual free films of the roof coating are first exposed in this weathering apparatus for 1000 hours, then the mechanical properties are re-evaluated. This artificial aging simulates re-evaluated. This artificial aging simulates extended exposure to sunlight and rain. During this time, it is possible for the coating to change its surface, physical, and functional properties. Retesting the mechanical properties identifies any changes in the material that may affect the long-term performance of the roof coating caused by polymer degradation or crosslinking. The surface of the weathered coating is also inspected to determine any change in appearance such as cracking, checking, or erosion. Its appearance after exposure in the Weather-Ometer is recorded.

Adhesion

Adhesion is also one of the most important criteria of this specification. Figure 3 shows some of the many roofing membrane substrates that can be used for adhesion testing. If the coating does not adhere, it cannot provide protective for the underlying roofing substrate. The ASTM D-6083 specification employs either the ASTM C-794 or D-903 method for measuring peel adhesion. This test uses a cloth strip imbedded into the coating applied to a small piece of the roofing substrate. The test sample is allowed to dry for two weeks at room temperature and tested using an Instron or similar device to determine the force required to peel the coating away at a 180o direction. Figure 4 shows a typical test specimen in the tester. The values are reported as pounds per linear inch (pli). A second portion of this adhesion test is to immerse the sample in water after the two weeks drying period. After one week under water, the sample is immediately retested in the same fashion to determine "wet adhesion". The substrate used for the adhesion test must be specified. Since there are numerous roofing substrates (and not all coatings are recommended for all substrates), the specification allows the producer to stipulate the substrate that were tested. The minimum values are 4.0 pli for dry adhesion and 2.0 pli for wet adhesion. In the same fashion as the mechanical property minimum values, these laboratory adhesion values were obtained based on successfully performing roofs over the specified substrate. Primers may be used in this test but they must be acknowledged in the documentation. Figure 5 shows one sprayed polyurethane foam (SPF) panel demonstrating adhesive failure where the coating peels away cleanly while the other shows cohesive failure where the coating adheres preferentially to the SPF roof substrate rather than the cloth strip. In this case, the true adhesion value is actually greater than the recorded value from the test equipment.

Low Temperature Flexibility After Accelerated Weathering

It is imperative that any roof coating have sufficient tolerance for movement and dimensional of the roofing substrate at low service temperature. Most thermoplastic materials, such as coating, have lower elongation or flexibility at low temperatures than they do at room temperature.

Therefore, it is vital that the coating be tested for low temperature flexibility. In this case, ASTM D-522 is employed. This test actually joins two tests to yield increased value from the testing protocol. Metal panels (with the roof coatings applied) that were exposed to the accelerated weathering apparatus to measure surface appearance are then chilled in a freezer. Next, the low temperature flexibility profile is measured by bending the coated metal panel over mandrels of decreasing diameter. If the coating becomes brittle on weathering, the film will not pass the low temperature flexibility test. The requirement here is for the coating to pass a $\frac{1}{8}$ inch mandrel bend at -15oF. While this temperature may seem too stringent to be considered as simulating some environments, such as Miami, Florida, or Phoenix the task group that drafted the specification felt that it would be possible for a product to perform successfully in some geographies, only to fail in colder climates. Thus, a single specification was established for low temperature flexibility.

Tear Resistance

Tear resistance is a method for determining the ease with which a film of the roof coating can be torn using an Instron tester. This test is based on ASTM D-624. The test simulates the propagation of a tear in a roof coating that has delaminated from the roofing substrate. Once again, minimum values were established based on the field performance of over 20 actual roofs in service throughout the US, ranging in age from 3-20 years over bitumen, simply ply, metal, and sprayed polyurethane foam substrates.

The water resistance of the coating is measured by two ASTM methods. The first is D-1653, a measure of the permeance of the coating. Figure 6 shows the typical cup that is used for this test. Since these acrylic coatings are water-borne, they are inherently "breathers". That is, they have water vapour permeance greater than 1.0. Ironically, if the coating had an extremely low permeance (less than 0.5) it would be a water vapour retarder and probably never fully dry because water (the solvent for the latex roof coating) would be trapped in the coating film during the drying process. These coatings function similarly to "Gore-Tex" R fabric used for camping and outdoor clothing. Once dry, they have the ability to prevent the passage of bulk water, while still allowing moisture vapour to move through the dry film coating matrix. The specification calls for a maximum of 50 perms for a 20-mil thick film. In actual field practice, the permeance of the coating usually drops to less than 10, as the water soluble components of the coating leach out after water contact from dew or rain. Thus, the actual in-service permeance value is considerably lower than the specification.

Water swelling is the second component test for water resistance. This is measured by D-471. A typical setup is shown in Figure 7. The purpose of this test is to determine how "sponge-like" the coating film is. Since it is possible for these coatings to imbibe water, thus reducing their inherent physical and related performance properties, this is an important value when judging a coating's laboratory performance. Simply described, a coating film is placed in a beaker of water and removed periodically and weighed while wet. The percent weight gain is recorded. A plot of water swelling is shown in Figure 8, The minimum values for this test and the permeance test were derived from evaluating actual roof coatings that were performing satisfactorily in ponded water areas and establishing maximum values based on these tests. The swelling test shown in Figure 9 is important, since, as the coating swells, it creates stresses at the coating/roof substrate interface. The greater the swelling, the greater the stress and the greater the propensity for the coating to delimitate from the roof.

It should be noted that while the roofing community often asks about the ability of a coating to withstand ponded water, the real question, and the one most consistent with the demands of water immersion, is the wet adhesion test. The ponding water question is really best restated as, "How good is the wet adhesion?"

Fungi Resistance

The final test is fungi resistant as measured by ASTM G-21. Fungi are biological micro-organisms that grow on moist surfaces. To maintain appearance, a successfully performing roof coating must have some measure of fungi resistance built into the formulation. Again using field performance as a guide, the minimum level of fungi resistance was established. Since the fungi resistance of a roof coating is derived from the fungicidal additives that are incorporated into the coating, it is expected that the resistance slowly lessens with actual service. This is particularly true on roofs that have poor drainage with continuous standing water, as these additives more quickly leach out and biological growth conditions are optimal.

Conclusions

ASTM D-6083, Standard Specification for Liquid Applied Acrylic Coating Used in Roofing, is the product of literally hundreds of hours of concerted efforts by participants to establish a minimum laboratory standard that can serve as a general proxy for actual field performance. Selection of tests and minimum standards were based on the actual, successful, in-service performance of acrylic roof coatings sold by numerous manufacturers on over 20 roofs ranging in age from a few to 20 years old, located throughout the US and applied on various roofing substrates. Thus, anyone using this standard in specifying or installing an acrylic roof coating will have additional confidence that the particular coating should perform successfully when properly applied.