

SAUEREISEN

TECHNICAL BULLETIN

Asset Protection with Polymer Linings and the Significance of Physical Properties

Overview:

Basic physical properties such as compressive strength, tensile and flexural have been used for product evaluation and comparison between different technologies. Recent studies as published in Journal of Protective Coatings (The Society for Protective Coatings), and Materials Performance (National Association of Corrosion Engineers) indicate Permeability, Chemical Resistance, Abrasion Resistance, and adhesion are the critical physical properties for increased corrosion protection. When utilized in conjunction with actual field results, Owners, Engineers and Contractors can be assured of maximizing the life expectancy of the nation's wastewater infrastructure.

Background:

Today's wastewater treatment systems have become more aggressive primarily due to the proliferation of microbiological induced corrosion and abrasive forces in the waste stream. Advances in Odor Control, I/I Reduction, and Regionalization are the primary reasons for the increase in the corrosive effects in today's wastewater treatment plants and collection systems. Historically the engineering community has relied on typical concrete properties such as compressive, tensile and flexural strength to compare protective coatings and linings. Unfortunately this methodology is quite misleading. What significance is tensile strength of a coating system at 0.020 inches, over a 6" slab of 4,000 psi Type III Concrete? (i.e. adhesion of a coating to concrete is a more informative test.) Selection criteria and appropriate methodology need to be employed when determining suitability of protective linings.

Case in point, Compressive Strength (reword) as measured by ASTM C-579, D-695, or similar standard has been utilized as a marketing tool by some manufacturers to establish misleading and in some cases false information. Since there are few if any documented cases (this department found zero) of wastewater concrete structures failing prematurely due to below grade compressive forces, excessively high compressive strength requirements for a coating/lining system are not an important design criteria. For example, Compressive Strength of a protective coating/lining with thickness ranging from 30 mils (0.030") to 250 mils (0.250") provide no useful structural integrity to a 6" concrete slab. Furthermore the compressive load associated with 100 feet of water (consider a 100' deep manhole submerged with water in a 100 year flood) is only 43.3 psi. ASTM C478, the standard specification for Concrete Manholes (water column/head pressure), recommends a 4,000 psi compressive strength for a 4-10" concrete structure, hence any coating/lining system (think 1/16"-1/4") with a compressive strength above the strength of concrete will be more than sufficient to meet the needs of any municipality.

ASTM

It is worth noting that the C-3 Committee of the American Society for Testing and Materials (ASTM) has established testing protocol specifically for "Monolithic Coatings, Surfacing, Grouts and Polymer Concretes". ASTM, whose sole responsibility is to oversee the testing parameters and recommend the appropriate test methods, does indicate different methodologies for testing coatings versus other materials such as plastic sheeting. Sauereisen, as a 30-year member of ASTM, adheres to the standards of C-3 as well as ASTM as a whole. Some coatings manufactures utilize different ASTM tests intended for other materials. This practice may result in high numerical values but are not appropriate for the intended use or purpose as determined by ASTM.

Typical Physical Testing Methods for Protective Coatings/Linings used in Corrosive (Wastewater) Environments

Flexural Strength

- *Sauereisen tests in accordance to – ASTM C-580 “Modulus of Elasticity of Chemical Resistant Mortars, Grouts and Monolithic Surfacing”.*

Sauereisen utilizes this method under ASTM guidance because Sauereisen SewerGard epoxies are applied wet to the substrate to produce monolithic surfacings at various thicknesses. The ASTM C-3 committee as previously stated recommends this methodology. ASTM D-790 “Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials,” is not used because this test is designed for plastic sheet goods such as Plexiglas and subsequently produce misleadingly high data points when compared to actual application environments (particularly to those coatings applied via plural component)

Compressive Strength

- *Sauereisen tests in accordance to – ASTM C-579 “Test Method for Compressive Strength of Chemical Resistant Mortars and Monolithic Surfacing”.*

Although Compressive loads are benign (as detailed in previous section) in wastewater structures, Sauereisen utilizes this method under ASTM guidance because Sauereisen SewerGard epoxies are filled products that form monolithic surfacings over the substrate (note: there is no test method for the compressive strength of an unfilled coating). ASTM D-695 “Test Method for Compressive Properties of Plastics” is not used because this test is designed for rigid plastics such as plastic suitcases and subsequently produce misleadingly high data points when compared to actual application environments.

Tensile Strength

- *Sauereisen tests in accordance to – ASTM C-307 “Test Method for Tensile Strength of Chemical Resistant Mortars”.*

Sauereisen’s SewerGard systems are aggregate filled and / or fiber filled products that produce monolithic surfacings and lend themselves to testing as mortar systems. ASTM 638 “Test Method for Tensile Properties of Plastics” is not used because this test is designed for plastic such as polyester boards used in integrated circuits.

Hardness/Abrasion

- *Rather than test simply for hardness, which in and of itself is not very meaningful, Sauereisen tests for abrasion resistance to ASTM D-4060 “Test Method for Abrasion Resistance of Organic Coatings by the Tabor Abrasion”.*

Some manufacturers use the same test method, but they have significantly greater losses (>2 x) in their coating systems than occur with the Sauereisen 210 systems. The fact that Sauereisen systems are filled with either aggregate or fiber contributes to their ability to resist abrasion. ASTM D-2240 “ Test Method for Rubber Property – Durometer Hardness” is not used because this test is for soft rubber and select rigid plastics such as automobile tires and bumpers.

Chemical Resistance

- *Sauereisen tests in accordance to – ASTM C-267, “Chemical Resistance of Monolithic Linings”.*

ASTM C-267 is utilized because it measures both the weight change of the test samples as well as their applicable change in a number of physical properties. Sauereisen expands upon this test by measuring the change in mass of the sample and the corresponding changes in physical properties. The reason behind this expanded test is because ASTM C-267 does not require the recording of mass change and many chemicals will attack a sample and penetrate a sample resulting in severe corrosion degradation but little weight change.

KEY Material Properties

Although concrete provides all the structural strength necessary for 50+ year life expectancies, it falls short in three key areas, which are the primary reasons for protecting concrete wastewater structures in the first place. They include:

- a. Chemical resistance
- b. Permeation
- c. Abrasion resistance

Chemical Resistance

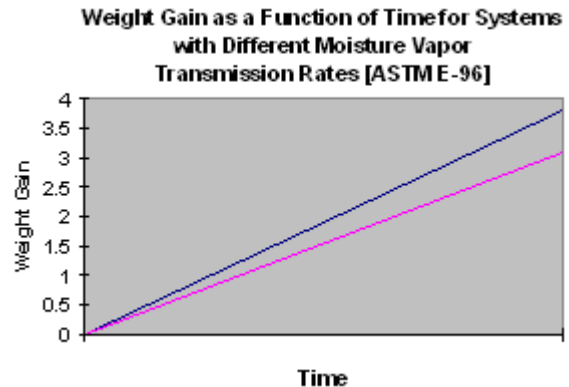
Although the largest constituent of wastewater is water, a multitude of chemicals such as alkalis, acids, solvents etc. are being found in small but corrosive amounts. Bacteria of the Thiobacillus genus are the primary cause of corrosion attack in wastewater systems, and Thiobacillus Concretevirus oxidizes hydrogen sulfide gas to create sulfuric acid at 43% (as discussed in the “Journal of Protective Coatings and Linings” 2005 SSPC Paper of the Year). Sauereisen’s SewerGard systems have been designed and tested and with a multitude of chemicals including 50% sulfuric acid, sodium hydroxide, bleach, acetic acid, acetone, just to name a few. These tests conform to ASTM C-267 and have been verified through testing programs at municipalities such as Los Angeles County Sanitation Department, City of Houston, and the Massachusetts Water Resource Authority. This extensive testing coupled with extensive third party testing and numerous case histories provide a high level of long-term protection.

Permeation

Permeation is one of the most important factors in determining protective coating/longevity and most likely the least understood.

Permeability is a material property which indicates the ability of vapors and molecules of corrosive particles (i.e. sulfuric acid, water vapor, hydrogen sulfide, salts, etc) to penetrate through the polymer matrix of a coating/lining system and begin attacking the coating/lining itself as well as it’s bond to the concrete substrate and the concrete itself.

Permeability is determined via ASTM 1653-93, which is the “Standard Test Method for Water Vapor Transmission of Organic Coatings of Films” and is calculated from the measured moisture vapor transmission rate.



All materials have a level of Permeability or “Rate of Water Vapor Transmission”. Products with lower water vapor transmission rates at a similar thickness provide greater resistance to corrosive materials migrating through a coating/lining, attacking polymer bonds and undermining the substrate bond. Sauereisen Systems have been engineered with some of the lowest permeability in the industry. Sauereisen’s SewerGard Systems have a permeance of less than 7×10^{-9} gms/pa.s/m². This means that 7 billionths of a gram is able to pass through our SewerGard System in and begin degrading the lining systems. The typical coating/lining system is more than 5x more permeable (4.5×10^{-9} gms/pa.s/m²). The effect of this engineering marvel has won Sauereisen praise from numerous publications and organizations such as the Society of Protective Coatings (SSPC) and the National Association of Corrosion Engineers (NACE).

Abrasion Resistance

Abrasion resistance is a measure of how well a material resists abrasive forces, which can be a primary reason for premature failure. Abrasion is determined via ASTM 4060—Taber Abrasion. Typically the testing is performed with a CS-17 wheel at 1000g for a 1000cycles. The amount of material abraded away is measured and reported as total weight loss. Since wastewater treatment systems see abrasives

from sand, grit, salts etc. ASTM 4060 provides an excellent window into wear resistance. Sauereisen systems are all designed to be well below the recommended 50mg wt loss.

Summary

When a system with good chemical resistance, excellent permeability and superior abrasion resistance, are selected and properly installed and inspected, longevity and maximum asset life cycles are guaranteed.

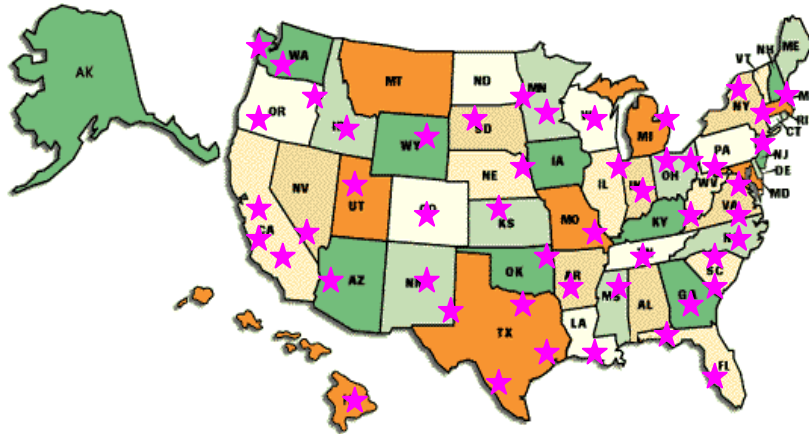
Sauereisen Story

Since 1899 . . . Sauereisen has been providing long-term solutions for customers as diverse as:



To name a few.

We are the market leader in corrosion protection for Municipal and Industrial wastewater treatment throughout North America. Working routinely with City Authorities such as:



. . . as well as small municipalities throughout suburban and rural America, engineers including . . . specify Sauereisen Solutions



- | | | |
|---------------|-----------|----------------------|
| Manholes | Wet wells | Oxygenation trains |
| Clarifiers | Digesters | Chlorination systems |
| Grit chambers | Flooring | |