

“Quality Assurance/Quality Control, Testing & Inspection of Epoxy Coatings”

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Abstract

“As federally mandated programs result in the successful removal of Infiltration/Inflow from existing sewerage systems, in cities, around the country, the resulting higher concentration of sewage will present an elevated corrosion problem at wastewater treatment plants and in collection systems. This paper will discuss the proper preparation, application of epoxy coatings but more importantly the quality assurance and testing requirements which must be included in all specifications. Good verifiable quality controls and testing documentation during construction are critical components for the long term success of corrosion protection coating. Warranties will be discussed and how regular project inspections will further insure that the customers’ desired results are met.”

Introduction

Epoxies were invented more than 60 years ago and are recognized by corrosion experts as the most effective coatings for protecting and rehabilitating concrete and steel. Epoxies are used in many industries providing a durable coating that rebuilds structural integrity and protects steel, masonry and fiberglass structures against chemical attack, abrasion, high temperatures infiltration and erosion. Epoxies are used as a corrosion barrier in virtually every industry.

The need for protection of concrete and steel structures against corrosion has been recognized for many decades. The type of coatings and their capabilities have varied, ranging from simply painting a structure to applying a lining or coating.

Emphasis by Federal Programs and local government awareness has opened up opportunities in a variety of industries with collection system renewal applications being a fast growing area of the market specifically related to manhole rehabilitation.

It is estimated that there are between 20 and 25 million manholes existing in the United States. Of these nearly one half have reached their useful life and will need some form of rehabilitation in the foreseeable future. The use of epoxy and other polymer coatings for manhole rehabilitation have become increasingly popular for long term rehabilitation.

This huge manhole inventory, pumping stations, wet wells and other collection system structures are regularly being coated with an epoxy protective system.

Like pumping stations and wet wells, wastewater treatment plants, water treatment plants and storage tanks for different applications are being coated to protect them against corrosion and to extend their useful life.

In addition to water and wastewater, there exist corrosion protection needs for epoxy coatings in power plants, industrial facilities, pulp & paper, food & beverage, pharmaceutical, aquariums, zoos, theme parks, marine & offshore and many others.

Background

Protective Coating technologies have evolved and improved significantly over the last 20 years. Through trial and error industry standards have been developed over those years, but coatings, in some cases, still do not perform as expected. Typically the wrong product for the application is selected or the specifications are not written sufficiently comprehensive to include good QA/QC, testing and inspection. In addition the product applicator may have minimal or no training in the proper application of the product.

As a result customers occasionally still suffer the inconvenience of accepting inferior products or having the expense of subsequent replacement.

Over the years corrosion protection coatings have been applied successfully in a variety of structures. Improvements in specifications have come about through lessons learned as a result of installation failures in the field.

“What is a Failure?”

“...an un-acceptable difference between expected and observed performance”

Coating and lining failures occur with virtually every product offered on the market today. Sheet liners fail from improper sub-base adhesion or improper welded seams. Pipe liners fail from excessive grouting pressures, improper liner sizing both circumferential and longitudinal and incorrect curing procedures. Coatings fail due to improper structure surface preparation, poor mix ratio, applied too thin and wrong product selection.

Remember the 80/20 rule which states that 80% of the success of a project is the contractor performing the installation and 20% is the product specified. Improved specifications and quality controls during construction this accepted ratio can be changed.

“The key to a successful Protective Coating Project is to have strong performance specifications in place, understanding what is required of the applicator, instituting quality controls during construction and selecting an applicator that installs proven materials using certified equipment with trained personnel”

Discussion of Topic or Purpose

Coatings provide solutions. They protect new construction and rehabilitation for old deteriorated structures. The purpose of the coating is to provide for a monolithic barrier to protect the structure against future corrosion attack. Properly applied coatings will extend the service life of the structure and provide improved maintenance characteristics.

In order to select the correct coating system it becomes important to understand the current condition and future service of the structure to be protected. The intended service of the structure needs to be accurately defined to determine whether the coating will be consistently submerged, be affected by a periodic splash of the effluent or will only be affected by residual gases present in the structure.

The structural condition of the structure should be evaluated and the need for structural build-back determined. Multiple, but compatible products should be evaluated and subsequently specified. Since all coating systems are not alike, the accessibility and environment of the structure must be evaluated to determine temperature and humidity, moisture filled substrates and the surface condition.

The application challenges presented for the selection of long term corrosion protection coatings include the selection of the correct product and the correct method of application. Typically an engineered system approach will insure a quality installation.

An engineered system would include:

Proven Product Selection. The product selected must have a proven history and should have a proven history and be friendly to the application environment. In the case of underground structures, a moisture friendly material is typically selected. The temperature capability and chemical resistance should be evaluated before the selection process is completed.

Certified Application Equipment. The product application must be with equipment specified or certified by the manufacturer. It must be capable of applying the coating material at the correct ratio, uniformly, at the required thickness and at a volume appropriate to the project size and complexity.

Certified or Trained Applicators. Historically more than 90% of all failures result from improper installation. The Contractor/Installer must be certified by the manufacturer after receiving adequate in field training on the preparation of the structure surface and the proper application of the coating system specified. Training through third party and NACE/SSPC channels should be a supplement to the required manufacturer training. The contractor/Applicator and field crew must have a minimum of in field application experience similar to the specific requirements of the project which should be verified either prior to or during the bid process.

Performance Specifications:

Performance specifications strive to adopt the best commercial practices and provide the means to attract the most qualified contractors, encourage greater technology innovations, maximize competition and obtain the best value for the customer. They are designed to deliver the end result and allow the bidders to be innovative in their approach subject to assessment of performance, as clearly spelled out in the specifications.

Performance Specifications are a statement of the project requirements in terms of the anticipated results including:

- Criteria for verifying compliance without stating the methods for achieving the results
- Functional requirements for the specified product and the environment that it must function operate or function
- Encouraging Contractor's to seek innovations to meet the specification performance criteria

Key Elements of Performance Specifications

Performance Work Statement describes the contractual requirements in terms of measurable rather than prescriptive performance. Required product performance in the required environment shall be defined and a reasonable timeframe for performance shall be specified. Quality assurance/quality control requirements and specific testing and inspection during construction must be outlined and must be representative of the final performance and quality expected by the customer.

- Materials provided, by the contractor, shall be as specified and verified through submittals and third party testing & evaluation.
- Equipment required to perform the tasks required must comply with the manufacturer's recommendations for the technology chosen.
- The product shall perform as claimed by the manufacturer.
- Documentation of contractor experience including project and crew level personnel as well as sub contractors.
- Verification of contractor training/ certification programs.
- Third party inspection during construction
- Warrantee requirements

Measurable Performance Standards defines acceptable levels of performance. The levels of performance should be determined on the minimum objectives of the customer and specific technology capabilities.

Remedies – specific procedures for addressing unacceptable performance may include required product repair criteria which will be acceptable and level of product failure where total replacement will be required. Monetary adjustments should be specified when performance and quality is below the specified contract requirements and re-performance in cases where the product is unacceptable.

Incentives – encourages performance that exceeds specification standards including projects completed ahead of schedule and below project estimate and projects with zero safety related incidences during construction.

Quality Assurance Plan– outlines in detail how contractor performance will be measured and assessed.

Performance is typically judged against the Quality Control Plan submitted by the contractor and should be measurable and verifiable. Quality assurance criteria should be incorporated in the specifications, which is relative to the technology and outlines nature and the minimum testing that will be required. The data should be meaningful and serve to set the standard for determining whether or not a product is installed properly.

Quality control should focus on project outcomes not contractor processes.

A Quality Assurance Plan would include:

- A complete description of the project site and structure condition specifying precautions if applicable.
- Defined assurance criteria.
- Defined quality control verifications during construction.
- A proposed safety plan for the execution of the work.
- Schedule for product material sampling at various milestones during application.
- Required manufacturers' submittals and certifications for the project.
- Training certifications for applicator personnel

Quality Controls during application would include:

- Written verification that all quality assurance requirements have been met.
- All safety requirements have been implemented and followed.
- Materials have been sampled at prerequisite times and the result documented in writing.
- The surface preparation implemented by the applicator has been fully documented.
- The structure surface has been inspected prior to the application of the coating material.
- Either wet film or dry film thickness measurements of the applied coating have been recorded.
- A holiday detection test has been performed and duly recorded.
- Adhesion testing at specified sampling locations have been completed and the results have met the contract specifications.
- Other test requirements as appropriate recorded and verified by the inspector.

Inspector Training – Inspectors who are charged with verification and implementation of quality control during the execution of a project must be thoroughly trained in the specific technology specified. They must be able to immediately recognize the key elements of the project and be able to determine when a project is going bad. They must be able to document all quality assurance requirements using the quality control tools provided for in the specifications.

Findings:

- Industry contract specifications are varied, general in content and tend to be vague on performance requirements.
- Customers using performance specifications including QA/QC requirements, good testing and trained inspectors are reaping the benefits of successful, quality work.
- Coating specification typically do not motivate applicators to perform beyond requirements which are usually limited by low bid parameters.
- With new coatings and new applicators emerging into the coating and lining industry, performance specifications that include quality assurance guidelines, quality controls during construction, timely third party testing results and trained inspector evaluation throughout the application process are needed.
- Customers, Engineers and Contractors all prefer a successful quality installation where subsequent warranty repair and/or replacement of the product are not required.
- Ongoing education and training, at all levels, is key to consistent, quality coating applications.

Conclusion

Quality workmanship, successful projects, and quality products for the coating industry are possible. Required performance and successful projects are a benefit to all parties. Key specifications issues and customer acceptance criteria must include:

- Clearly determine what issues or project problems exist and need to be rehabilitated. No coating technology fits all corrosion protection situations. In some cases a compliment of compatible products used together can result in a successful quality product.
- The Engineer must clearly understand that the product or process, that is specified, will solve the customer's problems without creating new problems.
- Specifications must be created, which clearly outline the project performance requirements and final product quality goals.
- Specifications must define, the product submittals that are to be furnished accepted and approved, by the Engineer.
- A detailed Quality Control and Safety Plan that details performance criteria must be submitted by the applicator.
- Time lines for all quality assurance requirements, testing, inspections and quality control documents during construction, must be specified, outlining the consequences and penalties.
- Incentives for providing the project ahead of schedule and under budget must be clearly spelled out.
- Contract completion requirements must be included in the performance specifications including applicable inspections and installation and product warranties.
- Installation warranties are typically given by the applicator and the product warranty is given by the coating manufacturer
- Warranties must include periodic inspections of the project. The longer the warranty period more periodic inspections should be included.
- Repair or replacement requirements for defects discovered during warranty inspections must be adequately defined.

“A positive working relationship between the applicator, the customer and the customer representative is critical to achieving quality work. The relationship should promote a strong business alliance to achieve the contractual goals to the benefit of all parties. The relationship should encourage open communications, teamwork and good performance to resolve conflicts and achieve the intent of the contract.”