Exterior Coatings for Precast Concrete Manholes, Utility and Wastewater Structures – Specifiers Guidance

The following document is intended to be a guide for specifiers for understanding specific conditions where high quality precast concrete manholes, utility and wastewater structures will be sufficient and when additional protection may be appropriate. For these conditions where additional protection is required, this may serve as a general introduction to how the protection can be provided.

Modern concrete used in buried precast structures is strong, dense, durable and leak resistant. However, in specific aggressive environments, additional protection – such as impervious liners or coatings – may be needed. When these protective measures are included, they can increase the service life of the manhole, and the corresponding added cost is warranted.

Reasons for providing Exterior Protection.

As stated, precast concrete is universally recognized as inherently strong, durable and impervious to measurable water leakage. Under normal conditions, it typically does not require additional protection or coatings. However, there are situations where specific soil or waste conditions may require additional protection in the form of coatings. Exterior coatings are generally used for one or more of the following reasons on manhole products:

- **Dampproofing:** Treatment of the concrete surface to retard the absorption of water or penetration of water vapor. In marine environments, seawater submergence conditions or estuarine areas, the effect of elevated sulfate and chloride concentrations should be considered. High sulfate concentrations can spall concrete, while chlorides can penetrate through the concrete and induce accelerated corrosion of reinforcing steel within the manhole. Most precast concrete mixes today use a low water-cement ratio (<0.42). These mixes produce dense, durable concrete, which will be dampproof. In marine environments where chloride ion intrusion may cause corrosion, a simple penetrating water repellent can be used. Most or all are variants of silicone. Examples are methyl siloxanes, oligomeric or aliphatic silanes. Each will penetrate the surface and create a hydrophobic layer prohibiting chlorides from entering and attacking the steel.

- **Waterproofing:** Treatment of the concrete surface to resist water under gravity, hydrostatic head pressure and atmospheric air pressure. High quality concrete with low w/c will be sufficient to resist these low pressure hydrostatic conditions. Specify a 0.42 max w/c from an NPCA Plant Certified producer. Specify that the manhole be designed with engineered joints using asphaltic sealant, O-rings or gaskets and watertight boot-pipe connections and that the structure pass watertightness testing. Examples of each can be provided by NPCA staff engineers.

- **Protection from chemical attack:** Treatment of the concrete surface to reduce the likelihood of damage or deterioration from a corrosive environment or other aggressive substances in soils such as sulfates. For these conditions, coatings or integral admixtures and/or special sulfate-resistant cements can be used.

Many specified exterior coatings are unnecessary

Yet, there still exists within some general requirements to coat a manhole structure on the premise to make the structure waterproof or damp resistant unrelated to corrosion resistance. This application of coatings is unnecessary and consequently not cost

1320 CITY CENTER DR., SUITE 200 • CARMEL, IN 46032 | (800) 366-7731 | (317) 571-9500 | FAX: (317) 571-0041 | precast.org

effective. Properly mixed concrete and precast structures made in accordance to the required ASTM standards will have the ability to resist water leakage through the wall. This has been proven by the successful acceptance testing of uncoated sanitary manhole structures throughout North America by vacuum or actual water infiltration/exfiltration methods.

It's possible that the original thought and eventual specified requirement of using exterior coatings to resist dampness or watertightness for manholes comes from the building basement codes of the International Residential Code that states, *"Foundation walls that retain earth and enclose interior spaces and floors below grade shall be dampproofed from the higher of (a) the top of the footing or (b) 6 inches (152 mm) below the top of the basement floor, to the finished grade. (1)".* The code further states that waterproofing is required *"In areas where a high-water table or other severe soil-water conditions are known to exist, exterior foundation walls that retain earth and enclose interior spaces and floors below grade shall be waterproofed from the higher of (a) the top of the footing or (b) 6 inches (152 mm) below the top of the basement floor, to the finished grade (2)."* There are many habitation and storage functional reasons to require this type of exterior damp and water proofing requirement for building foundations. However, with respect to manhole structures the engineer needs to closely analyze the benefit/cost ratio if this substantial added expense truly provides any defined benefit to the owner.

Coating or systems when additional concrete or steel reinforcement protection is required

- **Surface Coatings:** When selecting a coating, be certain that the coating itself is suitable in the specific chemical environment that is expected. After proper product selection, it is equally important to achieve proper adhesion to the concrete. It is critical for the applicator to be trained and follow the manufacturer's instructions for surface preparation and safety.
    - **Epoxy Coating:** The least expensive and most widely used acidic corrosion resisting coatings are epoxies. Specifically, polyamide epoxies are ideal for coating concrete as they are moisture tolerant and can be applied to precast concrete soon after being produced without the need to wait until a full 28-day cure. They have generally good chemical resistance, good adhesion with proper surface preparation and can be applied as a 100% solids material. This is important to stop any pin holes or voids from forming during application, a phenomenon known as out-gassing. A test sample should be prepared and the minimum adhesion or greater as required by the epoxy manufacturer should be achieved in the test. Further a sufficient mil thickness and application method should assure a continuous film is achieved. Again, a sample should be required, and a Holiday (spark test) performed to assure process and continuity. Any breaches in the film can be repaired prior to shipment using a supplier approved repair method.
    - **Waterborne Alkyds:** Many industrial coatings are mineral-based to contain and apply the resins which supply the protective coating. Many coating manufacturers developed the technology to utilize water as a primary base material in lieu of oil-based minerals. Initially, there was reluctance within the corrosion profession to utilize these waterborne materials because of the belief the mineral based products provided better attributes of coating and protection. However, the coatings industry continued to improve the waterborne coating technology and performance. This material proved to be a much easier process for tool cleanup and, combined with a construction focus toward more environmentally "green" solutions, have driven some waterborne alkyds to be a coating of choice of specifiers and applicators.
    - **Bitumen & Butyl Coating:** A bitumen coating is a compound made mostly of hydrocarbon molecules. This material is typically black and at ambient temperatures is very viscous. The coating can be applied by hand as a trowel grade material or spray applied with special heating equipment. Coating thicknesses can vary depending upon application requirements. Bitumen coatings have shown themselves to be excellent concrete water barriers for those applications that warrant their use such as: tiled flooring or basement areas subject to wet soil conditions. Like bitumen coatings, butyl coatings are typically black and highly viscous at ambient temperatures

1320 CITY CENTER DR., SUITE 200 • CARMEL, IN 46032 | (800) 366-7731 | (317) 571-9500 | FAX: (317) 571-0041 | precast.org

and proven to provide excellent water and vapor proofing when applied to concrete surfaces. Unlike bitumen coatings, butyl material is a synthetic rubber compound formulated to the appropriate viscous state. Butyl coatings never completely harden because of its longer chain molecules as compared to bitumen materials. This allows butyl coatings the ability to adjust to minor movement of the structure when such movement is anticipated.

- **Integral admixtures:** These products are added to the concrete mix during batching and interact chemically or mechanically to seal and plug the concrete pore structure. Like exterior applied coatings, it is important for the precast manufacturer to follow the manufacturer's instructions during the batching and curing of the integral admixture.
  - **Crystalline Admixture:** Widely accepted and specified are crystalline waterproofing admixtures. Added to the concrete during batching, these materials undergo a simple substitution reaction over time. The resulting product is a crystalline salt. As these crystals grow, they fill the microscopic void structure of the concrete thereby densifying it. As it densifies, the concrete will be more dampproof, waterproof and/or chemical resistant. Chemical attack cannot occur within the concrete if the chemical cannot penetrate through the void structure. These admixtures are often sold with a color identifier which will provide assurance of the product being present and in the correct dosage.
  - **Repellant Admixture:** Another type of integral waterproofing admixture is one which forms polymer barriers within the pores that form during the cement hydration process. Once the concrete cures, properly placed repellant admixtures will cause the water to bead on the surface of the concrete. This admixture is more prevalent with above ground structures but has made its way to buried concrete structures as well.

For a more detailed review of coatings utilized for concrete applications, a three-part series was published within the NPCA Precast Inc. magazine detailing the respective ASTM standards and testing requirements and specific applications for the different type of coatings.[3, 4, 5] Additionally, the Portland Cement Association has published *"Effects of Substances on Concrete and Guide to Protective Treatment"* which provides extensive information on protective options when corrosion protection is required[6].

Conclusions

Concrete is the most-used construction material in the world. Precast concrete manholes, utility and wastewater structures have provided robust, sound and durable structures for the past century. Additionally, modern buried precast concrete structures have proven themselves to be leak resistant without the expense of adding an exterior coating. However, when addressing known aggressive conditions, the use of an exterior surface coating or integral admixture can provide added corrosion protection to add to the precast concrete structure's service life. Being aware when to utilize these products and importantly when not to use them unnecessarily will lead to the most cost efficient and durable precast concrete manhole structures.

Notes

(1) IRC 2015 Section R406 Foundation Waterproofing and Dampproofing, R406.1 Concrete and Masonry Foundation Dampproofing

(2) IRC 2015 Section R406 Foundation Waterproofing and Dampproofing, R406.2 Concrete and Masonry Foundation Waterproofing

(3) Damp Proofing Vs. Waterproofing Part 1 - http://precast.org/2014/03/damp-proofing-vs-waterproofing-part-1/

(4) Damp Proofing Vs. Waterproofing Part 2 -http://precast.org/2014/06/damp-proofing-vs-waterproofing-part-2/

(5) Damp Proofing Vs. Waterproofing Part 3 - http://precast.org/2014/07/damp-proofing-vs-waterproofing-part-3/

*(6) **Effects of Substances on Concrete and Guide to Protective Treatment,** ISBN 0-89312-193-2 http://members.cement.org/EBiz55/ProductCatalog/Product.aspx?ID=332*

National Precast Concrete Association
1320 CITY CENTER DR., SUITE 200 • CARMEL, IN 46032 | (800) 366-7731 | (317) 571-9500 | FAX: (317) 571-0041 | precast.org