



"The COST Effective Answer To Concrete Corrosion"

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Recognizing Distressed Concrete Tank Walls

"The Key to Preventative Maintenance and Longevity"

Visual inspection of any concrete surface will evidence signs of deleterious conditions that shorten the life cycle of the structure and require unscheduled maintenance. It is imperative to note obvious surface defects and bring them to the attention of the party responsible for their upkeep. *This document is designed to familiarize personnel with basic information concerning degradation of concrete in this environment and offer an understanding of the cause of some of the observed conditions.*

The tank pictured in this article is only nine years old and is a two million gallon clarifier vessel in service at a waste water treatment plant in the Southeastern U.S. The conditions observed require immediate attention to correct these deficiencies before they become a more serious problem to the owner. Brief explanations and comments are included to identify the causes of the defects noted. This particular tank was constructed using pneumatically applied concrete; however these same conditions are experienced in pump and pour structures as well.

The first and most apparent sign of a problem is the brownish discoloration to the painted white surface of the tank indicating that contaminants on the surface are either leaching through the coating or being deposited on the surface from atmospheric sources. Note that the discoloration is most prevalent on the lower 1/2 to 2/3rds of the wall. This is an indication that a high moisture content of this concrete matrix exist in the lower wall levels due to gravity causing the moisture to wick down the wall interior and migrate out through the coating to discolor the surfaces.



Another confirmation of this condition is a more pronounced concentration of stain at Micro-Crack locations at these lower wall levels.

No information was available concerning ASTM C642 Testing (Boiled Water Absorption) that may have been accomplished when this tank was constructed, however it is noted the applied coating is allowing moisture migration out to the atmosphere and conversely permitting contaminants to enter the matrix in the same manner. The tank wall substrate is not waterproofed and is responsible for contaminants and chemistry to



migrate in and out of the structure. This is evident by noting that the wall surface facing to the East is more discolored than others. The rising sun and associated heat promote a cyclic wet-dry condition every day. As the surface heats, moisture within the wall evaporates from the surface and as it cools down humidity and rains are being absorbed back into the substrate. This free transfer of moisture allows airborne contaminants to migrate inward and internal chemistry of the concrete to migrate out where it reacts to form a host of unwanted surface conditions.



Efflorescence formations at several locations demonstrate a more active outward migration at Micro-Crack or Hydraulic Stress Fractures. Hydraulic action of filling a tank such as this will result in larger voids than shrinkage or curing cracks and offer an easier path for this outward migration if the substrate has not been waterproofed. A photograph of the tank wall top surface demonstrates vapor emissions to the vertical surfaces below. A larger crack or void carries more internal chemistry and moisture to these cracks where it is able to react freely with the atmosphere.



Embedded steel has begun to corrode at several locations causing spalling activity and rust stains to bleed through the coating creating a clear picture of the exact wire placement and areas of more advanced corrosion cell activity. In some areas the corrosion has advanced to the point that the volume of rust has pushed the concrete away from the steel to the extent a complete disbondment of the concrete has occurred. These "Pop-Out" areas are readily visible to the untrained eye whereas the other horizontal stained areas are showing the early stages of rust bleed through. A concrete surface without waterproofing and or a reliable coating will allow this stain pattern to give an early on indication of the corrosion taking place inside the matrix. A prescription for a mitigation or repair strategy should be implemented at the first sign of these conditions.

Another Coat of Paint is Not the Answer!



Samples of spalled concrete taken from the “Pop-Out” areas revealed severe carbonation at the depth of the steel and a pH of 5 at these levels. The Passivating layer on this steel has been compromised with these low pH levels allowing corrosion cells to form on the steel surfaces. Left untreated the corrosion, at this stage will advance rapidly requiring a more extensive repair/mitigation program. To compound these problems, pulverized samples from the “Pop-Out” areas also indicated unmeasured amounts of Sulfuric Acid in the samples. (Samples Not of a Volume to Allow Quantified Testing parameters)

It is believed that that Sulfuric Acid contaminants have been induced to these porous surfaces that were not waterproofed prior to a cosmetic coating being applied. Two digesters are located upwind of this tank allowing Hydrogen Sulfide to be wind driven to the tank wall where it is absorbed into this substrate exacerbating an already low pH caused by carbonation. Depth of cover issues, pervious substrate and the lack of a protective waterproofing system all play a role in the premature corrosion of the tank.

Early recognition of conditions such as this will allow for preventative steps to halt the corrosion and restore the concrete to a near new condition, thus avoiding a more complex and expensive repair. In this case, the concrete in the obvious areas of corrosion of steel will require removal. Steps to restore pH levels to above 12 should be taken in order to reestablish the Passivating layer on the embedded steel members. Realkalization could be in the form of electrochemical treatment or a wash to the surface. Post treatment pH testing should be accomplished prior to further work on the surface profiles. Patching or placement of shotcrete should be accomplished to allow sufficient depth of cover to offer protection against future corrosion cell formation.

Waterproofing this tank wall should be a priority after the repairs are complete. This will serve to reduce moisture and oxygen available to the concrete matrix. [Two of the essentials for corrosion cell formation]. A waterproofed surface will not show signs of chemical migration out to the surface and will prevent moisture/contaminate intrusion as well as Carbonation of the restored surface.

Protection of concrete surfaces by waterproofing them is the most Cost Effective means of corrosion control. If we expect to obtain maximum design life of a concrete structure, an understanding of the degradation process is a must.

Additional information on concrete preservation and waterproofing is available at:

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Please feel free to comment or offer suggestions for future topics.



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