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# Durability Consulting

Vector Corrosion Services (VCS) offers durability consulting to help owners and AE professionals maximize the service life of their projects.

Our wide range of experience in helps to identify potential problem areas in new construction or rehabilitation designs.

- Concrete and Concrete Repair Materials
- Corrosion Science
- Service Life Modeling
- Corrosion Evaluations of Existing Structures

Our approach is like a constructability review, where we identify the environmental challenges and details that will be most susceptible to premature deterioration. These susceptible details become the weak link from a durability perspective.

Example #1: Corrosion Engineering - Steel Pile Corrosion

A durability consulting example resulted from premature failure of steel piling supporting bridge abutments. In this case, VCS was asked to help determine the cause for premature corrosion of the steel piling under the abutment.

Figure 1 shows a photograph of a pile during demolition of the abutment, and Figure 2 shows a fragment cut off just below the abutment concrete. In this case, the piles were driven in highly resistive (>10,000 Ohm-cm), alkaline, sandy soil.

Normally, this soil environment would be considered minimally corrosive. However, one to two inches of soil subsidence below the concrete pile cap combined with contamination from deicing salt runoff produced an environment perfect for localized corrosion.

Note that corrosion reduced the pile thickness in a very localized manner resulting in perforation and buckling of the flanges. This rapid corrosion occurred in the buried portion, just below the soil line. Salt contamination acted to hold moisture in the sand just below the pile cap.

*Figure 1 – Corrosion of piles in deicing salt contaminated sand*

*Figure 2 – Pile fragment showing flange buckling caused by corrosion*

VCS cleaned and measured the thickness of multiple pile fragments encased in concrete and other representative pile fragments extracted immediately below the concrete. The measurements collected clearly show that the portion encased in concrete had negligible corrosion, with all locations at or above the thickness listed in the AISC handbook. Figure 3 shows the accelerated localized corrosion rate in the soil immediately below the concrete.

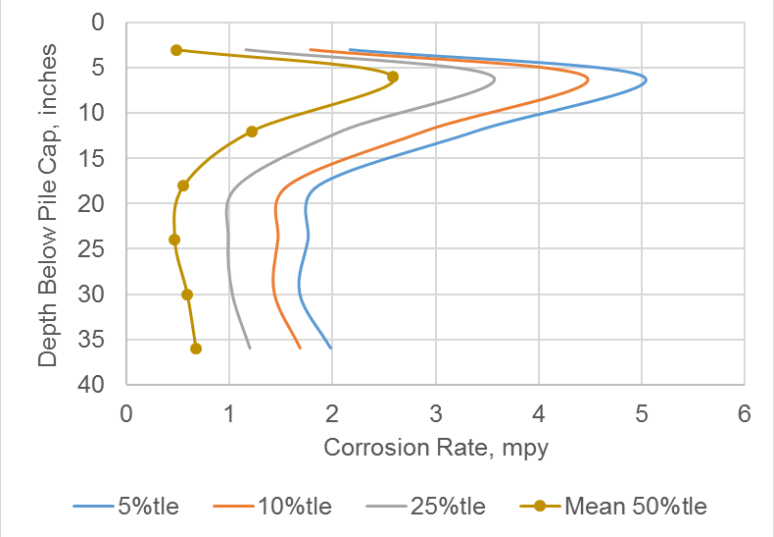


*Figure 3 - Pile corrosion rates with depth below pile cap*

With this information, the engineer can design a corrosion mitigation plan to allow the replacement piles to meet the full design life of 75 years. This can be achieved by designing a cathodic protection system based on the actual measured corrosion rates or with sufficient sacrificial steel thickness.

Example #2: Concrete Consulting - Prevention of Thermal Cracking

For example, high-early strength concrete may be susceptible to thermal cracking if used in large structural elements. These cracks essentially short circuit the concrete cover and provide a direct path for chlorides to reach the reinforcing steel. In the wrong environment, these cracks will make the structure vulnerable to premature corrosion. The solution could be changing the reinforcing or it may involve conducting a thermal analysis of the element long with the formwork and curing system. This type of thermal monitoring is common practice for determining the time for form removal in mass concrete construction.

In the Figure 4, the green line is the performance-based temperature differential limit (PBT Diff'l Limit) calculated for the concrete mixture based on maturity and other tests results. This is the temperature differential that will cause cracking. The red line is the actual temperature difference between the core and surface within the concrete. In this case the forms were insulated with curing blankets, so the temperature differential remained small. The blue line is the temperature difference between the core temperature and air temperature. If the forms are removed when the ambient differential exceeds the PBT Diff't limit, cracking is likely. In this case, forms were removed after 72 hours and no cracking of the cover concrete occurred.

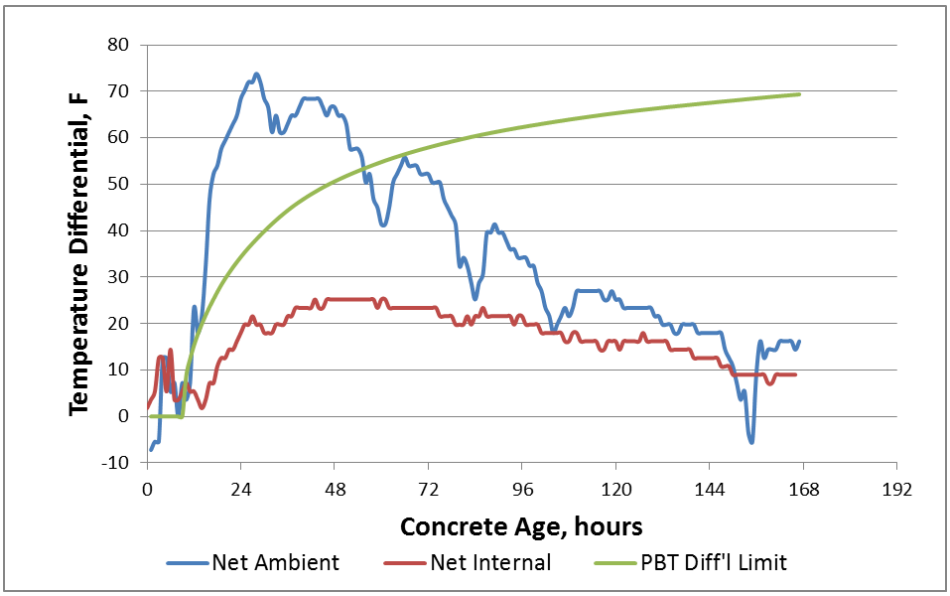


*Figure 4 - Thermal monitoring of concrete during curing*

## Summary

Vector Corrosion Services' (VCS) engineers have significant experience in corrosion of embedded metals in concrete and masonry, service life estimation, and corrosion mitigation techniques. VCS technicians and engineers undergo industry safety training and hold various NACE Certifications, including the highest level available in the field of cathodic protection: Cathodic Protection Specialist (CP4).

Vector Corrosion Services is your partner in corrosion and concrete preservation. Our experienced staff will assess the problems and provide repair and protection options that fit your service life objectives and budget.

For more information, contact

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