General Information on Cathodic Protection

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Use of Cathodic Protection in Everyday Life

Although Concorr, Inc. normally works with cathodic protection (CP) as it applies to steel in concrete, the technology is so widely used as an effective method of corrosion control, we thought it would be helpful to briefly cover some of the other common applications of CP.

For decades, impressed current and galvanic cathodic protection systems have been successfully used to protect buried pipelines, ship hulls, off shore oil platforms, heat exchangers, underground tanks, and many other facilities exposed to a corrosive environment. In the case of underground storage tanks, recent legislature requires that all tanks be cathodically protected.

Another common application of cathodic protection is in household water heaters where small magnesium rods are placed inside the water heater tank to protect submerged metallic components. In addition, all galvanized materials, such as nails, conduit, and guard railings along the nations roads and bridges, provide examples of cathodic protection at work in our everyday lives. In these cases, the zinc coating functions as a galvanic anode to protect the underlying steel.

Aluminum railing in contact with reinforcing steel in balconies is an example of galvanic cathodic protection in concrete. However, in this case, the application of cathodic protection is unintentional and undesirable. It is well known that corrosion of aluminum embedded in concrete can occur and can cause cracking and spalling. This situation can be made worse, however, if the aluminum is in contact with reinforcing steel. Aluminum being more active than steel can act as a galvanic anode to protect the reinforcing steel. As a result, the aluminum can corrode at an unacceptable rate. Hence, misapplication or accidental application of galvanic anodes can have undesirable consequences.

Selection of CP for Reinforced Concrete Structures

CP is not always needed nor is it necessarily applicable on every structure. The first step is to have a concrete and corrosion condition survey conducted in order to define the cause and extent of the problem. With the results of a thorough condition survey at hand, the engineer must analyze the data and make a determination on the type of repair and protection method to use. If cathodic protection is chosen then another determination must be made in order to choose the most appropriate system for the conditions encountered.

To select and design a proper repair and protection scheme it is imperative that the cause, or causes, of the distress are properly diagnosed and fully understood, and that the extent of damage is determined. Before selecting cathodic protection for a given structure a number of issues need to be considered. Some of these include:

- Is long term rehabilitation (say greater than 15 or 20 years) the aim? Cathodic protection is usually most cost-effective when a long-term rehabilitation is desired. The amount of damaged concrete (delaminated or spalled) is another factor in choosing CP. If only a small amount of delamination and spalling has occurred, CP may not be the most appropriate choice for future protection. Similarly, if the majority of a concrete structure is delaminated and spalled, replacement may be in order. The in-between situations require consideration of other information gathered from the condition survey. One significant advantage of using CP is that removal of sound concrete is not required, thus a considerable cost savings may be realized.

- The corrosion rate of the reinforcing steel must be considered. If the corrosion rate is high in areas which are yet undamaged, conventional repairs will not aid in controlling future corrosion. Actually stopping or slowing the corrosion rate down to an acceptable level may be necessary, and CP is the only corrosion control technique which is presently available for accomplishing this.

- Electrical continuity of the reinforcing steel to be protected is a primary factor in considering CP. A closed electrical circuit (unbroken electrical path) between all reinforcing steel is required in order for a CP system to function properly. Electrical continuity testing can and should be done during the condition survey.

- The chloride concentration in the concrete throughout the structure is also important. If sufficient chlorides are present at the reinforcing steel depth in many areas of the structure, CP may be the most economically viable alternative. However, if the chloride content is relatively low, or if the chlorides are generally located only in isolated areas of the structure, another protection system may be more appropriate.

- Another factor to consider is whether or not the concrete distress was solely caused by corrosion of reinforcing steel. For example, if freeze/thaw or alkali-silica reaction problems are encountered, CP may not be the way to go. Such deterioration will continue with or without CP. In fact, in the case of alkali-silica reactions, recent research indicated that CP current can actually accelerate the reactions.

Obviously, there are many things to consider in selecting a suitable rehabilitation plan for a deteriorated concrete structure. A few of the most important issues related to CP have been mentioned here. In many cases, a life cycle cost analysis is useful in selecting the most appropriate rehabilitation method.

As discussed earlier, once CP has been selected, the exact type of CP system must be chosen. The type of anode is one of the most critical components of a CP system. The particular application may preclude the use of some of the available anodes and CP systems. The type of surface to be protected (top surface, soffit, vertical, etc.) and its geometry, concrete cover over reinforcing steel, the environment in and around the structure, and structural considerations, such as whether the structure can support the additional dead load resulting from some CP systems, are all important factors in selecting a specific system.

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