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Study of Corrosion Control of Underwater Piles

VIKAS YADAV

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ABSTRACT: Structures that are used for the transferof loads from the superstructure to the sub surface strata are known as Foundation. And Piles are a type of foundation. For a hydraulic structure such as bridges, dams, etc. or for surfaces having high water content, the piles are driven into the ground and under the water strata. Piles normally used in underwater structures are subjected to corrosion. Corrosion reduces the structures stability and longevity. There is absolutely no method for elimination of corrosion; but corrosion protection measures can be employed for controlling the effects of corrosion. Corrosion protection can be done in different ways, depending on the environment and other atmospheric and hydrological factors. Types of corrosion protection include – treatment of surfaces, utilization of inhibitors, use of coatings and sealants, cathodic and anodic protection.

KEYWORDS: Stability, Longevity, ProtectionMeasures, Types of Protection.

I. INTRODUCTION

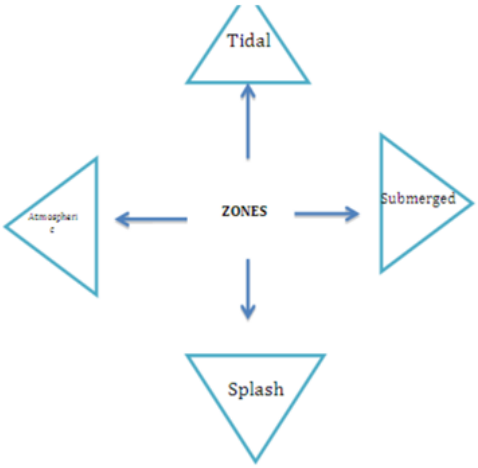
Corrosion means the damage, destruction or elimination of the metals and alloys by the chemical reaction of the metals and alloys with the environment. During the phase of corrosion taking place, metals gets converted to metallic compounds at the top surface and these compounds wear or deteriorate away as corrosion product. This process may also be called as the reverse process of the extraction of metals from their ore.

It is a problem that must be addressed for a wider range, example, the automotive industry; metals are often plated or coated for protection from the road salt and moisture. Indeed, many traditional metal parts are presently used with polymeric components-which are not only lighter but are also more cost effective for production. But these products are generally impervious to the electrochemical corrosion. The selection of the base metals for piling and well-designed structures will ensure no guarantee for absolute elimination of corrosion.

Therefore, corrosion protection methods are utilized for mitigation and controlling the effects of corrosion on piles. Corrosion protection can be established in a number of different ways with multiple methods applied in different environments. Types of corrosion protection include – treatment of surfaces, utilization of inhibitors, use of coatings and sealants, cathodic and anodic protection.

Mechanism of Corrosion of Steel in Sea Water: On the account that steel piling in carriedout in seawater, the more chemically active (charged) surface areas (anodes) are metallically coupled to the less chemically active surface areas (cathodes), which result in electricity flow and corrosion of the anodic areas. Roughening of the surface occurs when the local anodic and cathodic areas consistently shift during the corrosion process. There are times that there is no shifting of these active local areas from their position end, and there is a localized attack on the metal and pitting occurs. Generally, depth of pitting = ratio of the anodic sites / area of cathodic site [in contact with the electrolyte (seawater)]. As the anode area reduces in relation to the cathode area, the deeper is the pitting.

Corrosion Zones of Steel Pipes:



Tidal – It is an environment where the metals are submerged in the seawater and then exposed to the splash zone alternately as the tide fluctuates.

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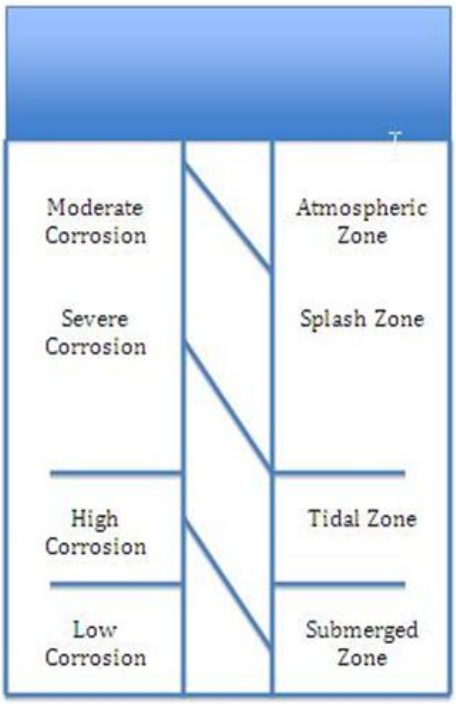
Submerged – This environment zone is usually characterized by well-aerated water in combination with the marine bio fouling organism of animal and the plant.

Atmospheric – It depends upon the temperature, pollutants, time of wetness. It is also largely responsible for large fraction of corrosion.

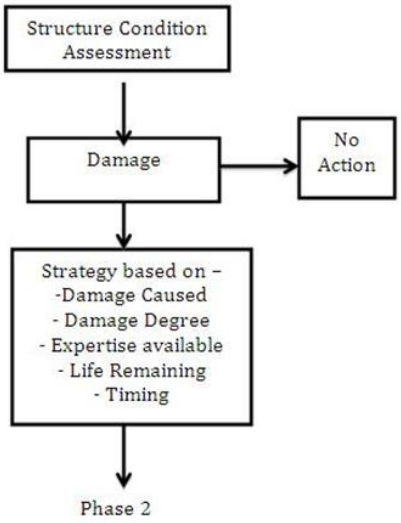
Splash – It is characterized as an aerated environment of seawater where the exposed material continually wet and there is no attachment of bio fouling.



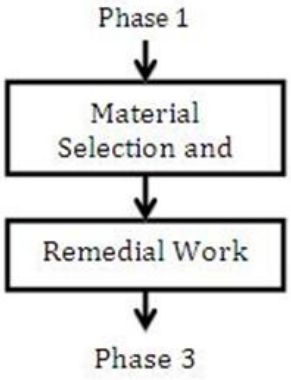
II. CORROSION MANAGEMENT:

Conceptual and feasibility studies of the corrosion control method are done. It is categorized into three major phases.

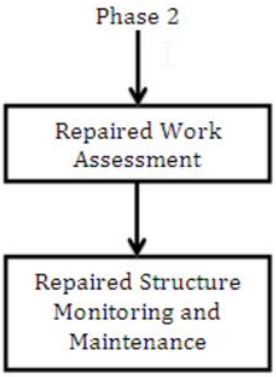
Phase 1– In this phase, the programmatic assessment of the project is done.



Phase 2 – In this phase, the physical assessmentand actual remediation work is done. Inspection of corrosion is also is carried out.



Phase 3 – In this phase, future monitoring of therepaired structure is done.



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III. METHODS FOR CORROSION PROTECTION:

Protective Coating –

For protection of metals from corrosion, the metal and the corrosive environment contact is required to be cut off. The surface of metals is coated with a continuous non- porous material inert to the corrosive atmosphere to prevent it from corrosion.

The coatings are classified into different categories –

a) Organic
b) Metallic
c) Inorganic

For Under Water Piles the types of coatings used are -

- **Inorganic Zinc Silicate Primers:** Structures(Steel) that are immersed in seawater – jackets below the Splash Zone, are usually not coated and protected solely by cathodic protection system. Many anticorrosive-pigmented primers, some that passivates the steel. Inorganic zinc silicate primers are the most effective as they essentially become anodic to the steel in a corrosion process. The advantage of this coating - it will arrest rust creep, high degree of heat resistance and spills of chemical.

- **Epoxy Coatings (High Build):** Epoxies incomparison to primers and topcoats are more chemical and abrasion resistant. It protects not only the substrate, but also the zinc primer and all other detrimental factors. One disadvantage of epoxy coatings is that, it has very little resistance against ultra violet rays from sunlight. This leads to the erosion of the coatings reducing the barrier protection.

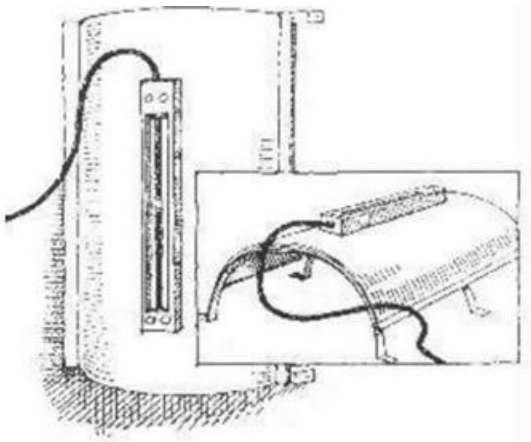
- **Epoxy Primers (Zinc Rich):** Epoxy anti-corrosives modified with Zinc will ensure a high level of service and are tolerant to different weather conditions and compromised surface preparation provided that the zinc loading is sufficient. It is also most effective in maintaining the damaged areas.

- **Aliphatic Polyurethane Topcoats:** Polyurethane coats provide optimum resistance to UV rays and have high degree of flexibility and high chemical resistance. It also helps to maintain a high degree (level) of cosmetic gloss, color retention and it can be easily cleaned. Polyurethane finishes does not provide any real anti-corrosive or barrier protection, they do provide a high degree of protection to integrity of the coatings system.

- **Non-Skid Deck Coating:** These coatings arethat are designed and engineered with anti-slip properties. These coatings incorporate course aggregates. The coatings are applied in very high film builds and usually without a zinc rich primer.

- **Cathodic Protection (CP):** Most preferredtechnique for mitigating underwater or marine corrosion is cathodic protection (CP) i.e. the practice or art of using electrochemical reactions for prevention of steel structures from corrosion.

The implementation of a Cathodic Protection system is quite simple. Let us assume, there is corroding steel in seawater, all we require is an anode and power supply. A protective circuit is achieved between the anode, steel (cathode), seawater (electrolyte) and power supply.



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Pile Mounted Anode: This method of anode delivery is used when the anode can be tied or attached to the piles or cathode directly. These anodes are designed for efficient distribution of current into and around the piling.

Sled Anode: These anodes are designed and engineered for operation in either seawater (electrolyte) or it can be buried in the mud. An anode mounted on the seabed ensures the best spread or distribution of protection for a marine structure. The advantage of this anode is its low profile, hence limiting the chances of damage by fishing nets, ships anchor, etc.

 Application Of Fibre Reinforced Polymer Composites: Fibre reinforced polymers (FRP)are mostly used for the repair and rehabilitation of concrete structural elements. The composites are very light in weight, are resistant to chemicals, have high strength and in fabric form have high degree of flexibility. The FRP composite when mixed with wet concrete makes it economical to conduct repairs on sub structure parts. When the FRP is used, then the corroded part of the structure element is carefully removed and the FRP composite induced concrete is applied. The FRP provides the lost tensile capacity and it also provides the steel with lateral support. When the FRP is applied with concrete, the spreading of corrosion to other piles is protected and it also ensures protection from UV radiation.

IV. CONCLUSION:

As there is no absolute way for elimination of all corrosion from under water piles, there are some effective methods or ways to control them. Cathodic protection is found to be most simple to understand and use and are largely used in marine conditions. The Fibre Reinforced Polymer composites have many advantages in comparison to conventional methods - they are lightweight, are chemical resistant and possess high strength and have high degree of flexibility.

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