Maintenance and Repair of Steel Piles in Water Environment

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Abstract: Maintenance and repair methods for steel piles in water environment were reviewed. Repair methods for steel pile can be categorized as: Protective Coating, Electro-chemical methods, Wrapping and encasement and partial replacement of steel.

1. Introduction

Steel is used extensively in construction and repair of waterfront facilities due to availability, cost, ease of fabrication, physical and mechanical properties, and the extensive design experience with it. Structural steel and cast or fabricated steel are used in all areas of the waterfront (USACE, 2011). Corrosion is the major cause of deterioration of steel structures and components. The extent or severity of corrosion will vary with the exposure zone of the material; that is, whether it is in the atmospheric zone, the splash or tidal zone, or the submerged zone. Selection of the repair technique must consider each of these varied conditions (MNC, 2005).

2. Objectives

The objective of this paper was to summarize the maintenance and repair methods for steel piles in water environment.

3. Literature Review

Based on the literature review, repair techniques for waterfront steel structures can be grouped as summarized in Table 1. Selecting a technique must address both immediate repairs necessary to restore the structure to full service and protective measures needed to prevent further corrosion. Selecting a means for restoring the structural capacity, being generally controlled by the level and rate of deterioration. The deterioration case of steel pipe pile and corrosion mechanism for steel under water is as follow.

Corrosion mechanism

Anode: $Fe \rightarrow Fe^{2+}+2e^{-}$ (Corrosion)----------(1)

Cathode: $O_2+2H_2O+4e^{-} \rightarrow 4OH^{-}$ ----------(2)

(a) (b)

Figure 1 Deterioration of steel pipe pile

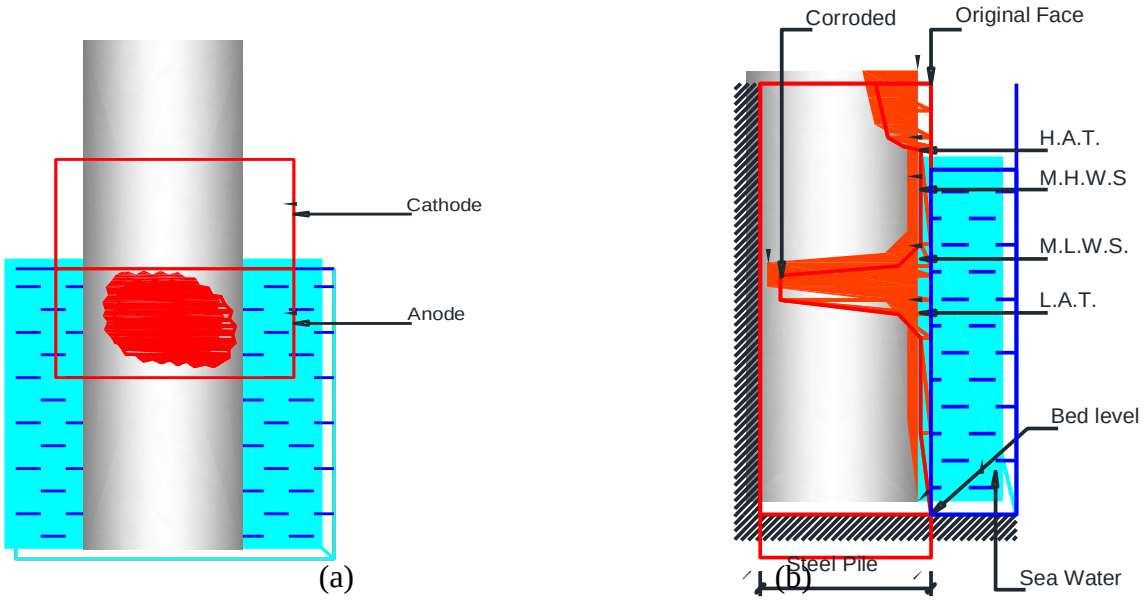

Figure 2 (a) Steel corrosion. (b) Sheet pile cross section showing corrosion zones (HAT-high astronomical tide; MHWS-mean high water springs; MLWS-meaning low water springs; LAT-low astronomical tide. Accelerate low water corrosion(AWLC) usually occurs between MLWS and LAT, however, it has been known to occur in immersed zone all the way down to the embedded zone. (MNC, 2005)

Table 1 Methods for corrosion control and repair of steel pile (USACE, 2011)

No.	Methods	Reference	Type of Material	Condition	Remark
1	Protective Coating	MNC, 2005	fusion-bonded epoxy, polyurethane	In service	Resist corrosion long term; corrosion can occur again once coating fails
2	Electro-chemical methods	MNC, 2005	protected material,Zinc	low corrosion rate or new structures as well as existing structures	High cost ;works well below-water level; in wet or damp soil not effetive
3	Wrapping , Encasement	USACE, 2005	Polymers and composite, FRP,Concrete	tubular and box piles;Slight to moderate deterioration	Low initial cost but easily damaged;Used as a protection technique but not restore bearing capacity lost
4	Partial Replacement of Steel Piles	USACE, 2005	Steel pile section	Moderate to heavy deterioration	Very costly, may need additional protection

Based on literature review four methods have been identified to repair steel piles (Table 1). Protective Coating is very common method to control corrosion of steel pile and can work well for a long time. Cathode Protection (CP) can be applied to new structures as well as being retrofitted to existing structures. It is always restricted to the area below-water level, or in wet or damp soil.

4. Conclusion

For repairs, protective coating will work well. Wrapping of polymers and composite are cost effective.

5. Acknowledgement

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6. Reference

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