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Corrosion rate measurements in steel sheet pile walls in a marine environment

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ABSTRACT

Corrosion of steel structures in the marine environment is a major problem. The deterioration of this kind of structures is costly and difficult to predict both when designing new structures and when estimating the remaining service life time for existing structures. The aim of this investigation was to find indicative values for the corrosion rate of steel sheet piles on the Swedish west coast. Such corrosion rates (mm/year) can be used both when designing new structures by oversizing the steel thickness and when estimating the bearing capacity of existing sheet pile structures. Earlier investigations on the corrosion rates along the Swedish east coast – with salinity from about 0.2% to 0.8% – are still used today as guidelines for the corrosion rate of all steel structures in the Swedish maritime environment even though the salinity on the west coast can be as high as 3.0%.

Steel sheet pile wharfs located in the port of Halmstad on the Swedish west coast were inspected by ultrasonic measurements. Three wharf structures with a total length of about 700 m were inspected. None of the inspected wharfs had or have had cathodic protection. The thickness measurements of the steel sheet pile structures were performed by divers.

The age of the three inspected sheet pile structures ranged from 36 to 51 years. The dimensions of the original sheet pile sections are known. One of the quay structures is located along a river. The salinity at all wharfs varied from low values at the surface to approx. 2% at the bottom (also in the river outflow).

The measured average corrosion rates were in the same order as the design values in the European code. However, the results indicate increased corrosion rates about 1 m below the mean

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water surface and at the level of the propellers from the ships berthing the most frequented of the inspected wharfs, 3–6 m below water surface.
The tolerances of steel sheet thicknesses – usually in the order of ±6% – are often neglected when investigating the remaining thickness in steel sheet piles. A simple calculation model shows that the sheet pile must be almost 50 years of age before an accurate estimation on the corrosion rate can be made, considering the tolerances, if the true original sheet pile thickness is not known.

1. Introduction

1.1. Background

A large part of the international trade in the world is today transported at sea. The higher volume of transported goods by sea, along with larger freight vessels, set increased demands on the quays and ferry berths in our harbors. Since the loads on the quay decks increase with increased handling of goods and the deterioration in form of corrosion reduces the bearing capacity of the sheet pile structure, this can lead to a collapse. Fig. 1 shows some typical quays in industrial harbors.

Many of the quays in Swedish harbors have reached an age of 60–70 years and have – according to the original design criteria based on assumed corrosion rates – reached their design life time. Even though most of these quays and wharfs are actually still in good condition there is a need for inspections and predictions of remaining life time for these structures in order to plan for renovations and the design of new quays.

The service life time of new sheet pile structure is usually fulfilled by oversizing the steel thickness in the sheet profile. Knowledge about the corrosion rate is also important when verifying the remaining bearing capacity of existing structures, and estimating the remaining service life time according to bearing capacity. When oversizing the structure, a certain corrosion rate (mm/year) is assumed. The corrosion is also assumed to be even all over the surface and pit corrosion or other types of uneven corrosion are not accounted for. In practice the corrosion rate is also assumed to be a linear function of time by most engineers. However, a report from a European research project [1] concludes that the corrosion rate decreases with time. The values on corrosion rates in this report are also given in reference [2] and are used by practicing engineers in Europe today when designing new steel structures. According to this report, the corrosion rate needs to be treated statistically. It is probable that a decreasing corrosion rate will be found if the protective layers of corrosion products formed are not damaged or eroded [3].

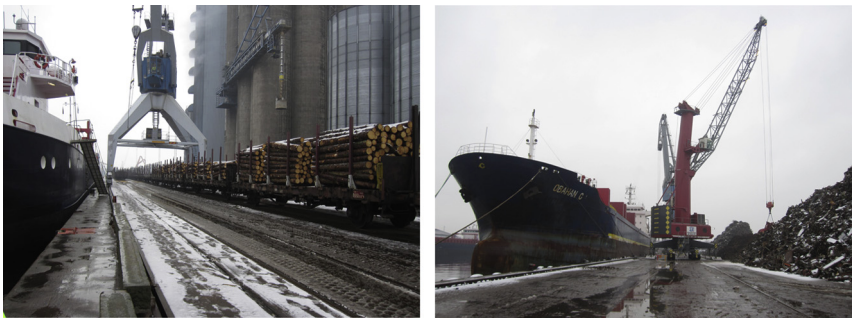

Fig. 1. Examples of vertical loads on quay decks.