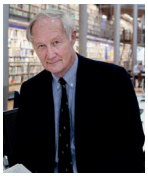
Recommendations for assessing and upgrading old urban quay walls

Alfred ROUBOS
Hydraulic engineer,
Engineering Dept.
Municipality of Rotterdam,
Rotterdam, Netherlands
aa.roubos@rotterdam.nl

Alfred, born 1983, received his civil engineering degree from Delft University of Technology in 2006.

Jarit DE GIJT
Assistant Professor Delft University and
senior consultant,
Engineering Dept.,
Rotterdam, Netherlands
jg.degijt@rotterdam.nl



Jarit , born 1947, is Ass. Professor since 2004 at Delft University of Technology

Summary

From the earliest days, quay walls have played an essential role in the shipment of goods in the Netherlands. Therefore the relative old cities have historic quay wall structures. During the life time of these quay walls, the structures have been exposed to various loads due to changing boundary conditions. Currently there is no specific guideline for determining the minimal required safety of these old and historic structures. A specific point of interest is describing the methods and the extension of an inspection in urban areas.

Therefore an expert group is preparing a guideline for upgrading and analysing old quay walls in urban areas. This guideline is called "CUR recommendation C186". In this CUR recommendation a design philosophy and practical guidelines for inspection protocols and verification are presented. The verification of the remaining life time in relation to the latest developments will be in line with the standardisation of the new Euro codes and national appendixes. Nowadays many urban quay walls are used for other purposes compared to their originally functional requirements. The quay walls have to withstand loads due to traffic and trees and have often a monumental functions. The quay walls are a part of the urban landscape in the city centres. Adaptation is necessary and commonly the execution of these adaptations will take place in highly populated areas. For these complex situations, adaptations and execution (near trees for example), practical recommendations are described.

Keywords: old urban quay walls, inspection, inspection protocols, verification, upgrading, assessing.

1. Introduction

From the earliest days, quay walls have played an essential role in the transhipment and in the transport of goods. The design and construction of quays is relative complex, because all disciplines of civil engineering are involved and the users and management of the quay walls also have specific demands and requirements. The oldest quays wall in Rotterdam date from the beginning of the 17th century. The oldest quay was made for a harbour reserved for fishing boats. In those days the ships needed a water depth of around 5 metres, but it was impossible to obtain a greater retaining height than 2.50 meter. For this reason the ships were moored to a row of wooden mooring piles at some distance from the quay where they were loaded and unloaded.

The quays were built of masonry walls on a wooden grillage. The difficulties encountered by the builders at that time were certainly challenging. The port areas were usually raised by using material obtained by dredging the harbour basin. This was unconsolidated weak clay. Angles of internal friction of 25° to 5° were not unusual and the weight-density was not much greater than that of water: 1.04 to 1.70 kN/m^3. The subsoil was so weak that the quays gradually subsided into the weak clay and peat layers. The raising of the ground level caused excess pore pressure and, because of the poor permeability of the soil, it was several decades before the ground was sufficiently consolidated to provide any bearing. Settlements of 1 to 2.5 metres were no exception at that time and during dredging major sliding was the order of the day. Despite this quays were constructed successfully. In this way the quay walls in the oldest harbours of Rotterdam, the Leuvehaven, Wijnhaven and Haringvliet, came into use. In time the port activities in Rotterdam

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shifted more and more to the west part of Rotterdam. At the moment a large port expansion called Maasvlakte 2 is under construction. Therefore almost no port activities are carried out in the urban city centres.

The design of these quay walls have been performed in the past using the overall safety principle, also called the level 0 approach. In some historic cases the structures were not computed at all and just based on trial and error.

It appeared that a many of Dutch cities have their own perception and approach in redesigning these old structures. This is an unwanted situation. Especially for the construction companies in a tender process. This has been one of the main reasons to initiate this CUR commission and prepare a clear guideline.

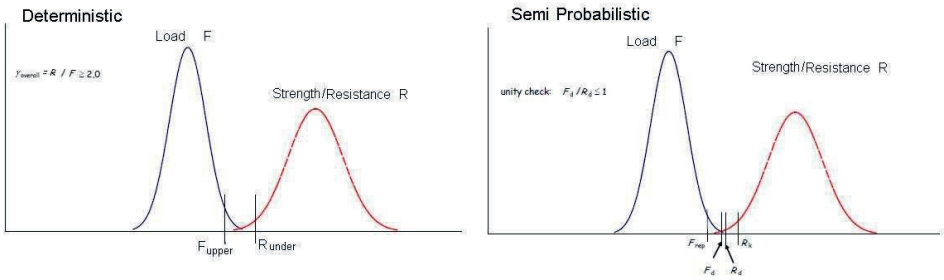

Figure 2 Deterministic and semi-probabilistic approach

Within the process of realisation of the CUR C186 guideline the overall approach of how to proceed with maintenance and redesign stage is adapted to a semi-probabilistic approach. The preparation of CUR C186 coincides with the preparation of the update of the Handbook Quay Walls (CUR 211). The upgrade of this handbook is necessary because of the interaction with the Euro codes and the semi-probabilistic approach. Both CUR recommendations use the same partial safety factors which are required to perform a semi probabilistic analysis.

2. Conclusions and recommendations

- With CUR publication 186 a comprehensive guideline will be presented for upgrading and analysing old quay walls in urban areas.
- In this CUR recommendation a design philosophy and practical guidelines for inspection protocols and verification are explained.
- The verification of the remaining life time in relation to the latest developments will be in line with the standardisation of the new Euro codes and national appendixes.
- It is recommended to organize a database with case studies so that information remains available.
- More research is needed to evaluate the effects of interaction between structures.

3. Acknowledgement

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