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OPTIMUM SAFETY LEVELS AND DESIGN RULES FOR THE ICELANDIC TYPE BERM BREAKWATER

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INTRODUCTION

Guidance on selection of breakwater types and related design safety levels for breakwaters are almost non-existent, which is the reason that PIANC has initiated working group 47 on this subject. This paper presents ongoing work particularly on the Icelandic type berm breakwater within the PIANC working group. It will concentrate on design guidance and on the optimum safety levels for this type of structure.

THE ICELANDIC TYPE BERM BREAKWATER

Berm breakwaters have basically developed in two directions. On one hand are the dynamic structures built using a few stone classes that are allowed to reshape. On the other hand are the more stable structures built of several stone classes, where only a few stones on the berm are allowed to move. These structures have been referred to as Icelandic type berm breakwaters. The general method for designing an Icelandic-type berm breakwater is to tailor-make the structure around the design wave load, possible quarry yield, available equipment, transport routes and required functions. Quarry yield prediction is presented as a tool in breakwater design.

OPTIMUM SAFETY LEVELS

In order to come to optimum safety levels for breakwaters a procedure has to be followed in numerical simulation for identification of minimum cost safety levels. Before such a numerical simulation can be performed, design rules should be available and also a description of the behaviour of the structure under (very) extreme wave conditions. The mentioned procedure in numerical simulation gives amongst others the following items:

- Design structure geometries by conventional deterministic methods corresponding to various chosen design wave heights.
- Define repair policy and related cost of repair
- Define a model for damage accumulation and consequences of complete failure.

Above procedure has not yet been performed for the Icelandic berm breakwater and this paper is, as a part of the PIANC work, an attempt to fill in the gaps. The base report for design is PIANC WG 40 (2003).

DESIGN RULES

The design of an Icelandic berm breakwater does not really depend on a formula for the recession of the berm. The main idea is that the biggest rock from a quarry is kept apart to make the upper two layers of the berm and a part of the down slope. From the total quarry output this will be only a few percent. This large and most important layer is constructed with care. Rocks are placed one by one and to achieve the high interlocking without loosing the porosity.

The Sirevåg and Keilisnes berm breakwater in Norway and Iceland have been taken as representative to develop deterministic design rules. In summary (explanation in the paper):

- The upper layer of the berm consists of two layers of rock and extents on the down slope at least to mean sea level.
- The rock size of this layer is determined by: $H_s/\Delta D_{n50} = 2.0$. Larger rock may be used too.
- Slopes below and above the berm are 1:1.5
- the berm width is 2.5–3.0 H_s
- the berm level is 0.5–0.9 H_s above design w.l.
- the crest height is given by $R_c/H_s * s_{op}^{1/3} = 0.35$.

DAMAGE AND REPAIR STRATEGY

PIANC WG 40 (2003) gives a formula for recession of the berm as function of rock and hydraulic boundary conditions and this formula shows a lot of scatter. Working group 40 was not able to find the reason for this scatter, which means that designers should take this into account. First of all the formula and the scatter has been reviewed with respect to the Icelandic berm breakwater type. The formula can be used to calculate the damage and cost along the repair strategy that has been developed.

RESULTS

Simulations on optimum safety levels are underway right now and results will be given in the paper. Part of the optimization by cost benefit analysis will be decisions including risk aversion.

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