*The 9th **International Conference on Coasts, Ports and Marine Structures (ICOPMAS 2010)***
Tehran, Iran, 29 Nov.-1 Dec. 2010

Stability of Multi-Layer Berm Breakwaters

محمد نوید مقیم Mohammad Navid . Moghim]
[آلف توروم Alf . Tørum]
[مهدی شفیعی فر Mehdi . Shafieefar]
[ایویند آرنتشن Øivind Asgeir . Arntsen]

Abstract
The front slope stability of the berm breakwater was studied with two dimensional model tests. The berm recession of a reshaping berm breakwater plays a very important role for the stability of this kind of structure. This paper deals with the investigations of the reshaping of a multi-layer cross section (Icelandic type). Tests have been carried out in two cases. The first case is the typical form of the multi-layer berm breakwater and the second case is a new idea for this kind of structure by using one order smaller stone mass in front of the berm. A comparison is made between the berm recessions for the different cases. It can be concluded that in the second test case, the total costs of the project can be reduced without decreasing the stability.

Key words: *Multi-Layer, Berm Breakwater, Stability*

Introduction

Berm breakwaters have proven to be a cost effective type of breakwater in exposed locations, at least in Norway and Iceland. The Icelandic Maritime Administration has in recent years pioneered the development of the multi-layer berm breakwater. Such breakwaters utilize the quarry material almost 100%. The main advantage of the berm breakwater is that lower mass of the individual armour stones is required compared to a conventional rubble mound breakwater. This enables the use of quarried rock to a larger extent than for a conventional rubble mound breakwater, for which it might be necessary to use concrete armour units in exposed locations. Concrete armour units have generally speaking a much higher cost than quarried rock.

In addition a well designed berm breakwater is a "tough" type of breakwater, which may easily take a "beating" of waves beyond the design waves without being damaged, only reshaped.

Reshaping of berm breakwaters

The most commonly used parameters in relation to the stability of berm breakwaters are the following:

$$\frac{\mathrm{Re\,c}}{D_{n50}}, Ho=\frac{H_s}{\Delta D_{n50}}, \Delta=\frac{\rho_s}{\rho_w}-1, HoTo=\frac{H_s}{\Delta D_{n50}}\sqrt{\frac{g}{D_{n50}}}T_z, D_{n50}=\sqrt[3]{\frac{W_{50}}{\rho_s}}, f_g=\frac{D_{n85}}{D_{n15}}$$

and recently Moghim et al. (2009a) introduced a new parameter $H_o\sqrt{T_o}$.

where Rec = recession of the berm, Fig. 1, g = acceleration of gravity, H_s *= significant wave height,* T_z *= mean wave period,* ρ_s *= mass density of stone,* ρ_w *= mass density of water,* W_{50} *=*