OPTICREST
The Optimisation of Crest Level Design of Sloping Coastal Structures through Prototype Monitoring and Modelling (1998 – 2001)

Introduction

This project frames in the MAST III programme within the Fourth Framework (1994-1998) of the European Community. Ten partners out of seven European countries participated in the OPTICREST project. Ghent University was project co-ordinator.

Four main objectives have been put forward:

1. Provide improved design rules for the crest level design of sloping coastal structures, mainly based on prototype data and supported by physical scale model results.
2. Verify and calibrate physical scale models with prototype data for wave run-up.
3. Calibrate numerical models with prototype data and physical scale model results for wave run-up.
4. Improve existing wave run-up monitoring devices plus ancillary software and install on two prototype coastal structures.

Methodology

Two types of coastal structures are investigated: a smooth impermeable sea dike and a conventional rubble mound breakwater.

Prototype measurements have been carried out on the Petten sea dike (the Netherlands) (Fig. 1) and the Zeebrugge rubble mound breakwater (Belgium) (Fig. 2). Small scale models have been built and tested in six laboratories all over Europe. Numerical calculations have been performed. The influence of wave run-up and wave overtopping on the crest stability has been investigated theoretically and by laboratory testing.

Results

For an impermeable dike, small scale model tests confirmed prototype measurement results. An important aspect, however, is the foreshore. The Petten site is complex because of the presence of a shallow foreshore with two sand bars which need to be modelled very accurately as these have an important influence on wave breaking and on the propagation towards the coast of low frequency waves. Based on the analysis of the Petten Sea-Defence measurements and other investigations of wave run-up on dikes, a formula has been derived to estimate the $Ru_{2\%}/H_{m0}$ value for wave run-up on dikes.

For the estimation of maximum layer thickness and wave run-up velocity, a theoretical model has been developed on the basis of simplifications of the two-

Fig. 1. *The Petten measuring site (smooth sea dike).*

Fig. 2. *The Zeebrugge measuring site (rubble mound breakwater).*

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dimensional Navier-Stokes equations and the continuity equation. This theoretical model was verified with laboratory test results. Both theoretical model and laboratory test results agreed very well.

The project has demonstrated that wave run-up on a prototype rubble mound breakwater armoured with grooved cubes is clearly higher than obtained by small scale model tests. A clear difference was seen between the results of the different laboratories and the prototype measurement results. Both scale effects and modelling effects have been identified as factors contributing to these discrepancies. Although suitable for sea dikes, the 2% wave run-up exceedance level cannot be considered as the key parameter in the design of rubble mound breakwaters. The overtopping discharge should be the criterion to determine the crest level of a rubble mound breakwater.

Four different numerical models have been used. Data from two prototype structures and data from a physical scale model have been used for validation of these numerical models (Fig. 3). One model, ODIFLOCS, is a one-dimensional model based on the non-linear shallow water equations. The three other models, VOFbreak^2, SKYLLA and 2D HYDROTUR, are two-dimensional models based on the Navier-Stokes equations and the Volume-Of-Fluid (VOF) method for treating the free surface configuration. In general, the codes provided a useful description of the physical phenomena involved in wave overtopping on the dike's crest. From the numerical simulations it is concluded that the choice of the computational grid is critical in obtaining good agreement with physical measurements, and that a lot of attention has to be paid to the definition of the grid.

Partnership

9 partners from 7 different European countries are involved in OPTICREST. These are:

- Ghent University (RUG), Belgium (coordinator)
- Flemish Community – Coastal Division (FCCD) and Flanders Hydraulics (FCFH) Belgium
- Leichtweiss-Institut für Wasserbau der Technischen Universität Braunschweig (LWI), Germany
- Aalborg University (AAU), Denmark
- Universidad Politécnica de Valencia (UPVLC), Spain
- Delft Hydraulics (DH), the Netherlands
- National Institute for Coastal and Marine Management (RIKZ), the Netherlands
- University College Cork (UCC), Ireland
- Instituto Hidrográfico (IH), Portugal

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Contact

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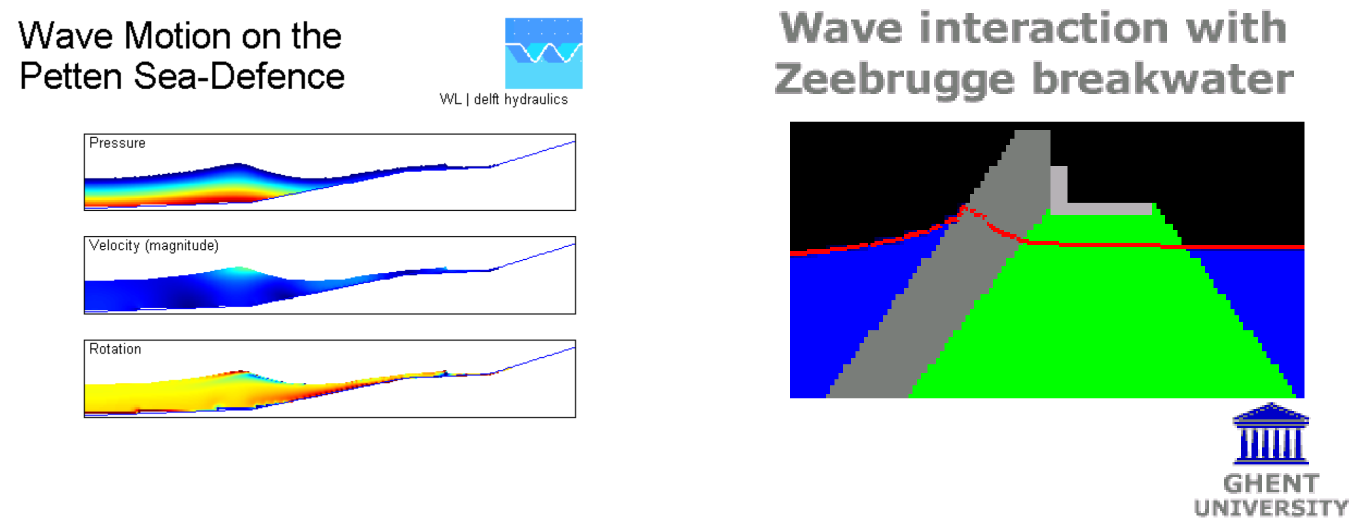

Fig. 3. *Examples from numerical simulations of wave-structure interaction: (left) using SKYLLA for Petten site, and (right) using VOFbreak^2 for Zeebrugge site.*

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