BERM BREAKWATER STRUCTURES

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INTRODUCTION

The second workshop on the MAST II research project on Berm Breakwater Structures was held on 6 October 1995 at Imperial College, London, United Kingdom.

A total of 14 persons from the eight participating organisations attended the workshop together with C Fragakis from the European Commission and J-P Latham from Queen Mary and Westfield College. S Sigurdarson from the Icelandic Harbour Authority (IHA) participated for the first time in a project meeting, following the decision at the start-up workshop to involve IHA in the project. A complete list of participants is presented in the following section, and the programme for the workshop is enclosed in Appendix A.

After a brief welcome address by P Holmes from IC, the workshop started with an introduction by the coordinator, J Juhl. The second workshop was arranged about one year after the start-up workshop, but the major part of the partners had met twice in between in connection with the planning and running of the three-dimensional model tests at DHI during the summer of 1995.

A twelve month report has recently been prepared by the coordinator, and a midterm report (15 month report) has to be submitted to the European Commission within short time.

At the Fourth International Conference on Coastal and Port Engineering in Developing Countries held in Rio de Janeiro, Brazil, from 25 to 29 September 1995, the partners had a total of five papers on berm breakwaters. A copy of the five papers is enclosed in Appendices H to L.

The report on the second workshop includes a list of participants, a summary of the presentations and the discussions, a short description of the planned research activities and the time schedule, and finally a summary of the agreements for future meetings within the project and some general remarks on the project.
LIST OF PARTICIPANTS

Partners

P Holmes  Imperial College (IC)
Z Tamburic  Imperial College (IC)
SSL Hettiarchechi  Imperial College (IC)
S Sigurdarson  Icelandic Harbour Authority (IHA)
R. Archetti  University of Bologna (UB)
H F Burcharth  Aalborg University (AU)
P Frigaard  Aalborg University (AU)
A Alikhani  Aalborg University (AU)
J W van der Meer  Delft Hydraulics (DH)
M van Gent  Technical University of Delft (TUD) and Delft Hydraulics (DH)
A Tørum  SINTEF NHL (NHL)
K Westeren  SINTEF NHL (NHL)
J Juhl  Danish Hydraulic Institute (DHI)
P Sloth  Danish Hydraulic Institute (DHI)

Guests

C Fragakis  European Commission
J-P Latham  Queen Mary and Westfield College

PRESENTATIONS AND DISCUSSIONS

Three-dimensional model tests

The three-dimensional model tests on berm breakwaters were planned and carried out by five partners: DHI, AU, UB, IC and DH. A draft test programme was prepared by DHI and discussed with the partners during a planning meeting on 27 June 1995 at DHI. During this meeting, it was ensured that the model tests would be carried out incorporating the experience of all the partners. Subsequently, two test series were carried out by researchers from DHI, AU, UB and IC. The experience from the first two test series was discussed during a second meeting at DHI on 1 August 1995, which led to some modifications of the remaining test programme (four test series and a series for measuring the velocities at the slope of a reshaped berm breakwater) and the test execution. Some data analyses have already been performed, and the results were presented at the workshop as outlined in the following. Based on the discussion at the workshop, further data analysis will be carried out and a meeting will be held at DHI on 4 January 1996 for discussing the data analysis and ideas for further relevant data analysis.
J Juhl (DHI) gave a description of the model set-up, the test programme and the performed measurements. This included a presentation of the wave basin and the location of wave generators, wave absorbers, etc. The profile for the trunk section of the berm breakwater was presented (the profile for the head is obtained by rotating the trunk profile around the centreline). The test programme consisting of six test series was described together with the measurements and observations made, ie profile measurements, wave measurements, velocity measurements and recordings of the stone movements at the trunk and roundhead (visual observations, photos and video). Further details are enclosed in Appendices B and C.

P Sloth (DHI) presented the system (consisting of two lasers) used for measuring the profiles at the trunk (every 0.5 m) and at the roundhead (every 0.1 m). The profiles were interpolated to give a three-dimensional representation of the data. From these data, it is possible to extract profiles in arbitrary cross-sections and to present the reshaping of the modelled berm breakwater as contour plots, further difference plots showing the areas of erosion and accretion can be extracted. Analysis has been made for calculating the changes in volumes at the roundhead (for each 10° section), and from these calculations, the transport of stones (volume) per test was calculated. The influence of the angle of wave attack and of the wave steepness on the berm reshaping and stone transport was described.

A Alikhani (AU) started with a description of the principle in the registration of the stone movements at the trunk and at the roundhead, ie coloured stones followed by visual observations, photos and video recordings. The physics in the stone movements and differences for the six test series were described by photos taken after each test. An expression of the longshore transport at the trunk as function of the angle of wave incidence was derived from analysis of the stone movements, and the results were compared to previous results from Burcharth and Van der Meer.

R Archetti (UB) presented the first analysis of the recession of the berm both along the trunk and at the roundhead. The recession was calculated on basis of the three-dimensional representation of the test data (see P Sloth's presentation), and the results showed the effect on the recession of the wave conditions (wave height and wave steepness) and the incidence angle. A summary of the findings is enclosed in Appendix D. Further, analyses of the longshore transport for different incidence angles were presented as function of the modified stability number, $N_s$.

Z Tamburic (IC) described the velocity measurements carried out on the three-dimensional model of the berm breakwater. Tests were run with regular waves, except for one test series for measuring the velocities at the trunk during exposure of irregular waves. The results of the first data analysis were presented, which included plots of the velocities in different water depths around the roundhead of the breakwater. It was found that the highest velocities occurred near the still water level at the tip of the breakwater, see Appendix E.

The researchers involved in carrying out the reshaping and stone movement tests have submitted two abstracts to ICCE’96 in Orlando, Florida, USA (see Appendices B and C).
Research at Aalborg University

P Frigaard (AU) showed results from a reanalysis of existing data from laboratory tests carried out at Aalborg University with the objective of assessing the effect of stone transport both on the roundhead and the trunk. Tests results are available for two different breakwaters, a slender breakwater having a width of 1/6 of the wave length and a very wide breakwater with a width of about one wave length, see Appendix F. The results from these analyses will be combined with the results from the three-dimensional model tests carried out at DHI.

Wave forces on individual armour stones

A Tørum (NHL) described the model set-up for the ongoing tests, which concentrate on measuring the wave forces on an armour stone located in various locations along a reshaped berm breakwater. The forces will be fitted to a distribution function, and the necessity to study slamming forces will be considered.

Research at Imperial College

Z Tamburic (IC) briefly summarised the content of the numerical model for calculating the reshaping of berm breakwaters, see Appendix G. The sensitivity and performance of the model will be documented, and the programme will be made more user-friendly and distributed to the partners. Finally, the model results will be compared to findings from the one-dimensional model at TUD (comparison of two models based on different modelling techniques).

Numerical modelling of wave motion and reshaping of dynamic structures

M van Gent (TUD & DH) presented results of the research on numerical modelling of subjects related to berm breakwater structures. The research covers a one-dimensional model at TUD and a two-dimensional model at DH.

The one-dimensional model describes the flow on and in berm breakwaters and has further been combined with a morphological model for calculation of the stone transport (based on Morison equations). Despite the neglect of many hydrodynamic and morphodynamic phenomena, the results indicate that these neglects do not make the approach unrealistic. The two-dimensional model (xz-model) is capable of simulating the flow on and inside berm breakwaters. The presentation included several examples of simulations with berm breakwaters, eg wave overtopping and variations of the surface and pressures inside the berm. Appendices H and L include two papers describing the models.
Berm breakwaters and quarry investigations in Iceland

S Sigurðarson (IHA) presented a paper on the experiences with berm breakwaters in Iceland. The main problem facing construction of rubble mound breakwaters in Iceland is the poor quality of stones and the often associated lack of sufficiently large armour stones. A total number of 17 berm breakwaters have been constructed in Iceland since 1983 and four are presently under construction. The berm breakwaters in Iceland are often constructed of several stone classes (four to five stone classes) compared to the typical berm breakwater only consisting of two classes of stones. The idea behind this is to increase the stability of the breakwater by using the largest stones as a protection of the berm. This method only results in a slightly increased sorting in the quarry as all the stones are weighted as part of the quality assurance programme.

PLANNED WORK

SINTEF NHL

The model tests including force measurements will be continued, and subsequent analysis of the test results will be carried out.

No monitoring of the two prototype berm breakwaters has been carried out within the first year of the project, and thus no analysis has been possible. For the same reason, the future workload within this task is uncertain.

SINTEF NHL has started working on theoretical aspects concerning probabilistic analysis related to berm breakwaters, and would like to receive more information on the 3D test at DHI in order to include the important 3D effects in their analysis.

AU

In the near future, the analysis of stone movements from the 3D tests at DHI and the previous model tests at AU will be combined to give a more complete picture of the longshore transport, stone movements at the roundhead and displacement lengths. A series of model tests will be carried out for studying the effect of the stone shape and for studying the transport in shallow water.

In the future, model tests will be carried out for studying the reshaping in shallow water, overtopping tests in short-crested waves, and the stability of repaired berm breakwaters. The above described model tests are carried out in research programmes outside this project, but the results will be made available for the partners. Finally, the work on reliability analysis will be initiated.
IHA

IHA contributes with their practical experiences with berm breakwaters, but would like one of the partners to look into differences in behaviour of a 'reshaping' berm breakwater and the more stable Icelandic type of berm breakwater, eg if the width of the berm can be decreased in the latter case.

IC

The research at IC was discussed, and it was agreed that focus should be put on finalisation of the 1D reshaping model including sensitivity analysis and comparison to existing trunk data. Further, the velocity measurements made on a berm breakwater roundhead at DHI should be analysed, and the findings be compared to observations from video recordings. Finally, emphasis should be put on a physical description of the 3D processes at the roundhead (ie the stability of stones at a berm breakwater roundhead).

TUD

The major part of the planned research is carried out, but results from sensitivity analysis will be presented at the next workshop.

DH

The development of the 2D model for describing breaking waves on berm breakwaters will continue. For practical applications, it will be necessary to look at the possibility to use smaller grid spacings and time steps at critical points of the model. Further, DH will continue their participation in the discussion of the analyses of the results from the 3D model tests.

UB

The recession analysis of the 3D model tests carried out at DHI will be completed as will the analysis of the stone movements. UB has collected all available data from previous model tests carried out by the partners and will establish a database with the data. The collected data will form input to a derivation of some new parameter expressions for the reshaped profile. Outside the MAST programme, R Tomasicchio develops a 1D model for studying the flow on berm breakwaters.

DHI

The analysis of the 3D model tests will continue together with the other partners (stone transport, recession and wave reflection). In the near future, a study report with all details of the model tests will be finalised.

Problems related to scour at berm breakwaters constructed on a sandy seabed will be studied in a limited test programme in the near future. This includes an investigations of the effect of a scour protection.
The model tests for studying scale effects and the model tests for studying the influence of gradation and permeability will be discussed between the partners prior to testing (which is planned to be in January and February 1996). It seems that the tests with different gradations can be omitted or reduced as some Canadian researchers already have carried out similar tests. The tests will include the influence on profile development, wave run-up, wave overtopping, and wave transmission.

FUTURE MEETINGS, ETC

The coordinator urged the partners to give faster response to request for contributions to progress reports, etc, and also for faster submission of cost statements in order not to delay the payment to all partners.

In December 1995, Marcel van Gent from TUD will defend his PhD thesis on numerical modelling of flows related to breakwaters and reshaping of berm breakwaters.

In connection with the MAST Days in Sorrento, Italy, from 7 to 10 November 1995, the project will have a poster space of 2 times 95x235 cm. J Juhl will prepare these posters and will in this connection ask some partners for a contribution in form of a small text and some illustrations.

Future meetings

Third meeting on the 3D model tests
Thursday 4 January 1996 at DHI. The analysis of the model results will be discussed together with ideas for further analysis (material to be sent to the participants in advance, i.e. not later than mid-December).
Expected participants: DHI, AU, UB, IC, DH (further it could be relevant for NHL to participate as they have some plans to perform 3D tests in shallow water).

Second workshop
Friday 10 May 1996 in Stavanger, Norway (a visit to a berm breakwater will be arranged on Saturday 11 May 1996).

Final workshop
Monday 4 November 1996 in Iceland (a visit to some berm breakwaters will be arranged on Sunday 3 November 1996).

Finally, the coordinator mentioned that the project has accelerated during the last five months and that the research is progressing well at all involved organisations. Especially, the 3D model tests at DHI has shown a well functioning cooperation between the five involved partners. Considering the way the project is running at the moment, it will without doubt contribute to increased understanding of the physics and a better design basis for berm breakwaters.