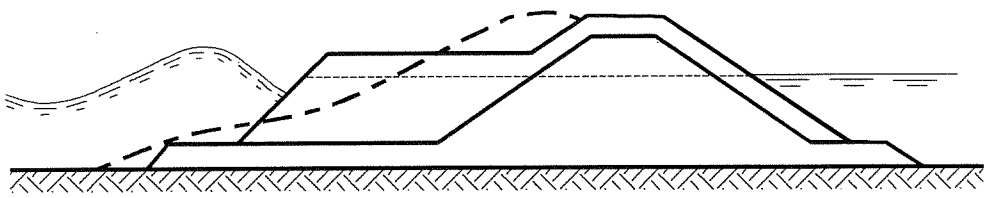
PROCEEDINGS
THIRD WORKSHOP
HELD IN STAVANGER, NORWAY
10-11 MAY 1996



BERM BREAKWATER STRUCTURES

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INTRODUCTION

The third workshop on the MAST II research project on Berm Breakwater Structures was held on 10 and 11 May 1996 in Stavanger, Norway.

A total of nine persons from the eight participating organisations attended the workshop together with a guest from the Norwegian Coast Directorate. No representative from IC was able to attend the workshop even though the date of the workshop already was fixed during the previous workshop on 6 October 1995. A complete list of participants is presented in the following section, and the programme for the workshop is enclosed in Appendix A. A brief description of the site visist on 11 May is given on page 9.

After a brief welcome addressed by A Tørum from SINTEF NHL, the workshop started with an introduction by the coordinator, J Juhl. The third workshop was arranged about seven months after the second workshop, but some of the partners had met for a meeting at DHI in connection with discussions on the results of the 3D model tests and exchange of ideas for further analysis.

A mid-term report (15 month report) has been prepared by the coordinator and lead to some comments from C Fragakis concerning the timing of some of the planned model tests. These comments were considered and taken into account in the planning of the remaining model tests. The revised time schedule was presented in the eighteen month progress report, covering the period up to 1 January 1996.

In connection with the MAST Days in Sorrento, Italy, from 7 to 10 November 1995, the coordinator with the assistance from some of the partners prepared a paper describing the objective and progress of the project (enclosed in Appendix I) and figures and text for a poster space of two times 95x235 cm.

At the International Conference on Coastal Engineering (ICCE'96) in Orlando, Florida, USA, a number of papers based on the research within this project will be presented. This includes two papers directly related to the analysis of the 3D model tests carried out at DHI during the summer 1995. A copy of the two final abstracts is enclosed in Appendices J and K.

The coordinator, J Juhl, informed that he had joined COWI Consulting Engineers and Planners on 1 May 1996, but that he will continue as coordinator for the project as a DHI employee. All correspondence still has to be sent to DHI, with attention to J Juhl and/or P Sloth.

The report on the third workshop includes a list of participants, a summary of the presentations and the discussions, a short description of the planned research activities for the remaining project period, and finally a summary of the agreements for future meetings within the project and some general remarks on the project.

LIST OF PARTICIPANTS

Partners

S Sigurdarson	Icelandic Harbour Authority (IHA)
A Lamberti	University of Bologna (UB)
P Frigaard	Aalborg University (AU)
A Alikhani	Aalborg University (AU)
T Hald	Aalborg University (AU)
J W van der Meer	Delft Hydraulics (DH)
A Tørum	SINTEF NHL (NHL)
P Sloth	Danish Hydraulic Institute (DHI)
J Juhl	Danish Hydraulic Institute (DHI)

Guest (part time)

Arnold Jakobsen	Norwegian Coast Directorate

PRESENTATIONS AND DISCUSSIONS

Research at DH

JW van der Meer briefly described the work DH/DUT had performed in three tasks:

Task 1.2 on numerical simulations had the objective to increase the understanding of the physical processes related to flow on and in berm breakwaters. DUT has completed their work on a 1D model. Modelling with the 2D model Skylla is going to be made at DH.

In relation to the parameter analysis for the profile development of berm breakwaters (**Task 2.2**), DH has released all their profile data both from research and commercial projects. DH will continue to be involved in the discussion on parameter analysis.

DH has and will continue to participate in the analysis of the 3D model tests (**Task 4.1**).

Research at SINTEF NHL

A Tørum presented results from analysis of the tests carried out for measuring the wave forces on an armour stone located in various locations along a reshaped berm breakwater. The technical note is included in Appendix B. The sampling frequency was 500 Hz and the force transducers were set to zero in still water. The forces were fitted to a three parameter Weibull distribution function, and the 90 per cent and 99 per cent level forces found and compared for the four locations along the slope. Future analysis will include stability calculations (rolling) and assessment of

equilibrium profiles based on the force measurements/stability analysis. So far, the analysis have shown that a combination of run-up and run-down is responsible for the stability.

During the construction of the roundhead for the 3D tests in shallow water, a significant variation in the gradation curves was found from samples taken at different locations at the head (even though the stones were well mixed before placing). This was not found during the 3D tests at DHI, but the variation could be due to the fact that the samples were taken from the built structure. Comparisons to experience from prototype would be of interest.

A first test was made with a profile similar to the one used for the deep water tests at DHI in order to facilitate comparisons. The second test was made with a modified profile (Norwegian type) having a smaller berm width, lower crest elevation and core extended into the berm. The results from the latter test series resulted in rear side damage.

NHL and DHI will make comparisons of the 2D and 3D tests to study the effect of the water depth in front of the berm breakwater.

Research at UB

A Lamberti presented the data sources included in the database and showed results from preliminary parameter analysis, see Appendix C.

During the presentation, it was found that the DH tests did not fit to the DH formula which they should. Therefore, it is necessary for UB to look closer into their application of DH's test results and formula.

UB will include the results from the extensive 2D tests made at DHI during MAST I. These results have already been made available to UB.

Research at DHI

J Juhl presented the results from four test series carried out to study the scouring in front of a berm breakwater and the effect of various scour protections. R Archetti from UB stayed at DHI for two weeks to participate in the scour tests and the subsequent analysis.

During the last workshop, IHA expressed that they would like one of the partners to look into differences in the behaviour of a 'reshaping' berm breakwater and the more stable Icelandic type of berm breakwater, eg to study if the width of the berm can be decreased in the latter case. As part of the 2D tests at DHI, several alternatives of the Icelandic type of berm breakwater were tested.

A description of the test programme, profile development, and selected photos from the 2D tests are presented in Appendix D.

During the discussion, it was proposed to look into the start of reshaping for the Icelandic type of berm breakwaters, and then compare to the stability of traditional rubble mound breakwaters.

More detailed analysis has to be made on the influence of stone gradation as this aspect seems very important. The tendency of the tests was confirmed by experience from IHA.

Based on the discussion at the last workshop, further data analysis of the 3D model tests was carried out, and a meeting was held at DHI on 4 January 1996 for discussing the data analysis and ideas for further relevant data analysis.

The analysis presented at the last workshop has been refined and additional analysis made. The transport of stones (volume) at the roundhead and adjacent trunk section was calculated and related to the relative angle of wave incidence (angle between angle of wave attack and location at the roundhead). The influence of the angle of wave attack and of the wave steepness on the berm reshaping and stone transport was also presented by P Sloth. Plots of the analysis are enclosed in Appendix G.

The uncertainty related to the analysis, which is based on the measured profiles, was discussed with respect to initial settlements and differences in volume compaction in the areas with erosion and deposition. The sensitivity/reliability of the test analysis will be considered taking into account measuring uncertainties, analysis corrections, etc.

Presentation by IHA

S Sigurdarson (IHA) presented a paper on Berm Breakwaters, tailor-made size graded structures, see Appendix E.

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. This philosophy was the background for the extensive 2D tests carried out at DHI during this Spring.

IHA has experience with using dredged material for part of the core of berm breakwaters, Keilisnes breakwater.

Inspection of the reshaped Bakkafjordur breakwater showed small rounded stones on the damaged part of the breakwater.

Research at AU

A Alikhani presented a revised expression of the longshore transport at the trunk as function of the angle of wave incidence considering the 3D test results, and the results were compared to previous results from Burcharth and Van der Meer, see figures in Appendix F.

Additionally, a presentation was made of the 'recession' and other characteristic values including the point of rotation of the reshaping profiles. It was urged that Van der Meer's cosine influence of the berm reshaping was checked.

In the analysis, it should be taken into account that the maximum wave height is smaller for breaking waves than in deep water.

In the description of the analysis, it is important to mention if the considered longshore transports are for each test or are the accumulated number of stones (ie including the number of stones moved in previous tests).

P Frigaard (AU) showed results from a series of model tests carried out for studying the effect of the stone shape for a berm breakwater without core, and only minor influence was found as outlined in the technical note enclosed in Appendix H.

Further, a theoretical analysis of the influence of the effect of the water depth in front of the breakwater was presented. A Lamberti will look further into this matter, also considering the method described in BREAKWAT (L_s and h_s dependent on h/H_s).

Research at IC

IC had informed that they are working on the numerical model for calculating the reshaping of berm breakwaters. 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 1D model at TUD (comparison of two models based on different modelling techniques).

IC has not been able to prepare a note on the progress with the numerical model.

PLANNED WORK

SINTEF NHL

Detailed analysis will be made of the already performed 3D model tests in shallow water. Two additional test series are planned:

- Norwegian type with increased crest height in order to facilitate comparison to the deep water 3D tests

- Norwegian type for an angle of wave attack of -30°

The analysis of the model tests including force measurements will soon be finalised.

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 will together with AU perform reliability analysis related to berm breakwaters.

AU

The analysis of stone movements from the 3D tests at DHI and results from other model tests will be combined to give a parameterisation for the longshore transport as function of the angle of wave attack. Displacement lengths as function of the wave conditions and angle of wave attack will be analysed.

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 together with NHL.

The coordinator asked AU and UB to coordinate their analysis methods, eg of the recession, as it is inefficient and confusing to analyse the same data in different ways.

IHA

IHA contribute with their practical experiences with berm breakwaters. This summer, a caisson breakwater in Keflavik will be protected by construction of a berm breakwater in front of the caisson.

A general comment from S Sigurdarson is to focus more on the start of damage than on the reshaping process.

IC

During the last workshop, it was agreed that the research at IC should focus on finalisation of the 1D reshaping model including sensitivity analysis and comparison to existing trunk data. Further, 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).

As IC, to the disappointment of the other partners, were unable to attend the workshop, it was requested that written material soon has to be circulated to the partners in order to have the possibility to comment on the research and propose adjustments.

TUD

The planned research at TUD has been completed, and Marcel van Gent has defended his PhD thesis with success. All partners should have received a copy of the thesis.

DH

The development of the 2D model for describing random waves has been delayed, which might influence the research on berm breakwaters as the model has to be used for these simulations. DH still hopes that it will be possible to make analysis with the 2D model, else additional analysis will be made with regular waves.

DH will continue their participation in the discussion of the analyses of the results from the 3D model (**Task 4.1**) tests and the parameter analysis (**Task 2.2**).

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 continue to establish a database with the data. The subsequent parameter analysis will attempt to include the effect of water depth, height of berm, initial slope (profile), etc.

DHI

Some final analysis of the 3D model tests will be made together with the other partners (stone transport, recession and wave reflection). A coordination with the results from the shallow water tests at NHL will be made.

Study reports with all details of the 2D model tests will be made. This means one report for the tests on problems related to scour at berm breakwaters constructed on a sandy seabed (including investigations of the effect of a scour protection), and one report on the effect of the Icelandic type, stone gradation, permeability, etc.

The model tests for studying scale effects were discussed between the partners, and it was agreed that it was more important to make further analysis of the already performed 2D tests. The information to be obtained from the two originally planned series of model tests was intended to supplement results from previous tests at DH, but it was found that these data were sufficient for assessing scale effects for the major part cases.

In-depth study report on the 2D and 3D model tests has to be prepared by the partners (incl model set-up, stone gradations, test conditions, profiles, stone transport, etc).

FUTURE MEETINGS, ETC

The coordinator reminded the partners that they soon had to submit the second cost statements (covering the period from 1 July 1995 to 30 June 1996). The partners are urged to forward the cost statements as soon as possible, and not later than 1 August 1996, in order not to delay the payment to all partners. Together with the submission of the cost statements to the Commission, we have to prepare a twenty-four month report, which mainly will be based on the report from the third workshop.

The second call for proposal for MAST III will be on 15 September 1996, and the partners discussed the possibilities of forwarding a proposal on berm breakwaters. All the present partners agreed that the cooperation within the small group was functioning very well, and that it would be very advantageous for the berm breakwater research in Europe to continue also within MAST III. However, it was also felt that it would not be possible to come up with a proposal including sufficient innovative research tasks (without putting a lot of effort on numerical modelling). The conclusion from all partners was that the existing group should not apply for a new project on berm breakwaters, but that some of the aspects maybe can be incorporated in other projects on costal structures, eg rubble mound breakwaters.

Please forward abstracts for papers on berm breakwaters to be presented at ICCE'96 to the coordinator.

Future meetings

Meeting on the 3D model tests

A part of the analysis of the 3D model tests carried out at DHI will be presented at the International Conference on Coastal Engineering in September in Florida, USA. Prior to the conference, the authors will coordinate and discuss the content of their presentations. The conference will be attended by several of the partners involved in the 3D tests, and discussions on the integration of the results and ideas for further analysis will be made during the conference.

Final workshop

The fourth and final workshop will be held on **Monday 4 November 1996 in Reykjavik, Iceland.** A visit to several berm breakwaters will be arranged on Sunday 3 November 1996, and a presentation of the Icelandic Harbour Authorities including a visit to the test facilities will be arranged. The organisers from IHA will make an invitation including a tentative workshop programme around mid-September.

All partners are reminded that papers and/or technical notes are to be sent to the other partners about two weeks before the meeting.

Finally, the coordinator mentioned that the research presented shows that the research is progressing well at these organisations. Especially, the continued cooperation on the analysis of the 3D model tests is positive and will certainly contribute to a better design basis for berm breakwaters.

The coordinator initiated a discussion on what should be the outcome of the project by the end of 1996.

Site visit, third workshop, 11 May 1996 in Stavanger

A visit to Mortavika ferry terminal was made on 11 May 1996 and included the following:

- overall description of the ferry terminal and the connecting new road system by engineers from the County Roads office at Rogaland
- travel to Mortavika including a few stops on the new road system
- visit to Mortavika ferry terminal including a walk on the protecting berm breakwater
- lunch and visit to Utstein Monastery
- return to Stavanger

A paper describing the Mortavika breakwater is enclosed in Appendix L.

APPENDICES