Seawall Overtopping Tests

sea erosion study : Sohar Cornice

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Seawall overtopping tests.
Sea erosion study.
SOHAR CORNICE
Diwan of Royal Court.
Sultanate of Oman

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Enclosures

Introduction.

At the request of Mr. J. Bulow Beck, Havnecon A/S the Hydraulics Laboratory at University of Aalborg, Denmark carried out model tests with the objective of studying the overtopping of a seawall designed for the protection of a new road and promenade, the SOHAR CORNICE, in the Sultanate of Oman.
The tests were carried out in the period 1.1-1.2.1990 by M. of Sci. Carsten Pedersen, supervised by Professor H.F. Burchart. The models was build by the staff of the laboratory.
Mr. J. Bulow beck inspected the models several times during the testing period.

The models.

Due to early observations of heavy overtopping of the seawall in the model test program, it was decided to run tests with offshore breakwaters. Two heights of offshore breakwaters were tested. In all three different models were used :

Model 1 consisting of the seawall only, see appendix 1.

Model 2 consisting of the seawall plus an Dolosse offshore breakwater with crestlevel at + 3,8 m and course sand (model scale) to level + 1,8 m between the breakwater and the seawall, see appendix 2.

Model 3 as model 2 but with crestlevel of the offshore breakwater at + 4,8 m, see appendix 3.

Only overtopping was studied in the models.

The seawall structure to be tested were specified in drawing D-2.

A relatively large model scale of 1:20 was chosen in order to reduce scale effects to a negliable level.

No wind was applied in the model. This introduce a small underestimation of the overtopping solid water and a relatively larger underestimation of the reach of the overtopping spray.

The model seawall was constructed in a 0,6 m wide wave flume equipped with a wavegenerator for generation of irregular waves in accordance with prespecified spectra.

To be on the safe side a relatively steep concrete mortar foreshore of 1:20 was chosen for the model.

The model seawall was constructed of specially made concrete blocks to give a structural surface identical to the one shown in drawing "Details of seaward slope construction", no. D-2, see also photos in appendix 4.

The seawall model was not designed for testing of the structural stability.

In front of the steel sheet piles a 4,0 m wide toe protection of 0,2 t. stones, C_s = 2,5 t/m³, was arranged. In front of this stone protected a 10,0 m. wide area of coarse sand (1-2 mm. model scale) was placed.

Overtopping was measured in trays placed behind the crest wall. Run-up gauges were placed on the surface of the seawall.

The cross sections of the offshore breakwaters were constructed in accordance with the specifications of Havnecon A/S except that the mass of the dolos used in the model correspond to 1,6 t. prototype. The model dolosses were kept in position by chicken wire to avoid displacement under heavy wave attack.

Environmental conditions.

Because no design wave conditions were specified it was decided to test the structure for a range of wave conditions.
The maximum waveheight at the structure are depth limited due to the shallow water. As agreed upon by Mr. J. Bulow Beck the following programme for combination of water levels and waveheights/periods was chosen for the tests.

T_p	H_s	Model 1	Model 2	Model 3
	1,0	X		
	2,0	X	X	X
6,0	3,0			X
	4,0	X	X	
	1,0	X		
	2,0	X	X	X
8,0	3,0			X
	4,0	X	X	
	1,0	X		
	2,0	X	X	X
10,0	3,0			X
	4,0	X	X	

Figure 1. Wave conditions used in the tests. Model 1 was tested with water level +1,8 , +2,6 and +3,4. Model 2 was tested with water level +2,6 and +3,4. Model 3 was tested with water level +3,4.

Results :

The results can be divided into 3 main groups, corresponding to the 3 models, see appendix 1-3.

Model 1 :

Water level + 1,8 m.

As it is seen from Figs. 2-7 the overtopping is very much dependent of the peak period T_p (waves with H_s = 4,11 m. and T_p = 9,97 sec. have 75 % more overtopping than waves with H_s = 4,22 m. and T_p = 8,49 sec.).

It is also seen that for the smallest of the peak periods, the overtopping is very dependent on the significant waveheigth H_s.

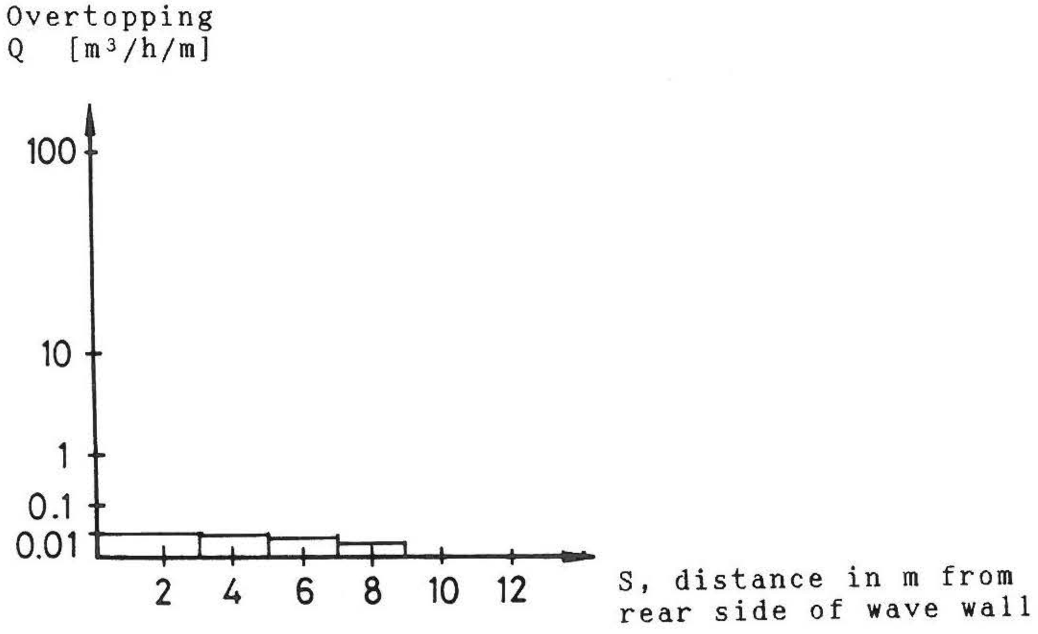


Figure 2. Overtopping for H_s = 2,55 m and T_p = 5,59 sec.

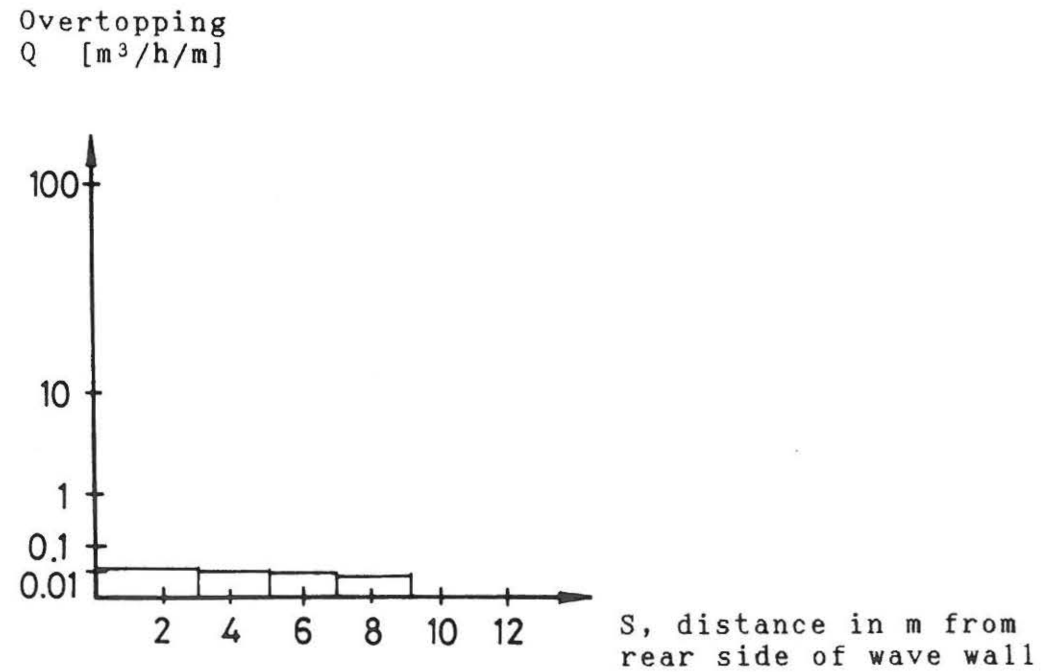


Figure 3. Overtopping for H_s = 2,98 m and T_p = 7,92 sec.

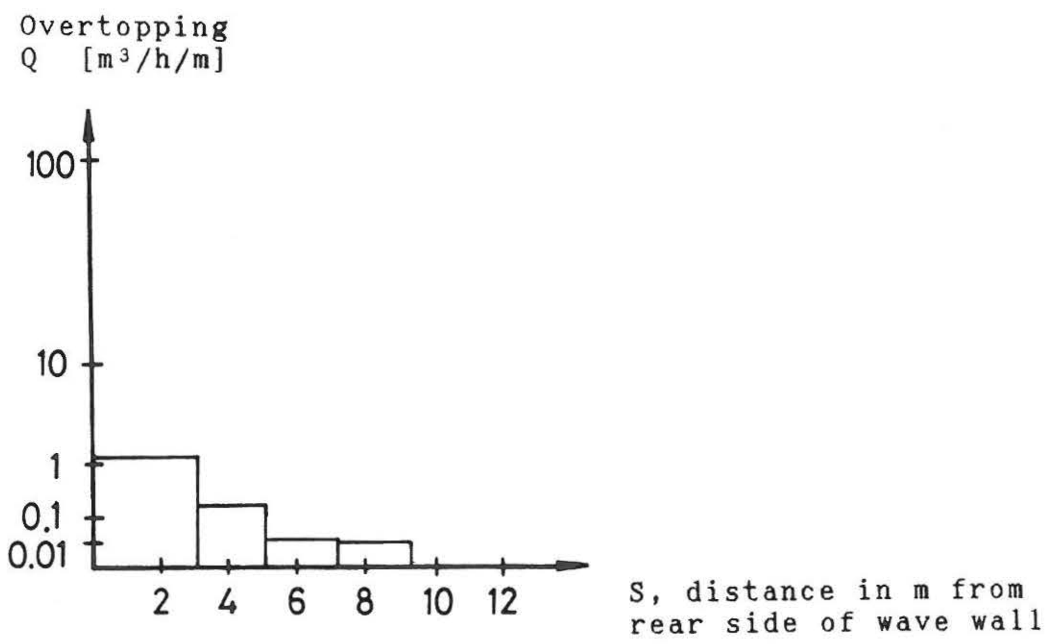


Figure 4. Overtopping for H_s = 3,25 m and T_p = 9,17 sec.

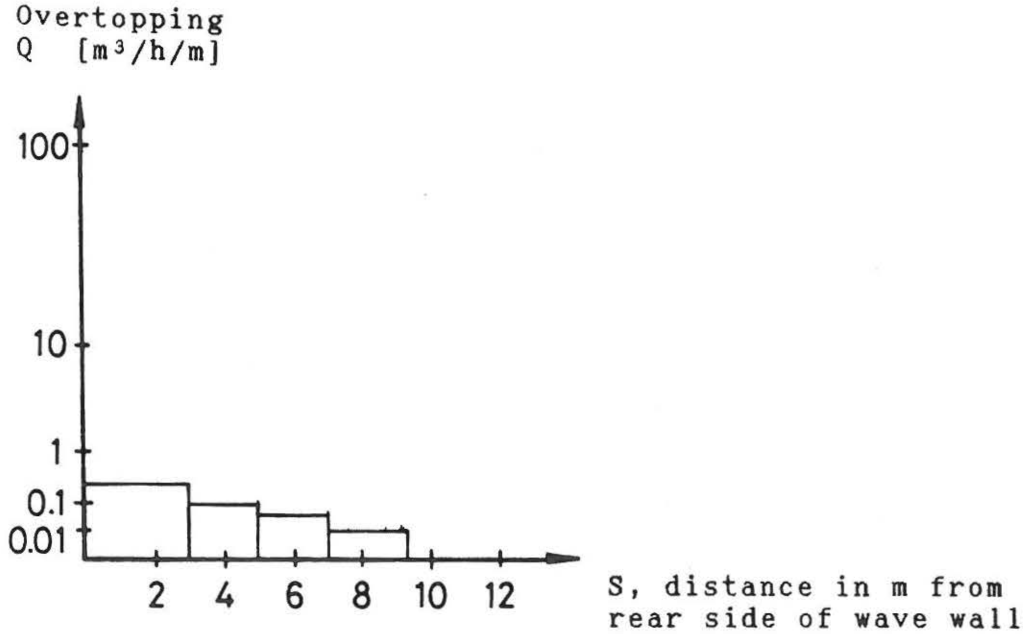


Figure 5. Overtopping for H_s = 3,89 m and T_p = 6,17 sec.

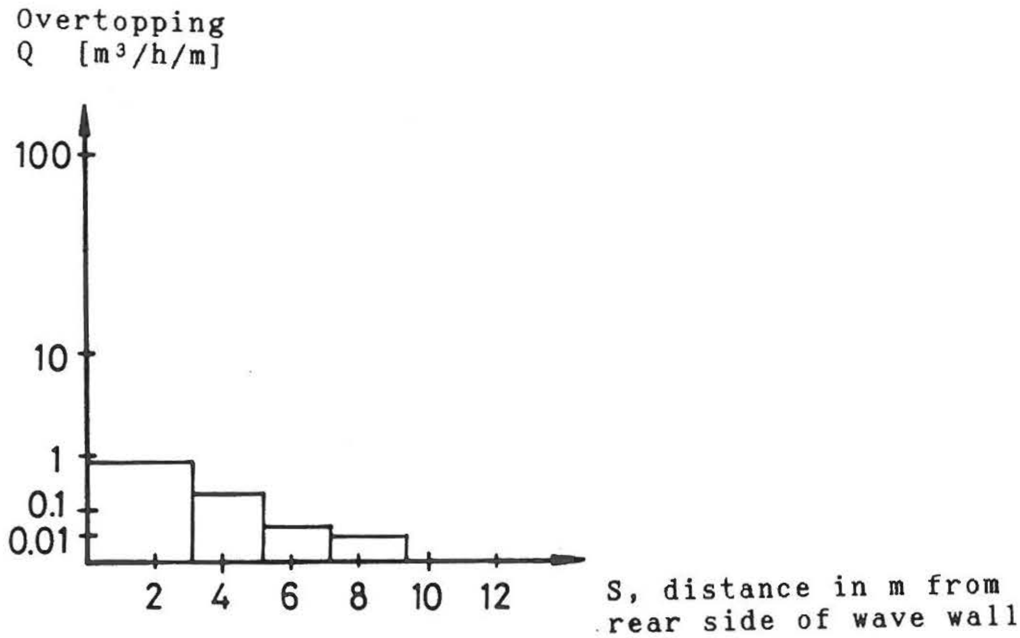


Figure 6. Overtopping for H_s = 4,22 m and T_p = 8,49 sec.

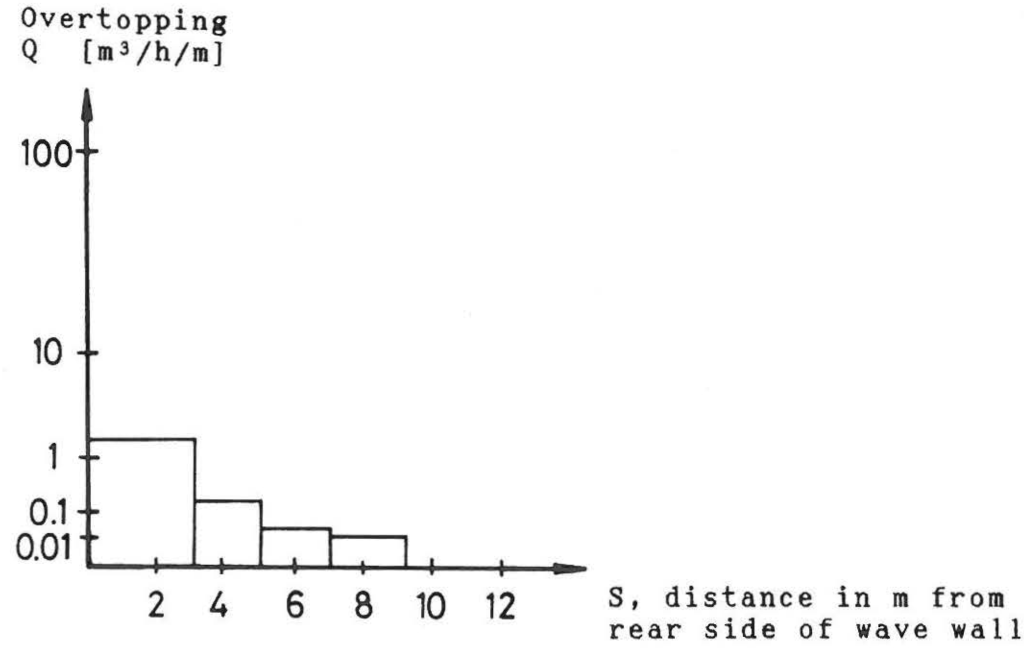


Figure 7. Overtopping for H_s = 4,11 m and T_p = 9,97 sec.

<u>water level + 2,6.</u>
As it is seen from Figs. 8-13 the overtopping at this water level is also very dependent on the peak period. It is also seen that the overtopping is very dependent on the significant waveheigth H_s, since an increase of H_s of 69 % gives an increase of the overtopping of 550%.

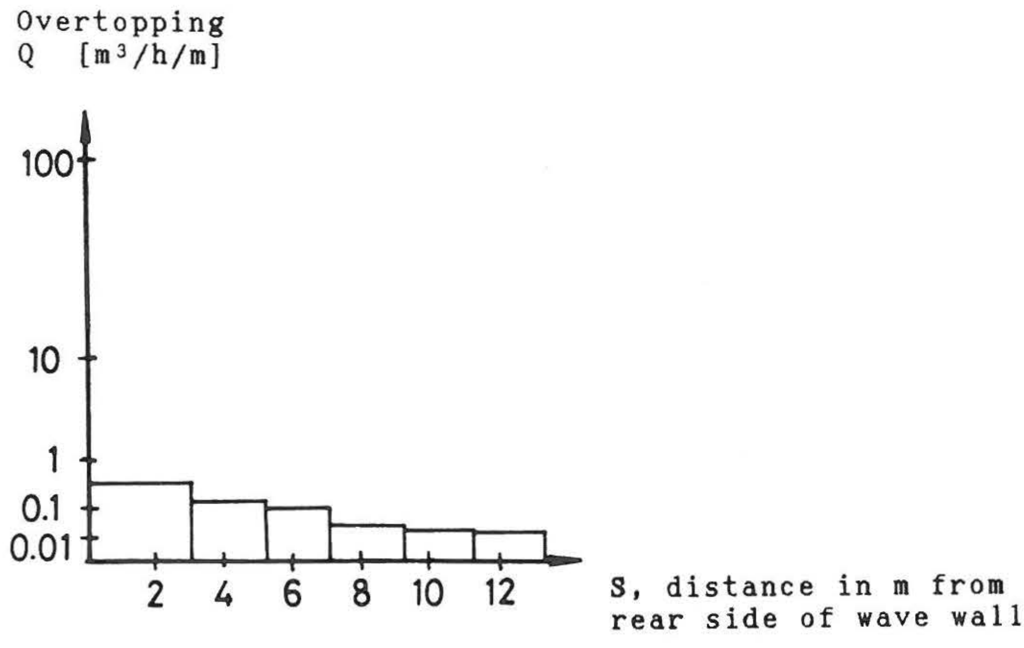


Figure 8. Overtopping for H_s = 2,48 m and T_p = 6,17 sec.

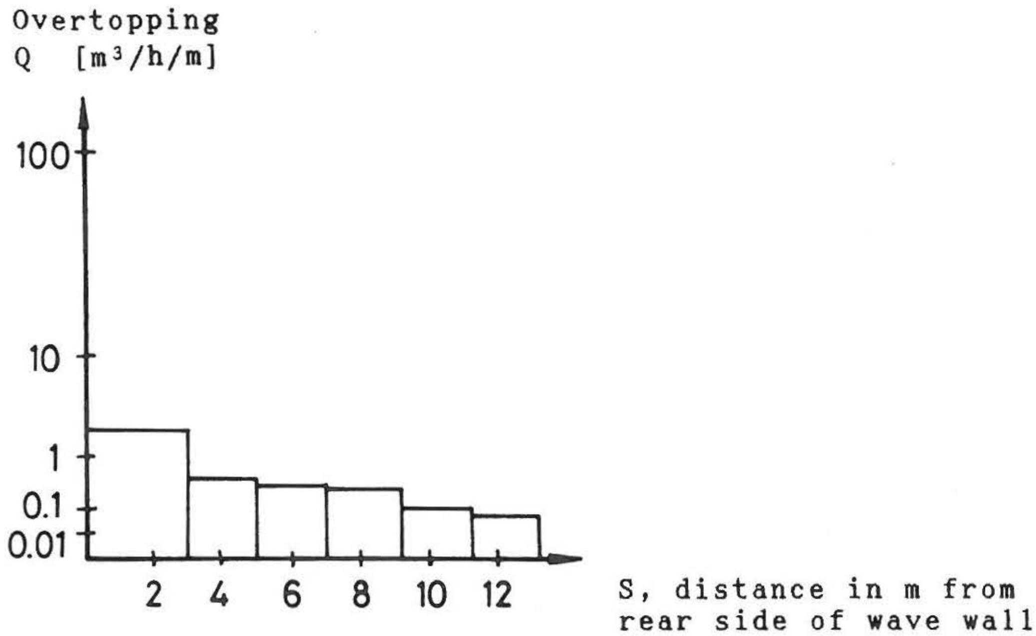


Figure 9. Overtopping for H_s = 2,45 m and T_p = 7,92 sec.

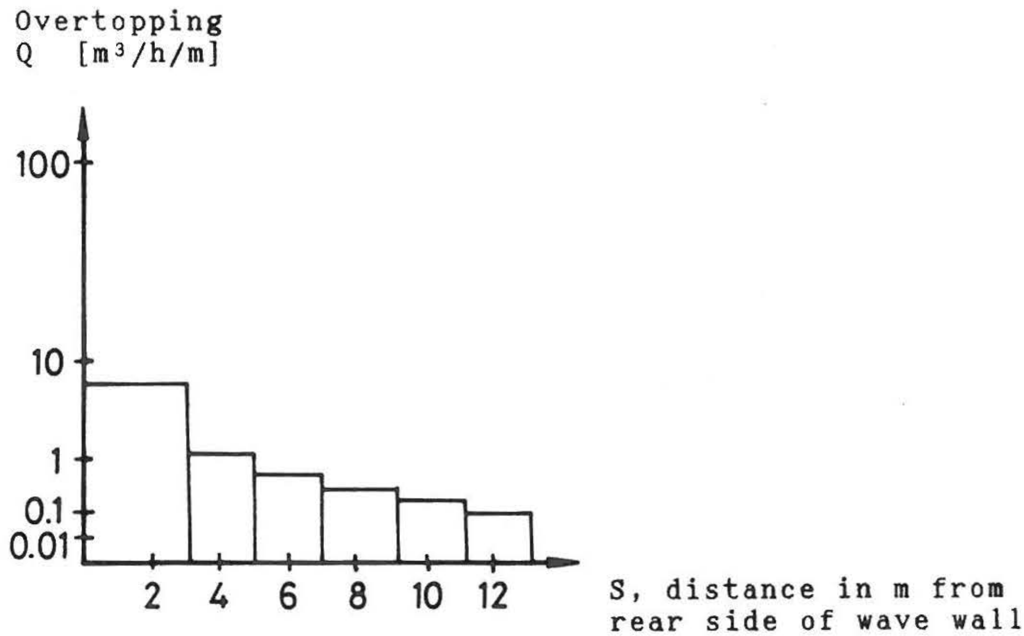


Figure 10. Overtopping for H_s = 2,47 m and T_p = 9,97 sec.

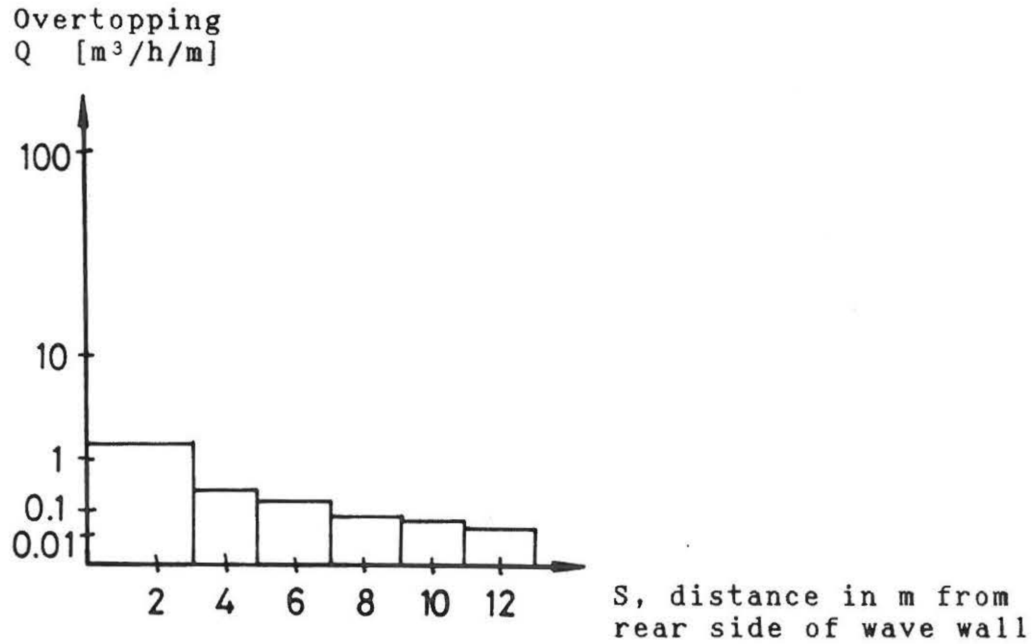


Figure 11. Overtopping for H_s = 4,10 m and T_p = 6,17 sec.

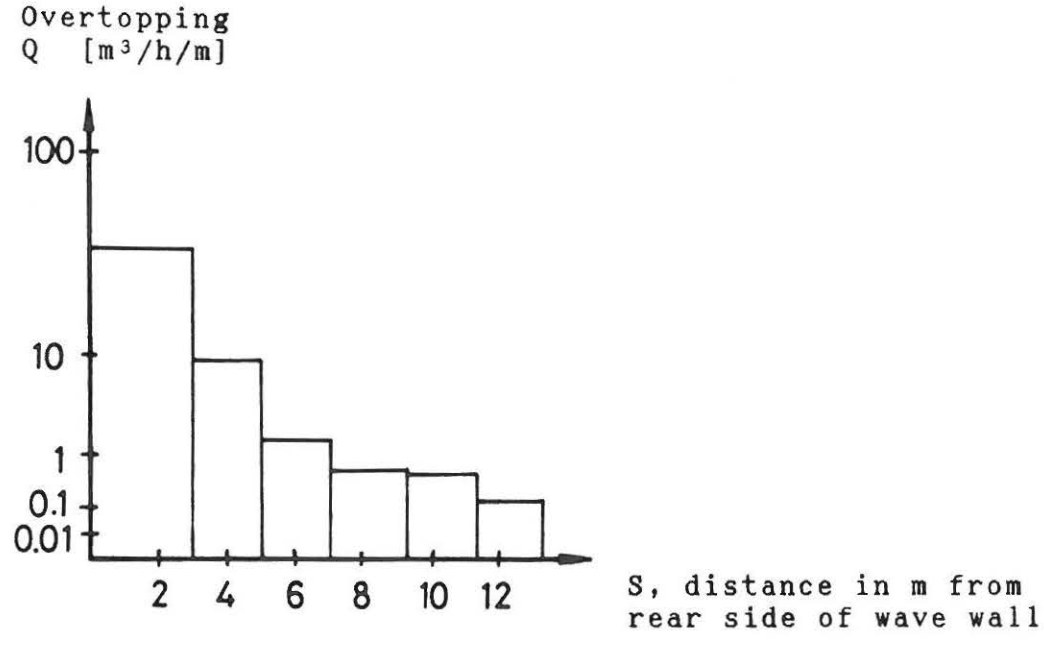


Figure 12. Overtopping for H_s = 4,37 m and T_p = 8,17 sec.

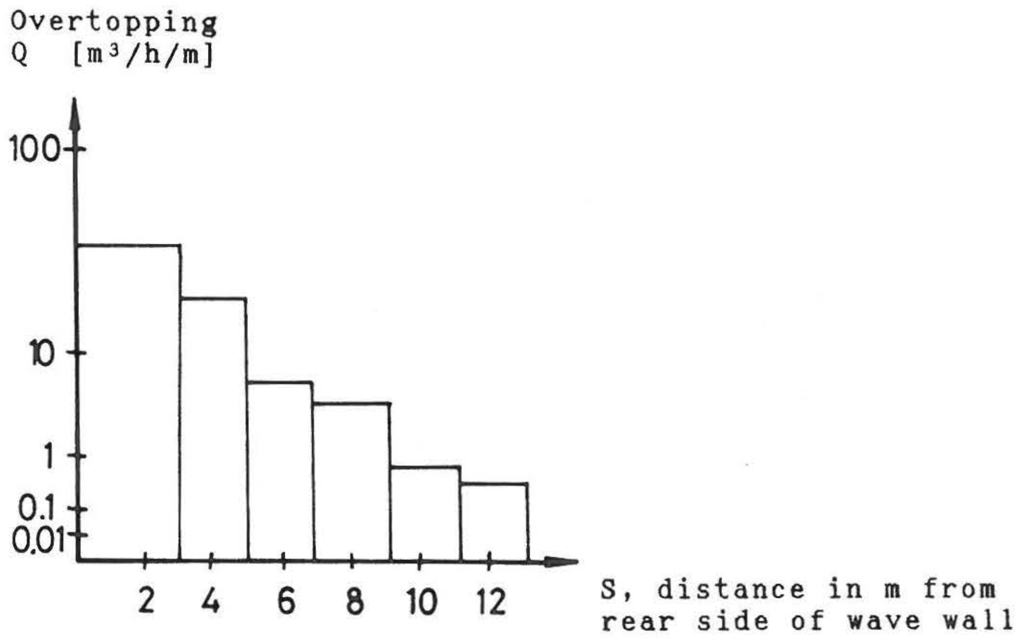


Figure 13. Overtopping for H_s = 4,18 m and T_p = 9,97 sec.

Water level +3,4 m.

From Figs. 14-19 it is seen that the overtopping is dependent of the peak period, but even more dependent on the significant waveheigth.
The reason to that the maximum significant waveheigth H_s 2,5 m is that it was not possible to measure the overtopping for H_s > 2,5 m. because single waves filled the trays completely.

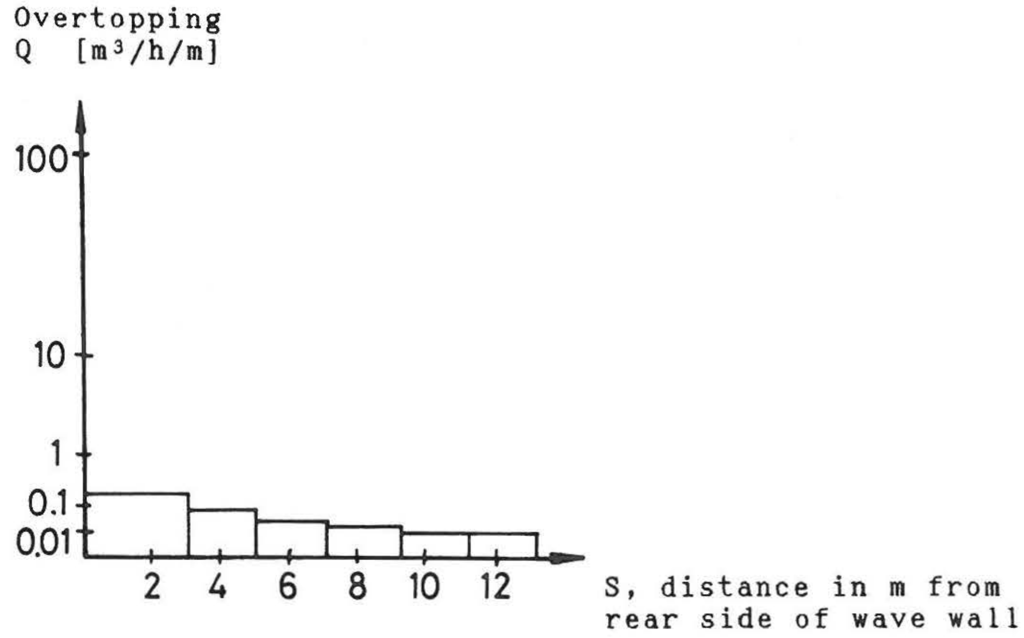


Figure 14. Overtopping for H_s = 1,60 m and T_p = 5,59 sec.

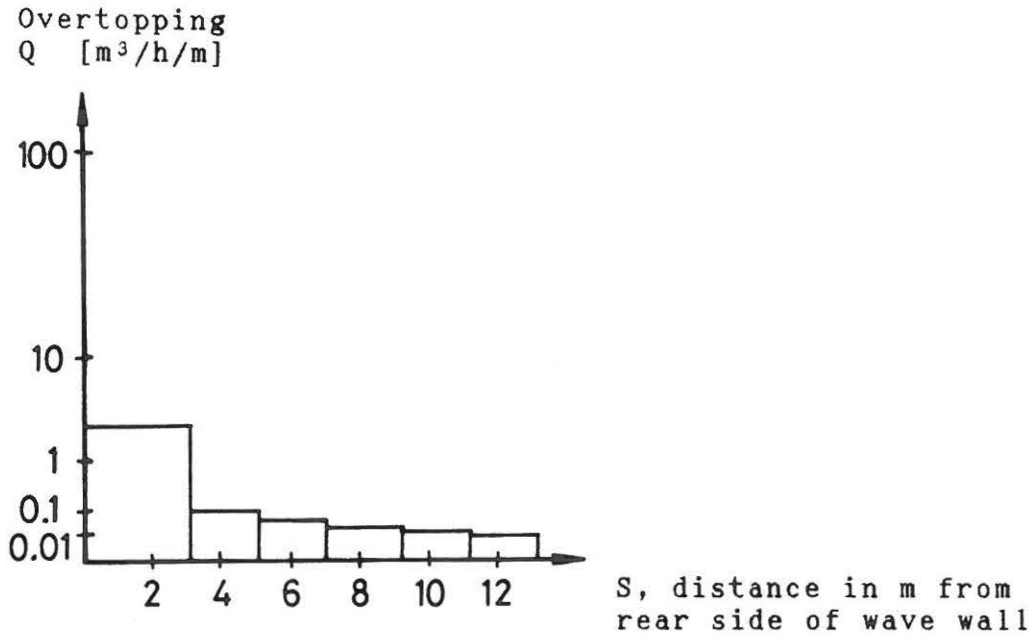


Figure 15. Overtopping for H_s = 1,66 m and T_p = 8,50 sec.

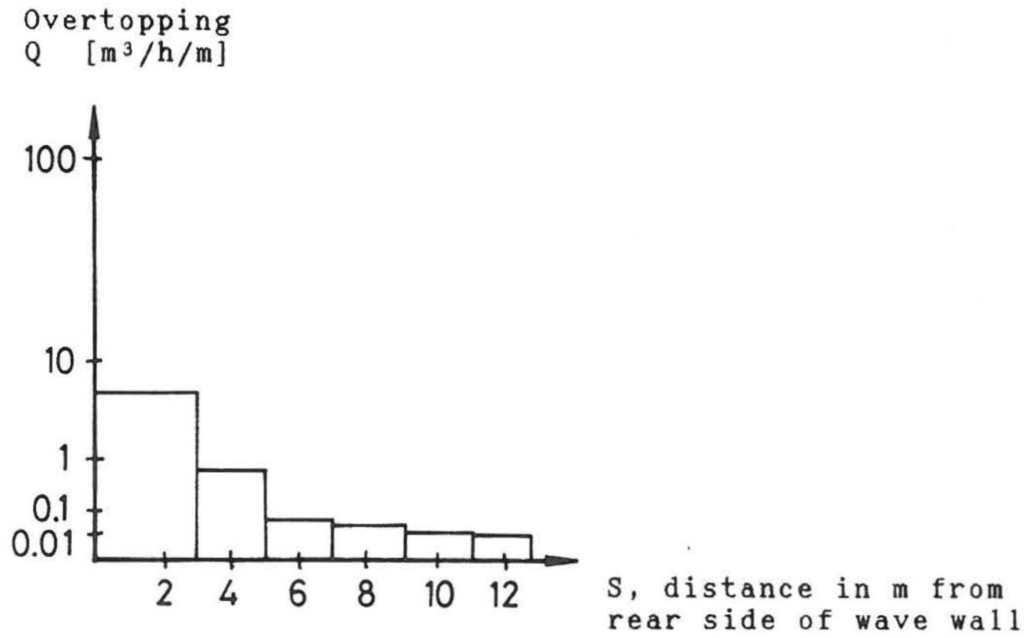


Figure 16. Overtopping for H_s = 1,53 m and T_p = 9,97 sec.

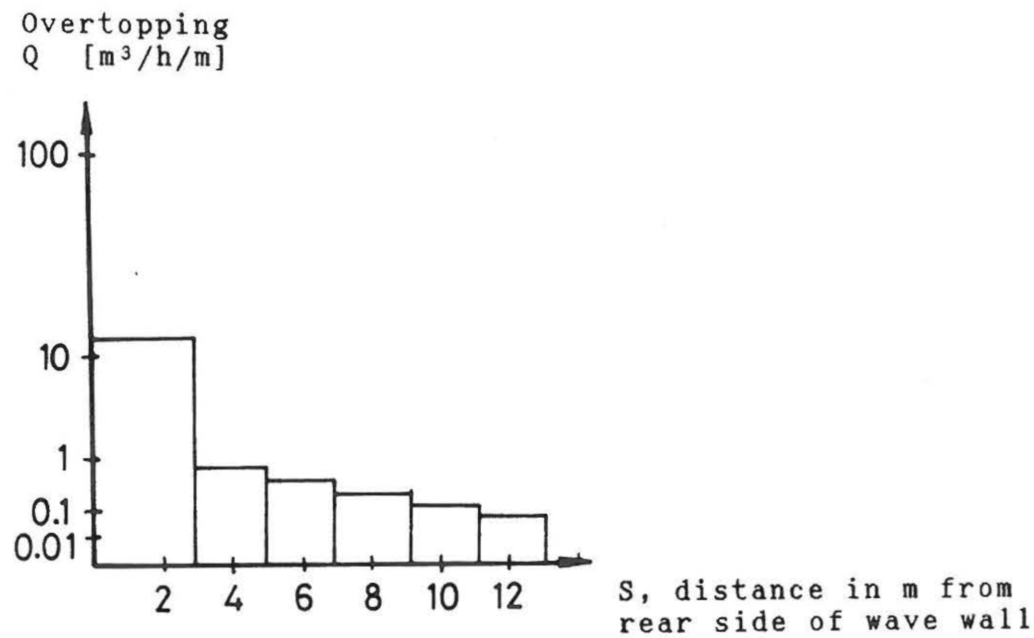


Figure 17. Overtopping for H_s = 2,68 m and T_p = 5,59 sec.

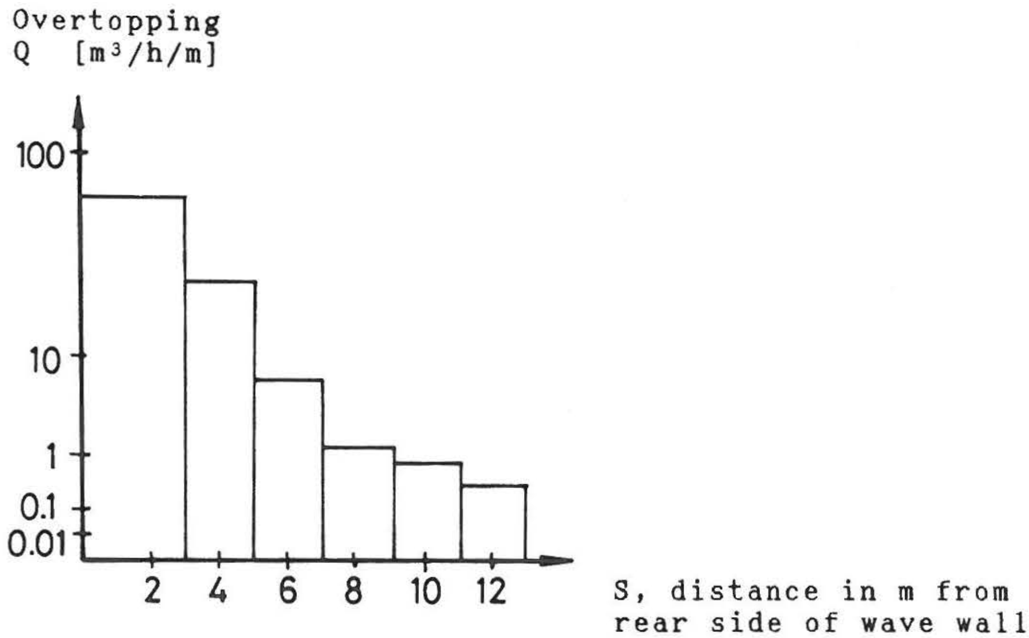


Figure 18. Overtopping for H_s = 2,67 m and T_p = 8,50 sec.

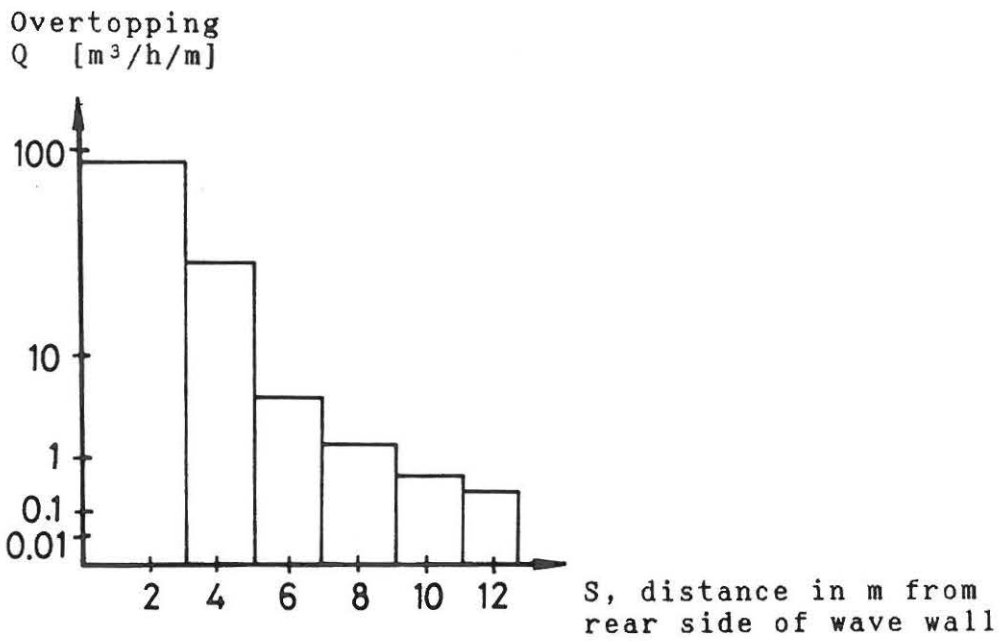


Figure 19. Overtopping for H_s = 2,77 m and T_p = 9,97 sec.

An overall result of the tests of model 1 is that the higher the water level the higher the sensitivity of overtopping to changes in the significant waveheigth.
The results for model 1 is summarized in Figs. 20-22 wich shows the overtopping dependency of the peak period and the significant waveheigth.

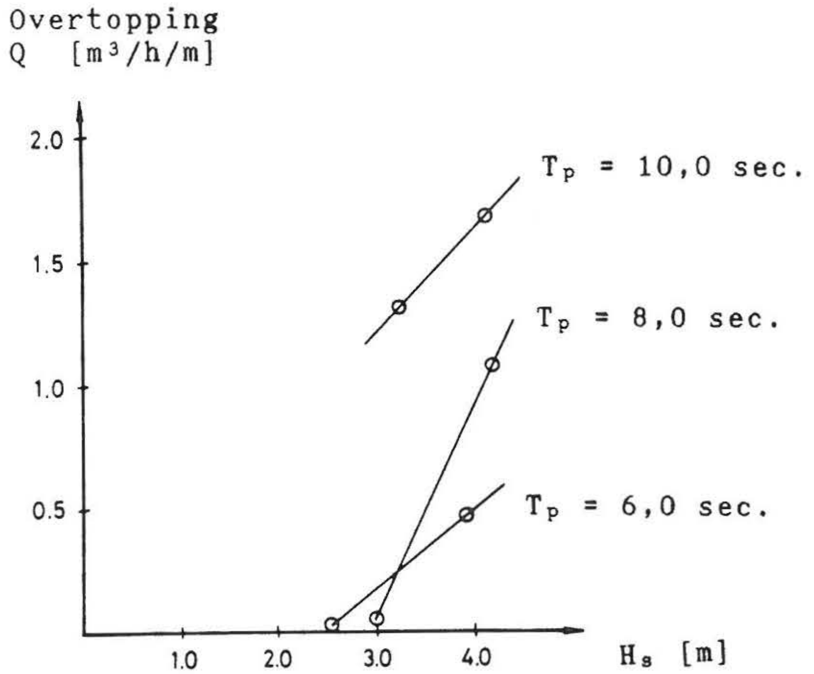


Figure 20. Overtopping for waterlevel +1,8.

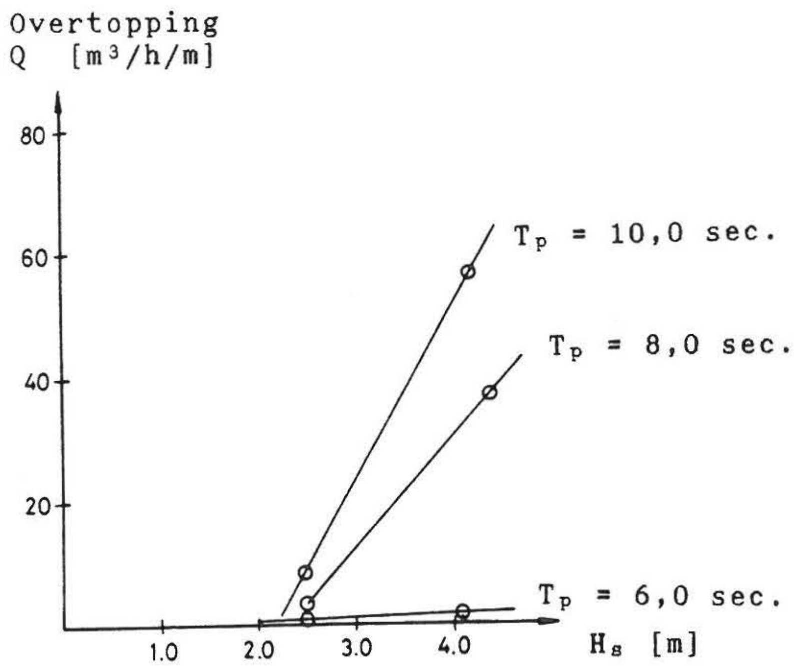


Figure 21. Overtopping for waterlevel +2,6.

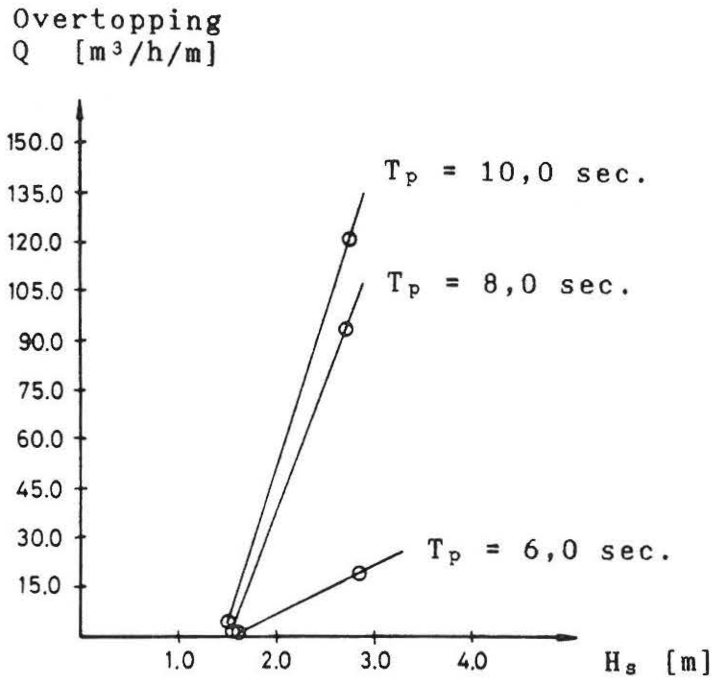


Figure 22. Overtopping for waterlevel +3,4.

<u>Model 2:</u>

<u>Water level +2,6 m.</u>

By comparing Figs. 23-25 with Figs. 10-12 it is seen that the effect of placing a wavebreaker in front of the cornice is very obvious. The overtopping is hereby reduced with 95 %, but it is at the same time seen from Figs. 23-25 that the overtopping is still dependent of the peak period.

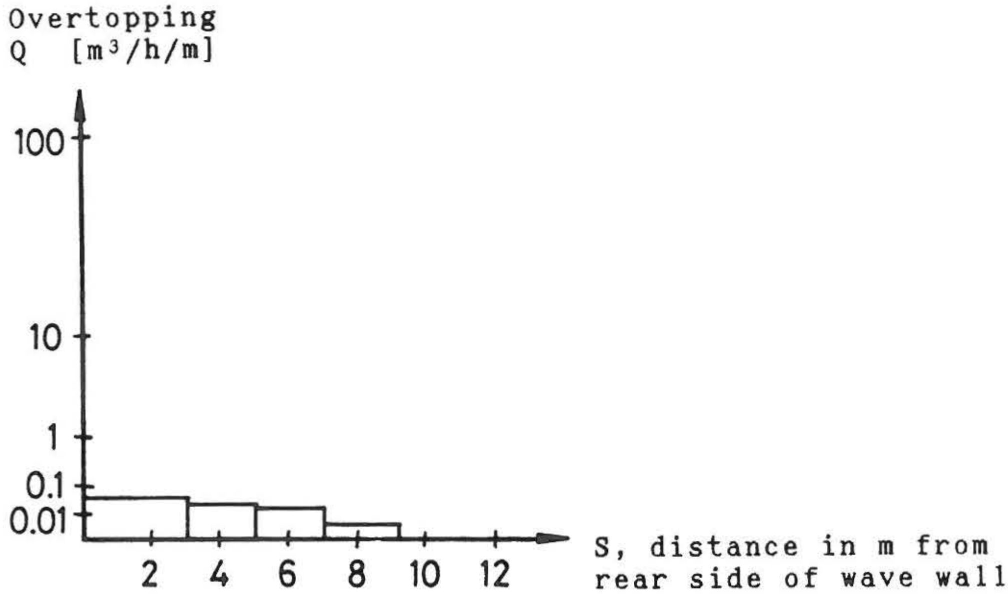


Figure 23. Overtopping for H_s = 4,22 m. and T_p = 5,59 sec.

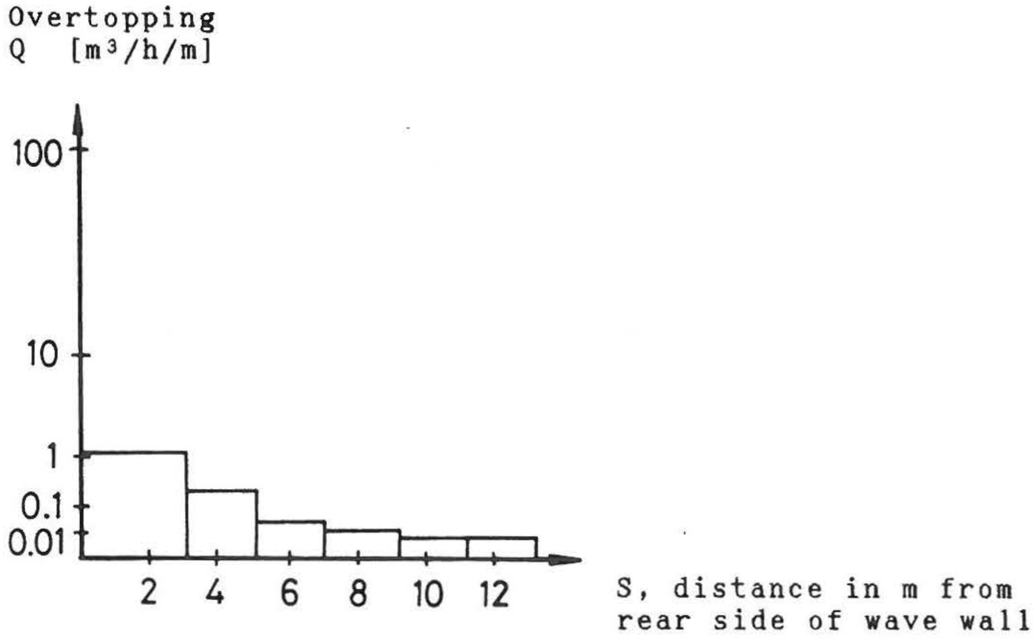


Figure 24. Overtopping for H_s = 3,50 m. and T_p = 7,92 sec.

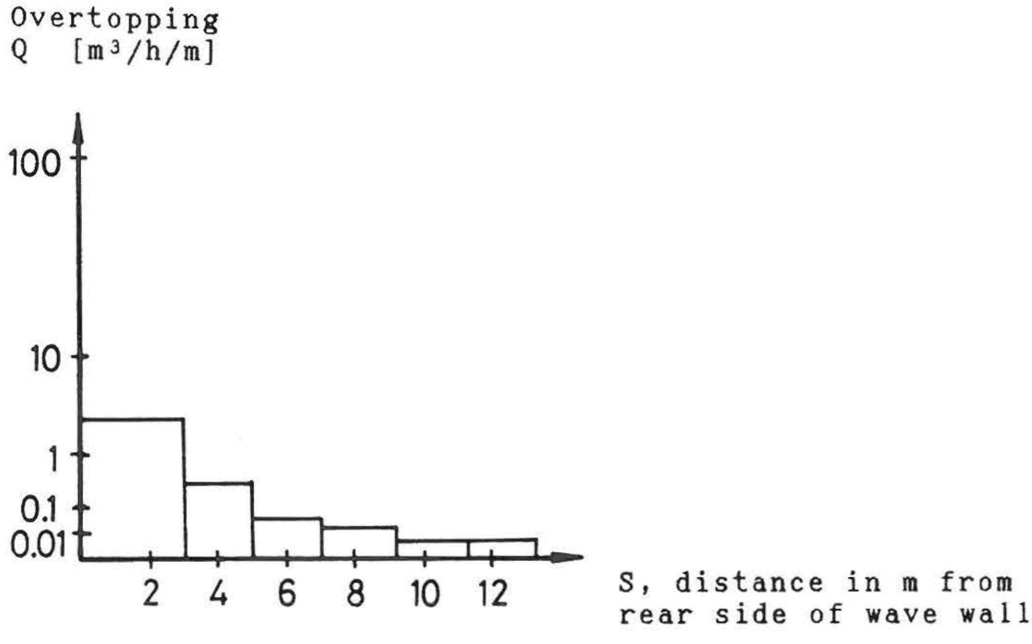


Figure 25. Overtopping for H_s = 4,12 m. T_p = 9,17 sec.

Water level +3,4 m.

By comparing Figs. 26-28 with Figs. 16-18 it is seen that the wavebreaker also for this water level has a very obvious effect. The overtopping is hereby reduced with 90 %.

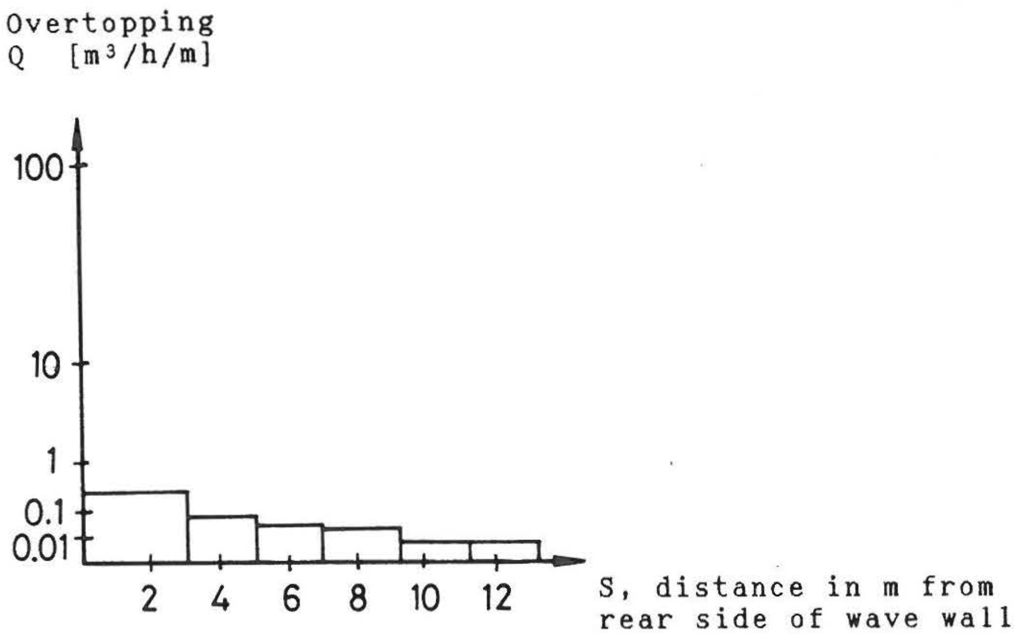


Figure 26. Overtopping for H_s = 2,34 m. and T_p = 6,17 sec.

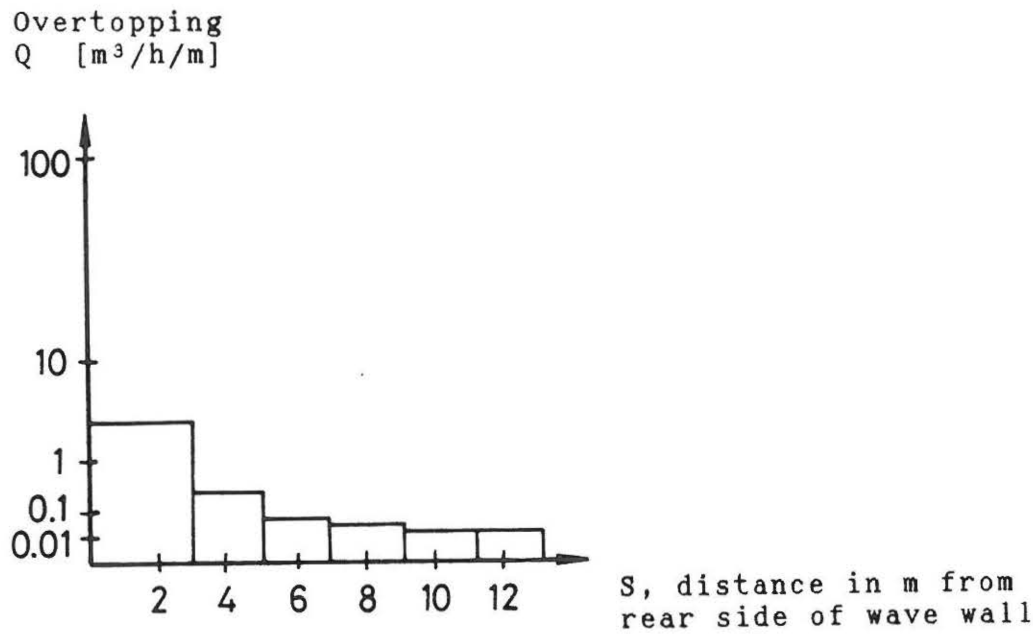


Figure 27. Overtopping for H_s = 2,33 m. and T_p = 7,92 sec.

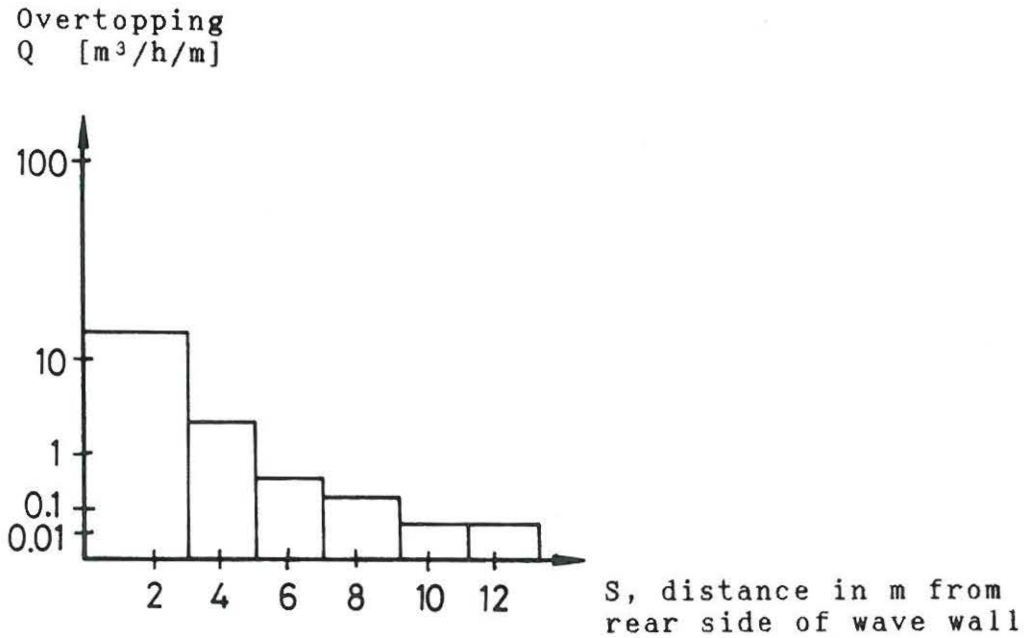


Figure 28. Overtopping for H_s = 2,39 m. and T_p = 9,17 sec.

The reason that the largest wave for waterlevel +3,4 m. is H_s = 2,5 m. is that it was not possible to measure the overtopping for waveheights larger than 2,5 m. This is because the first 2 trays were filled within 1-3 waves, and each bucket contains 4 l. which in prototype is the same as 32 m^3.

<u>Model 3:</u>

<u>Water level + 3,4 m.</u>

As it is seen from Figs. 29-34 the overtopping for this model is very dependent of the significant waveheigth. By comparing Figs. 29-31 with Figs. 26-28 it is seen that the effect of making the wavebreaker 1 m. higher is very obvious. The overtopping is hereby reduced with 75 % in relation to model 2. In relation to model 1 the overtopping is reduced with 99 %.

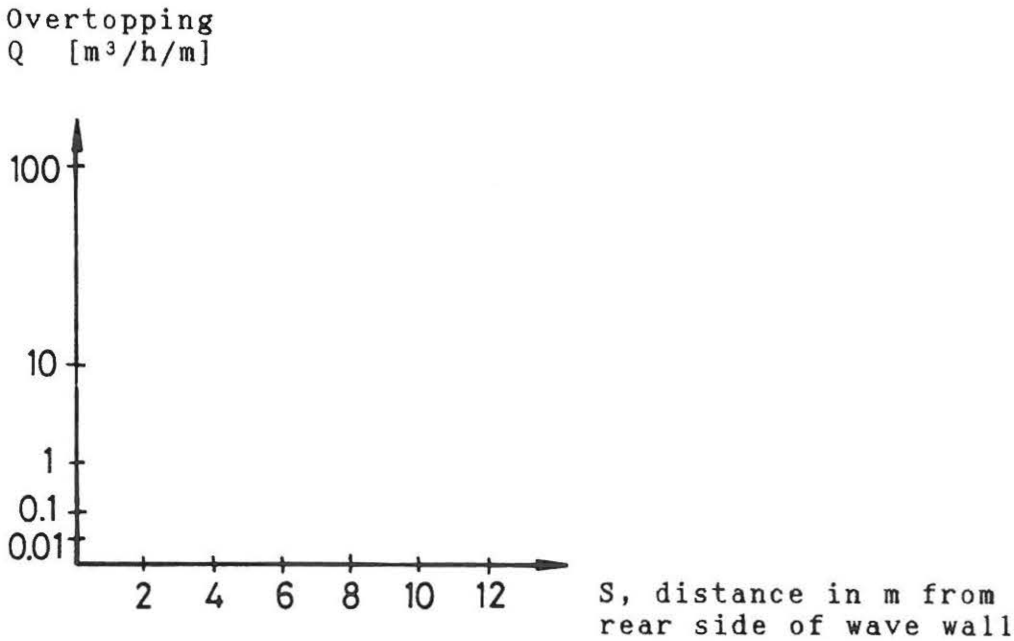


Figure 29. Overtopping for H_s = 2,36 m. T_p = 6,17 sec.

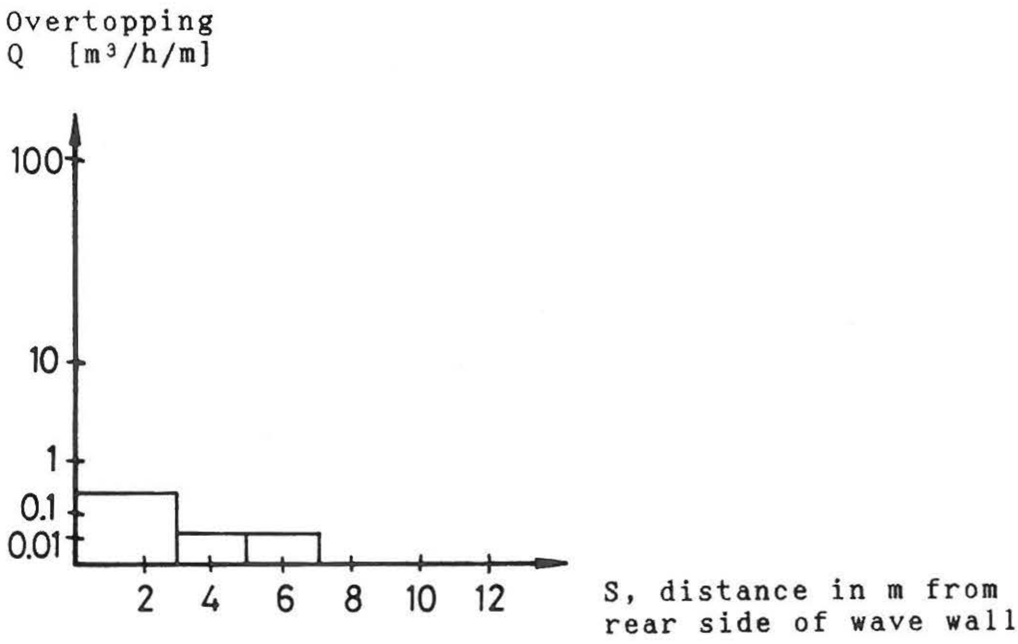


Figure 30. Overtopping for H_s = 2,40 m. and T_p = 7,51 sec.

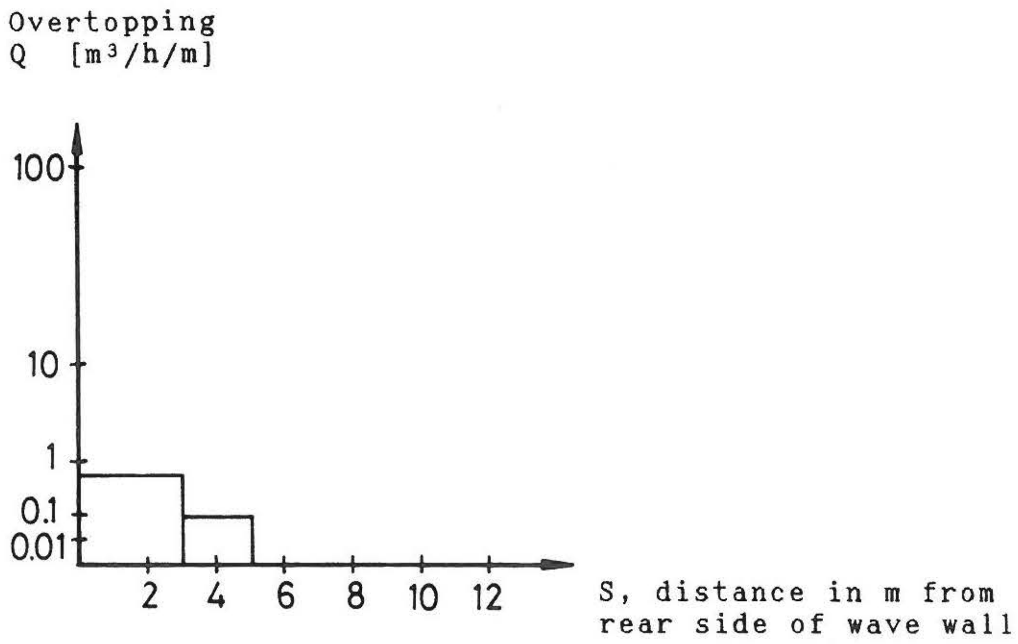


Figure 31. Overtopping for H_s = 2,23 m. T_p = 9,17 sec.

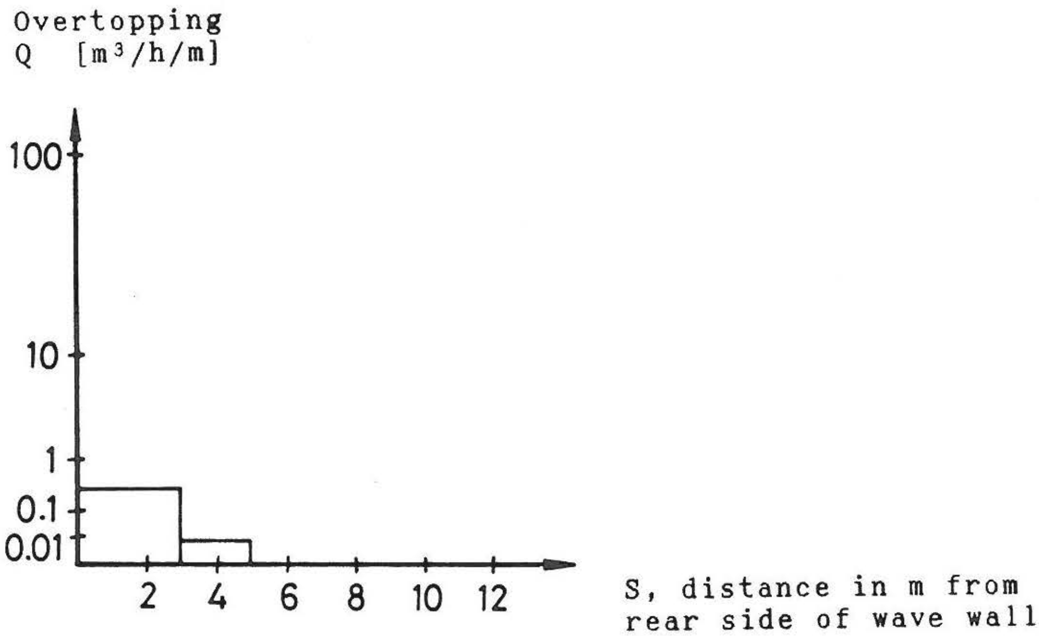


Figure 32. Overtopping for H_s = 3,23 m. and T_p = 6,17 sec.

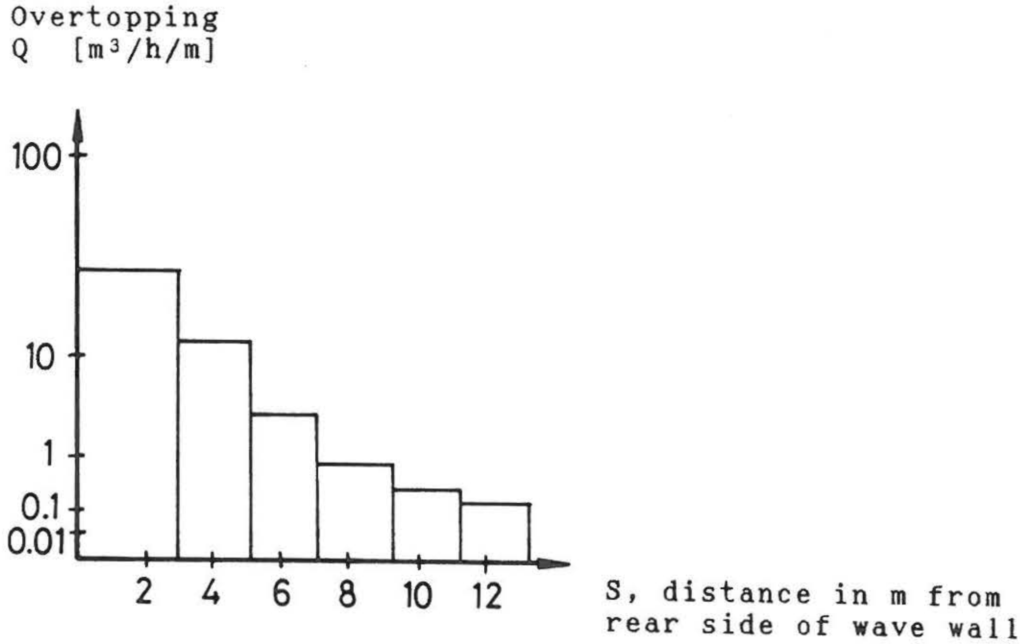


Figure 33. Overtopping for H_s = 3,71 m. T_p = 7,38 sec.

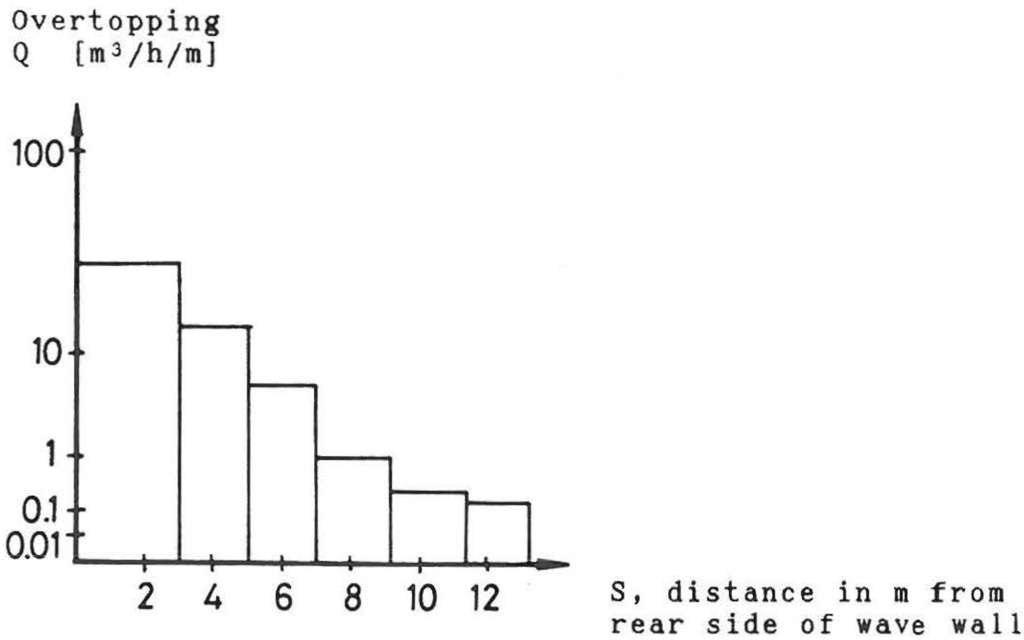


Figure 34. Overtopping for H_s = 3,19 m. and T_p = 9,17 sec.

For this model it was not possible to measure the overtopping for H_s > 3,5 m. since the buckets were filled within 1-2 waves.
The results of the model tests for model 3 is summarized in Fig. 35, which shows the overtopping dependency of the significant waveheigth and the peak period.

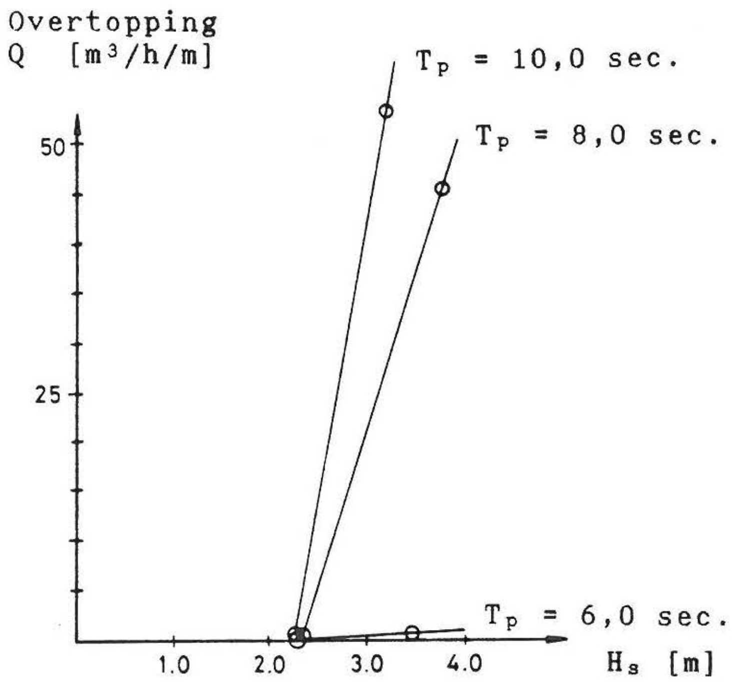
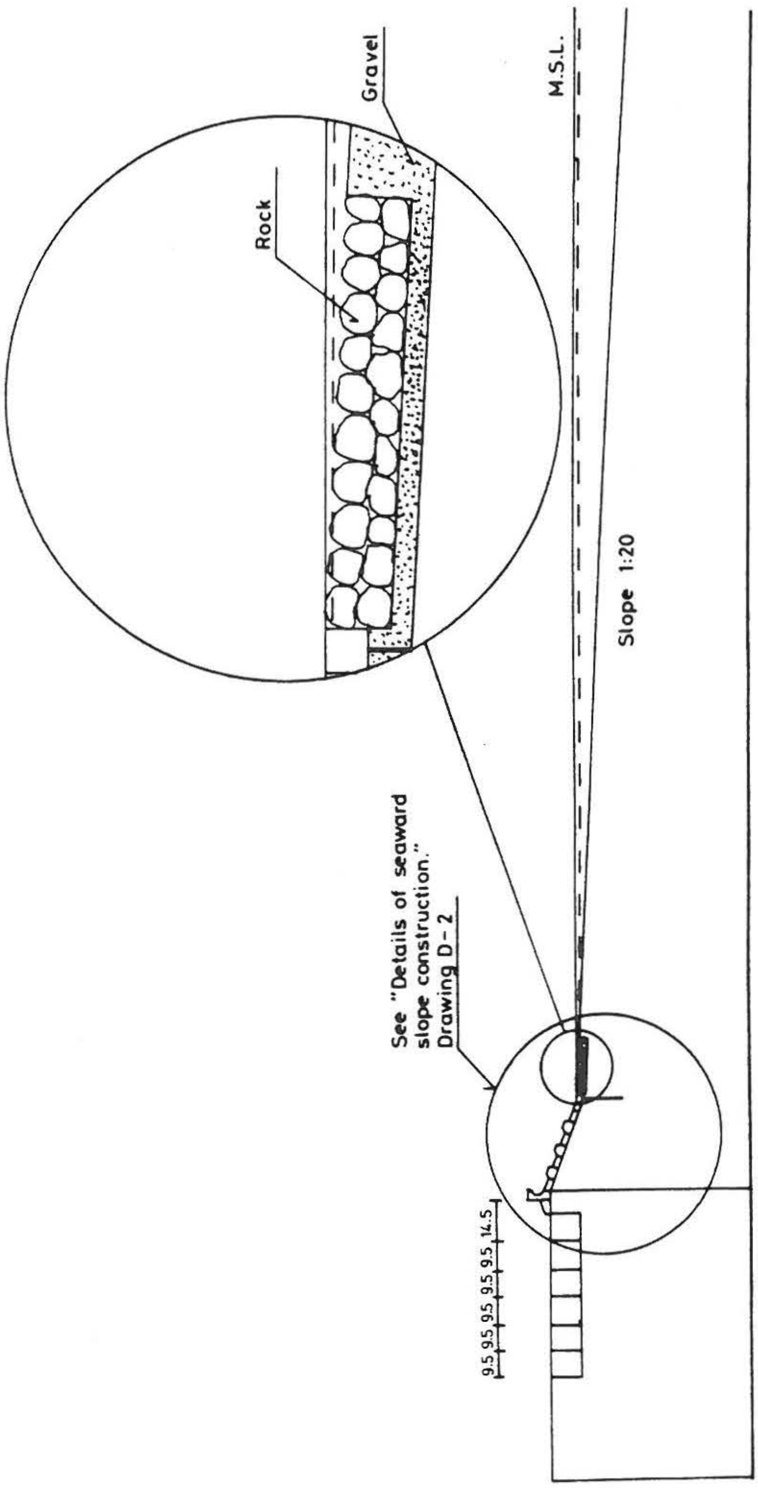


Figure 35. Overtopping at water level + 3,4.

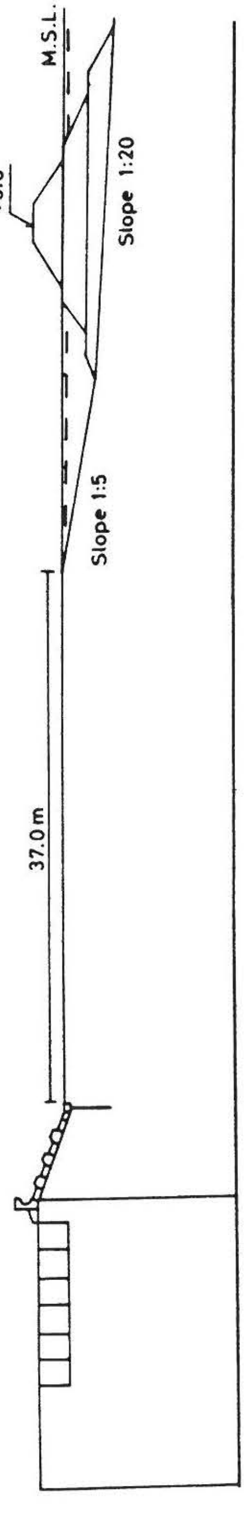
For all of the model tests it is obvious that detailled information about the run-up on the cornice is of no interest, since almost all of the waves hit the wave wall, at the top of the cornice.

Appendix 1.



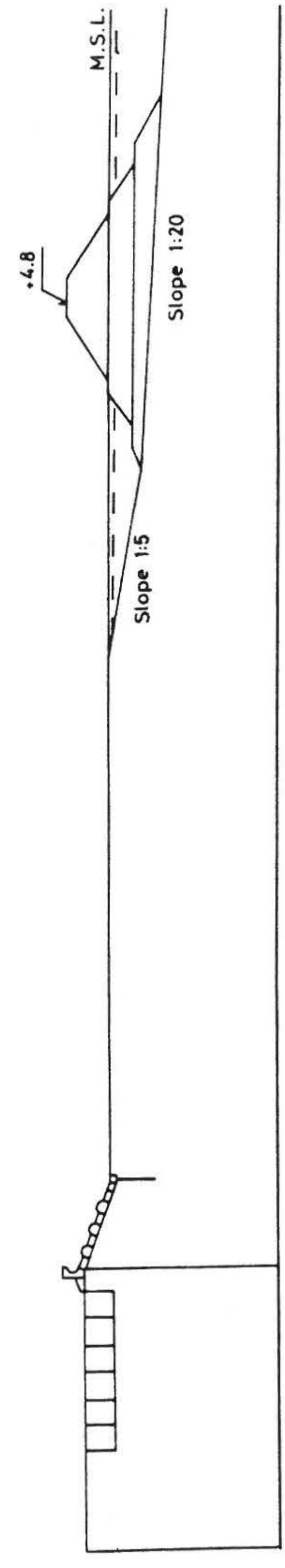
Drawing of model 1.

<u>Appendix 2.</u>



Drawing of model 2.

Appendix 3.



Drawing of model 3.

Appendix 4.

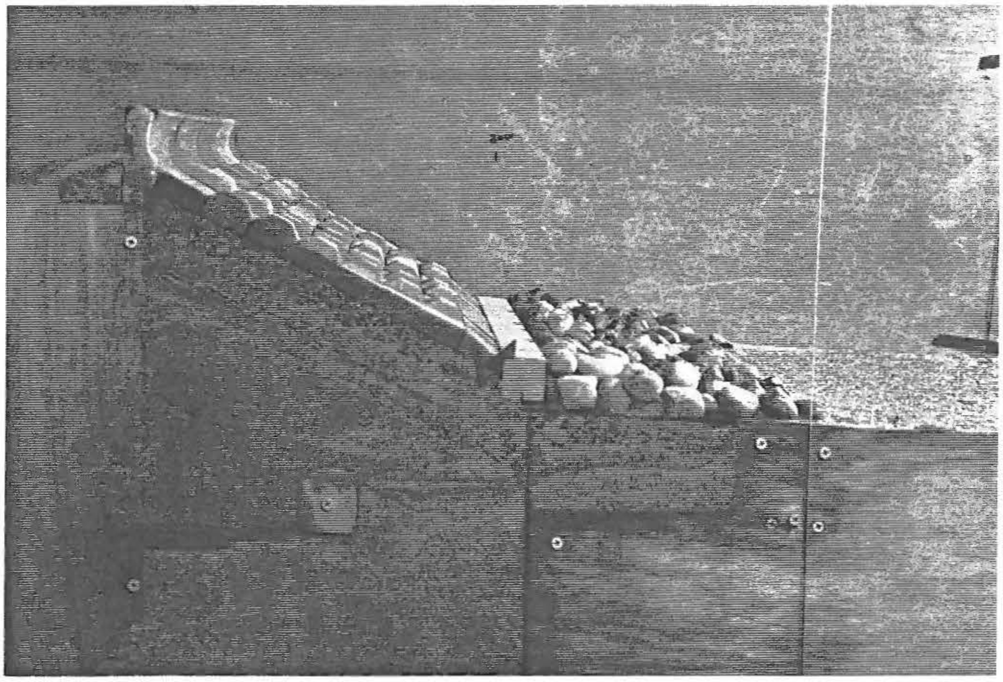


Photo of cut through the model.

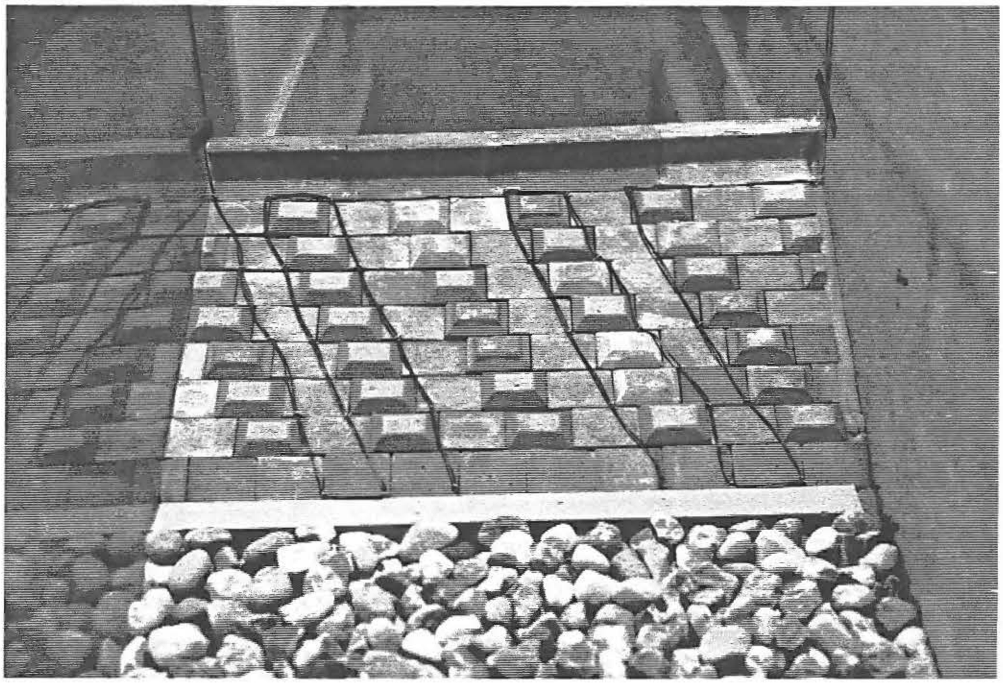


Photo of model seen form the seaward side.

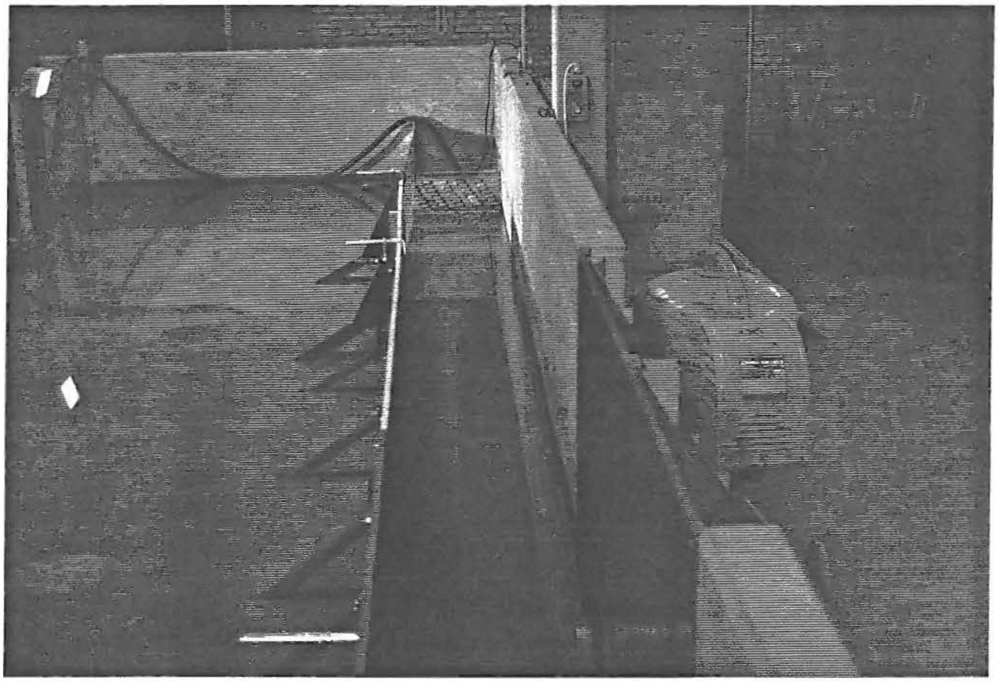


Photo of model 1, with slope seen from the seaward side.

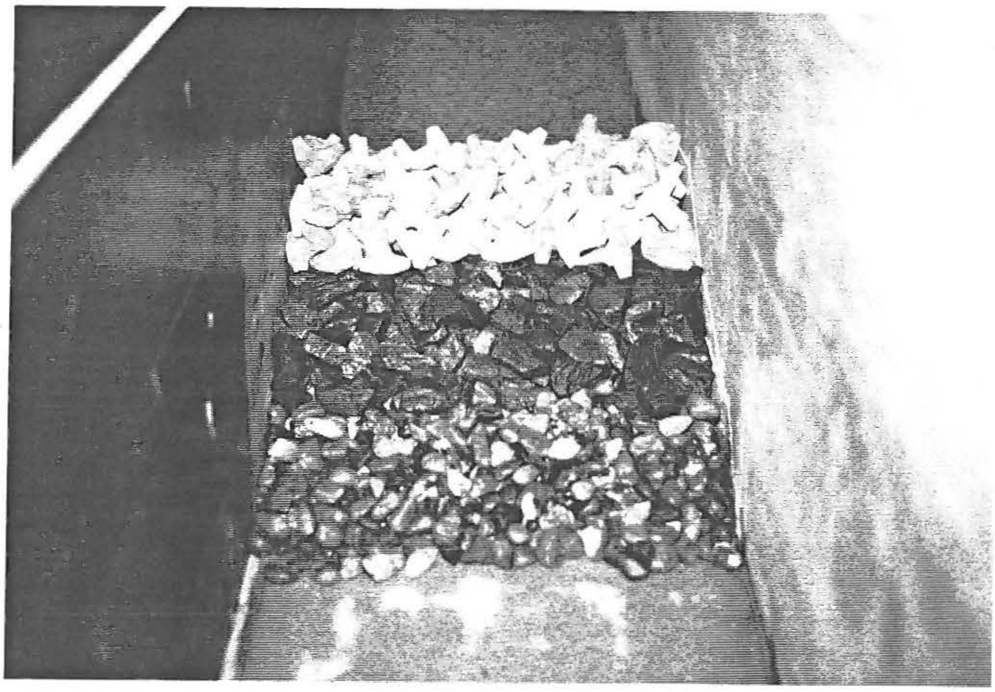


Photo of wavebreaker used in model 2 and 3.

Photo of model 2 and 3 seen form the saeward side.

Photo of overtopping for water level + 2,6, H_s = 4,0 m, T_p = 10,0 sec. in model 1.

Photo of overtopping for water level + 3,4, H_s = 4,0 m and T_p = 10,0 sec. in model 1.

Photo of overtopping for waterlevel + 3,4, H_s = 4,0 m. and T_p = 10,0 sec. in model 1 seen from the air.