PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
TECHNICAL UNIVERSITY OF NORWAY

DIFFRACTION BY BLOCK MOUND OR SUBMERGED BREAKWATER

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1 INTRODUCTION

Shallow water waves passing through block mound breakwaters or submerged breakwaters reciprocally interfere with the waves diffracted by the semi-infinitive breakwater or the breakwater with a single gap. The results of the researches concerning the rigid impervious breakwater up to now, therefore, sometimes cannot be adaptable in practice. The object of this experimental study is to know the effect of the water diffraction in the case of block mound breakwaters or submerged breakwaters. It was intended to make certain the phenomena which to be caused by transmitted waves in this case.

2 LABORATORY EQUIPMENT AND PROCEDURE

Experiments were performed on the case of semi-infinitive breakwater and block mound or submerged breakwater gaps in a plane wave tank. In carrying out the study, the four different waves were used on each case when the depth of water was the five different values. Strain gages were used for measuring the wave height and photographical method was also used. Model was constructed with 25 by 30 meters in size by motor in the plane wave tank. The water depth of model was 0.40 meters uniformly.

3 RESULTS OF MODEL TEST

1) Interfere regions between the diffracted waves and the transmitted waves.

In the zone of the geometric shadow of breakwaters as is shown in Fig.1, the transmitted waves passing through breakwaters interfere with the diffracted waves from the end or the gap of breakwater, and it can be seen that the eminent interfering regions are generated by phase difference. The position of the eminent interfering regions considerably varies with the rate of wave transmission, and it to be seen around when a height of transmitted wave, H_T nearly equals to diffracted wave, H_D , where the phase difference between diffracted waves and transmitted waves is 180° as shown in Fig.1.

For example, when X/L = 7L, where L is a length of the incident wave, co-ordinate, X is taken in the direction of the breakwater axis,

when H_T/H_0	= 0.4,	X/L = 2.6	3.0
"	= 0.6,	" = 2.3	2.8
"	= 0.8,	" = 1.2	1.5

2) The comparison of the diffraction coefficient K between the rigid impermeable breakwater and breakwater transmitting the waves. (see Fig.2-5)

The relations between the transmission coefficient and K are shown in Fig.3, and the relations between the gap width of breakwater, B and K, in Fig.4. The damping effect of diffraction wave height on the center line of the gap with the variation of gap width are shown in Fig.5.

a) The phenomena occuring in the direct zone of incident wave travel.

The value of K in case of a semi-infinitive breakwater is somewhat small as compared with that of general rigid impermeable breakwater. It seems that disturbance due to incident wave reflection at the site of breakwater end is small as compared with solid sea wall of breakwater. The value of K in case of the breakwater with a gap, however, is considerably large as compared with that of rigid impermeable breakwater and it seems to be caused by the interference of transmitted wave at the direct zone. When the value of H_T/H_0 (i.e. H_T) in case of the breakwater with a gap become large, the value of K is large as compared with that of impermeable breakwater, as shown in Fig.3. For instance, the comparisons of the value of K in both cases of the breakwater with a gap and the impermeable breakwater at X/L = 5 is as the following table.

H_T/H_0	K	K_o
0 (Impermeable Breakwater)	0.46	0.46
0.4	0.57	"
0.6	0.70	"
0.8	0.90	"

As regards the value of K influenced by the variation of gap B, it can be seen that the value of K becomes large in proportion to the width of gap, B in both cases of impermeable breakwater and that with a gap (see Fig.4) and the value of K in case of a breakwater with a gap is generally larger than that in case of the impermeable breakwater by 0.2 to 0.4. (see Fig.5)

b) The phenomena occuring in the geometric shadow of the breakwater.

The value of K in both cases of semi-infinitive breakwater and that with a gap is small as compared with that of general impermeable breakwaters. It seems that the transmitted wave at the geometric shadow zone interferes with the diffracted wave. Test are shown, however, that the K value does not vary with construction structure of breakwater when $H_T/H_0 \leq 0.02$.

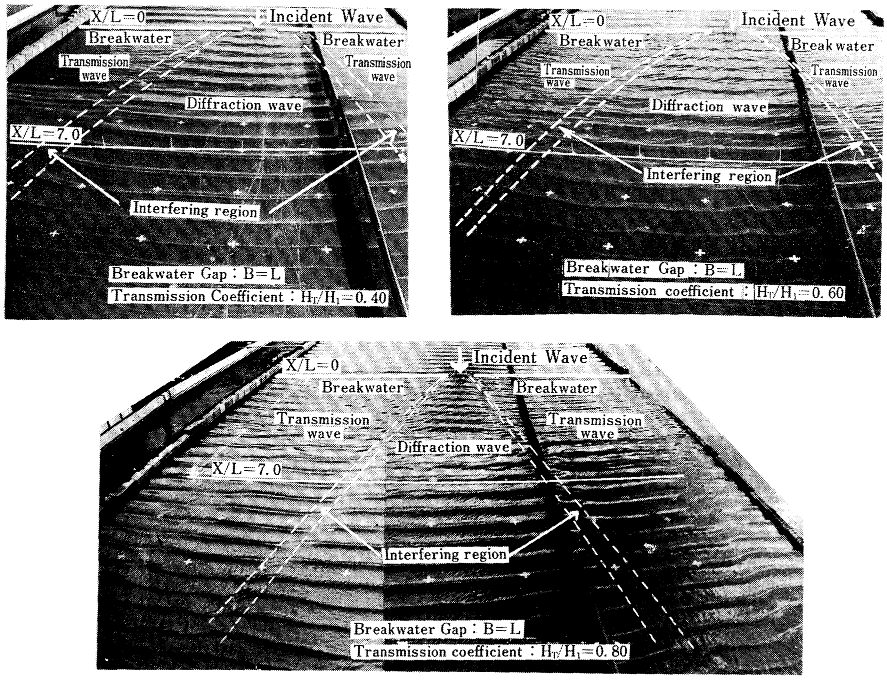


Fig. 1 Interfere regions between the diffracted waves and the transmitted waves.

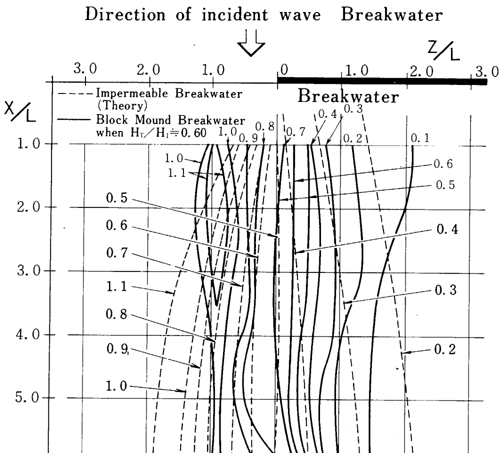
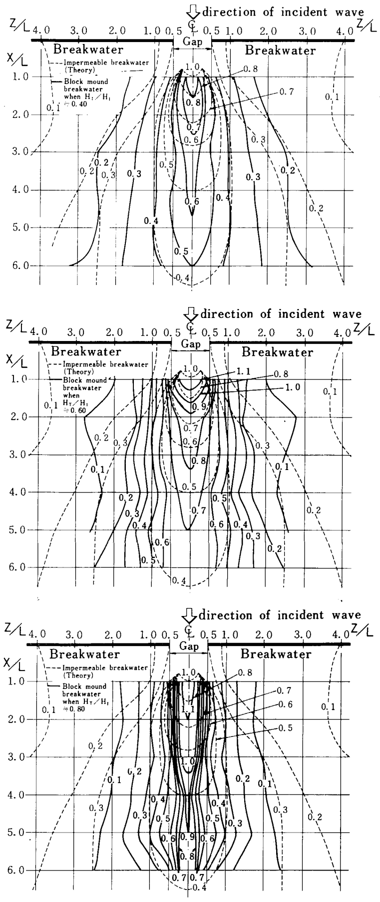


Fig. 2. Comparision of a experimental diffraction coefficient for a rigid impermeable break-water and block mound breakwater in case of a semi-infinited breakwater (contours of equal diffraction coefficient : K)



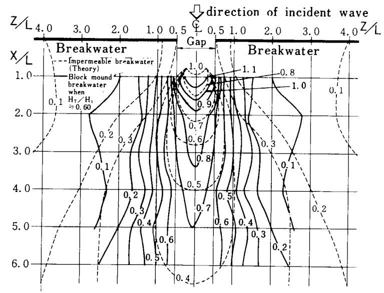


Fig. 3. Comparison of a experimental diffraction coefficient a rigid impermeable breakwater gap and block mound breakwater gap (contours of egual diffraction coefficient)
B : breakwater gap mesured in wave length (L)
K : diffraction coefficient

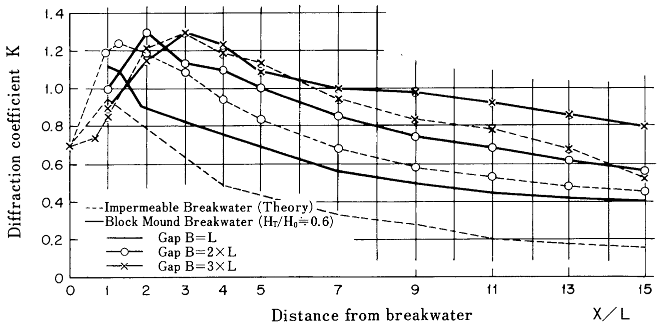


Fig. 5 Comparision of a experimental diffraction coefficient on the centerline of a rigid impermeable breakwater gap and block mound breakwater gap.
B : breakwater gap mesured in wave levgth (L)

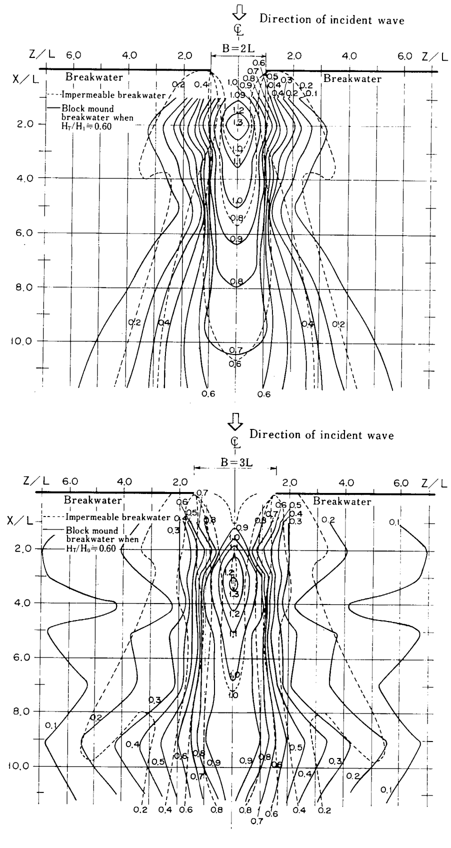


Fig. 4 Diffraction of waves at breakwater gap
— contours of equal diffraction coefficient.

QUESTION by Mr. L.C.S. Kobus, Zapata Offshore Company, Houston,
Texas, USA,
to
Mr. L. Draper, National Institute of Oceanography,
Wormley, Godalming, England
and
Sen.Res.Eng. J.A. Battjes, Delft University of Technology,
Delft, The Netherlands.

Are we really justified in projecting the maximum wave probability curves beyond the limit or range the data (recorded) points since the 50, 100, 25 year intercepts are so sensitive to the almost arbitrary extension of the data curve ?

ANSWER by Mr. L. Draper:

Until such time as we have, for example, 50 years' data we will have to make the best possible estimate. This must be based in part on the records, and if a way can be found to express them in a well-behaved manner it is reasonable to extrapolate them just to see if an acceptable figure can be derived. There is no compulsion to use the result, but it would be unforgivable not to try.

QUESTION by Sen.Proj.Eng. C.C. Anderson, Phillips Petroleum Co., Stavanger, Norway,
to
Mr. L. Draper, National Institute of Oceanography, Wormley, Godalming, England.

What justification is there for extrapolating wave heights on a straight line basis ?

There is a point where the wind will blow the tops off the waves or the waves will collapse of their own weight. Other factors such as fetch and depth of water will affect wave height. Have these factors been taken into account ?

ANSWER by Mr. L. Draper:

The whole procedure is non-linear, and tops can be blown off when waves are only a few feet high. Even so, it is possible to plot the data in a form which yields a straight or slightly curved line, so this is extrapolated in a way which fits the data in the best possible way. At any one measurement point the fetches and water depths are constant, and so they are of necessity taken into account for that data by virtue of having measured at that point. For other locations, even fairly close ones, these factors must be looked at very carefully.