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Experimental investigation of wave parameters effect on damage of the berm reshaped seawall under irregular wave attack

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ABSTRACT: This paper presents an experimental study the influence of wave parameter on the damage of reshaping seawall, model tests have been performed in several water level conditions. The experiments of physical modeling of this research have been done in the flume of the Soil Conservation and Watershed Management Research Institute (SCWMRI). The waves applied to the structure model are irregular and the energy spectrum of the applied waves is JONSWAP. The material of arm our layer have been regarded with the scale of 1:25 model and grading class of D_{85}/D_{15}=1.82. A number of 3000 waves were applied on the structure over the research in general and some 60 experiments have been totally accomplished. The results of tests after drawing graphs, has been analyzed. That it can be harvested with %82 increasing in wave steepness, damage parameter %85 decreased and also with %57 increasing in wave height, the damage parameter %87 increases and with %57 increasing in wave length, the damage will %83 increase.

Keywords: *Damage; Reshaping Seawall; Berm Seawall; Wave Parameters*

INTRODUCTION

Seawalls are the structures built in parallel and near coastline to protect seaside buildings and installations. Seawalls are categorized according to their shape and materials used in them, such as rubble mound seawalls.

Rubble mound seawalls are also divided into two groups, statically stable non-reshaped and dynamically stable reshaped. Picture1 shows a sample of bemire shaping seawall.

Using reshaping seawalls is prior to traditional seawalls because it's possible to use lighter materials and more expanded grading class to reshaping of the structure. Therefore it's practicable to use barrow materials so as to construct them. It's also possible to use simpler methods and lighter and more available tools.

Structural parameters

1. Damage parameter

There are several parameters to describe the behavior of structural damage, one of which is variable. Baird and Hall (1984) damage parameter to be defined this way:

$$S_d = \frac{A_e}{D_{n50}^2}\,,\ D_{n50} = \left(\frac{W_{50}}{\rho_a g}\right)^{1/3} \qquad (1)$$

In the above equation, A_e the surface is eroded and the D_{n50} no mina diameter of arm our rock, W_{50} medium weight of unit given by 50% on weight distribution curve.

2. Dynamical stability parameter

Stability parameter is the most important parameter that shows the relations between a seawalls structure and waves. Basically seaside structure such as breakwaters and seawalls categorized according to these parameters (Van der Meer, 1988).

$$H_o T_o = \frac{\mathrm{H_s}}{\Delta D_{n50}} \times T_m \times \left(\frac{g}{D_{n50}}\right)^{0.5} \qquad (2)$$

Parametersof the above formula are
$\mathrm{H_s}$ = significant wave high
Δ= relative buoyant density ofamour
ρ_a = mass density of rock
ρ = mass density of water

Previous research

Sayao (1999) analyzed the reshaping profile of reshaped breakwaters by a series of physical model experiments. The results show that Iri barren number has a great effect on the profile.

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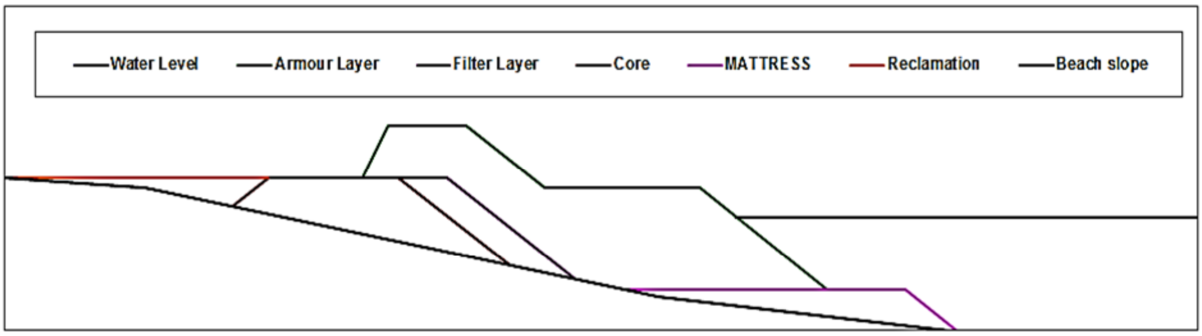

Fig. 1: Berm reshaped seawall

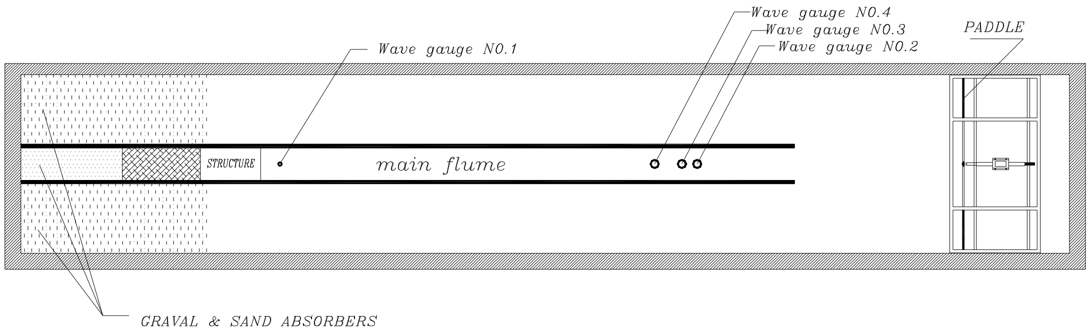

Fig. 2: Plan view of the wave flume and setup of wave height meters

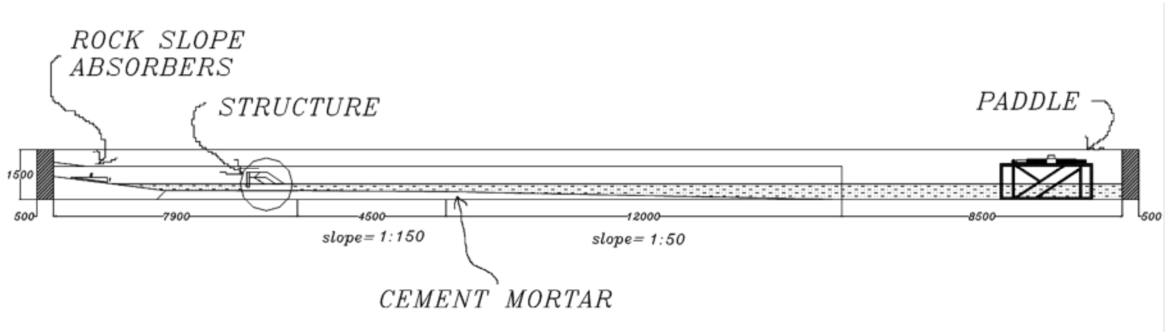

Fig. 3: Cross section of the wave flume

Torum *et al.* (2002) also performed extensive experiments on that kind of breakwaters and managed to produce a relation for receding rate (degree) of a berm in forming final stable profile. In the relations, they added some sentences including the effect of the grading coefficient and depth coefficient to their relations.

Rao *et al.* (2003) found out that as rubbles grow smaller, the amount of damage is more extensive. Using damage leveland10% and 30% reduction of rubble weight, they proved that there's a sight relation between the increasing of stability parameter and the increasing damage level.

Aghtoman *et al.* (2005) presented an arm our layer thickness design instruction on reshaping breakwaters.

Aghtoman *et al.* (2011) studied the effects of reshaping breakwater berm width on their final reshaping.

MATERIALS AND METHODS

The present research has been carried out using the results of hydraulic model tests accomplished in the wave flume of Soil Conservation and Watershed Management Center.

A large number of tests were performed in the wave flume and the wave basin of this laboratory. The wave flume of SCWMRI has a length of 33m, a width of 5.5m and a depth of 1.5m. This flume is divided into three parts longitudinally. The model tests were performed in the middle part of the flume. The wave basin of SCWMRI has a length of 27m, a width of 16m and a depth of 1m. All the tests were performed using irregular waves (JONSWAP). To conduct the experiments, four wave gauges, which have been fixed in different places, are used.

The wave height spread of between 8 and 14 and maximum period between 1.2 to 2.8 seconds have been used in the model. And totally 60 experiment, each of which and consists 3000 waves, have been conducted. In all experiments, structure profile has been recorded both the experiment and after the wave attack.

Dimensional analysis

In order to achieve these goals, beginning to understand the various parameters that are effective in changing the structure of the action and overall relationship with the dimensional analysis of dimensionless parameters were extracted.

$$F(H_s, L_p, A_e, g, D_{n50}, V_w, \mu, \rho_a, \rho_w)$$

$$S_d = \frac{A_e}{D_{n50}^2} = f\left(\frac{H_s}{D_{n50}}, R_e, \frac{H_s}{L_p}, \frac{L_p}{D_{n50}}, H_o T_o\right) \quad (3)$$

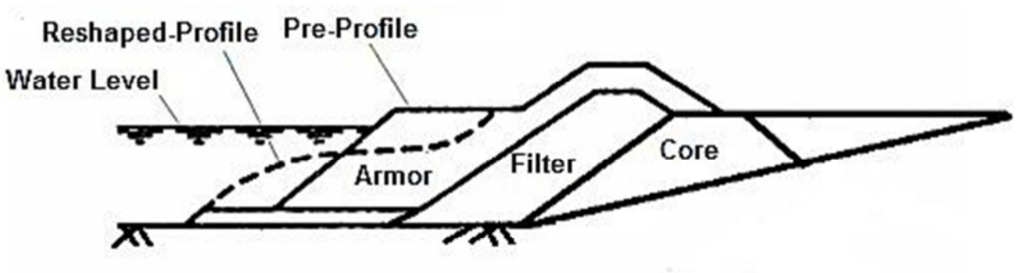

Fig. 4: physical modeling of berm reshaping seawall

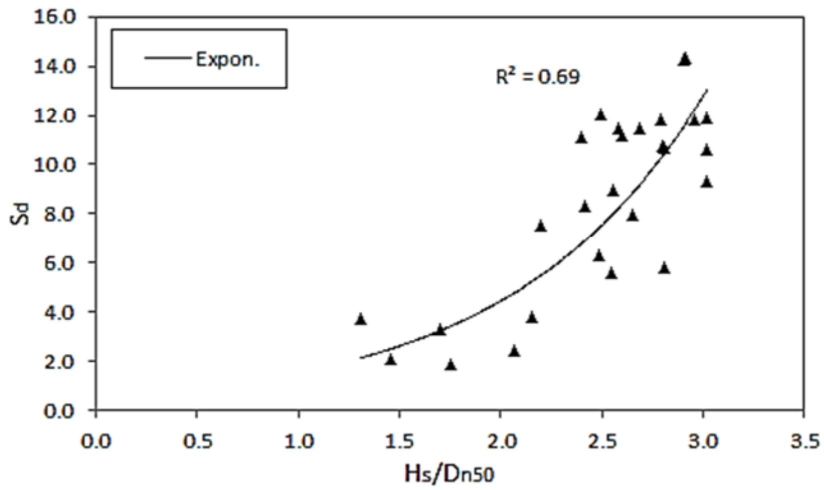

Fig. 5: damage parameter diagram against significant wave height

Table 1: Range of parameters available

Parameter	symbol	range
High wave	H_s	8-14(cm)
Maximum period wave	T_p	1.2-2.8(s)
Water level	D	18.2-20.8(cm)

RESULTS AND DISCUSSION

The results of tests after drawing diagrams, been analyzed and the effects of wave parameters on seawall reshaping of the profile is to be reviewed.

Damage parameter diagram are presented according to significant wave height in Fig. 5.

That it can be harvested with %57 increasing in wave height, the damage parameter %87 increases.

In Fig. 6, Damage parameter diagramis draw againstmaximum length wave.

That it can be harvested with %57 increasing in wave length, the damage will %83 increase.

Fig. 7 shows to relation between damage parameter and maximum wave steepness

That it can be harvested with %82 increasing in wave steepness, damage parameter %85 decreased.

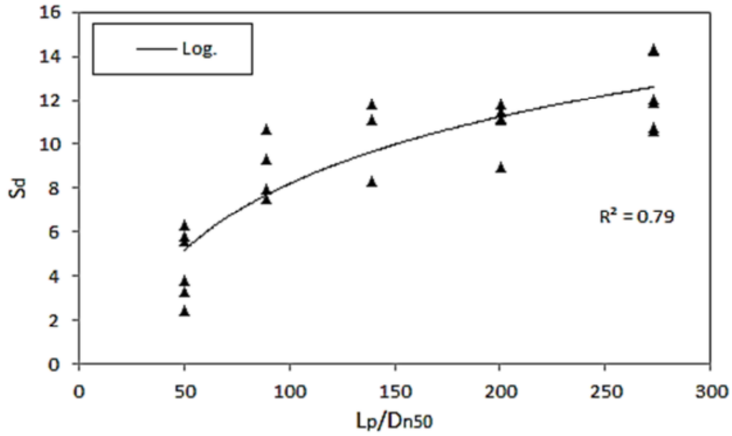

Fig. 6: damage parameter diagram against maximum length wave

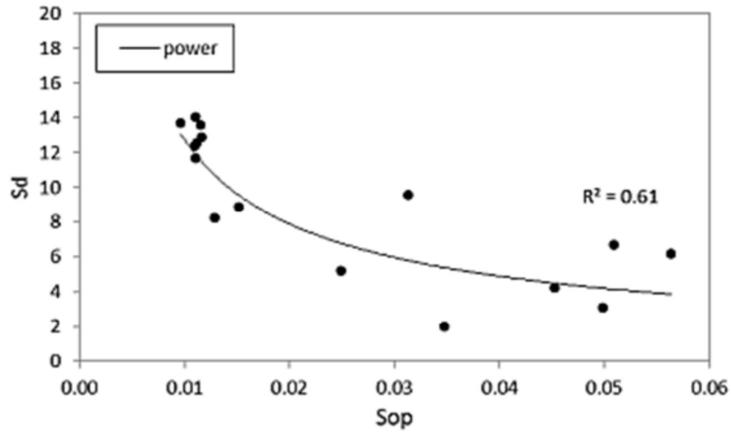

Fig. 7: damage parameter diagram against maximum wave steepness

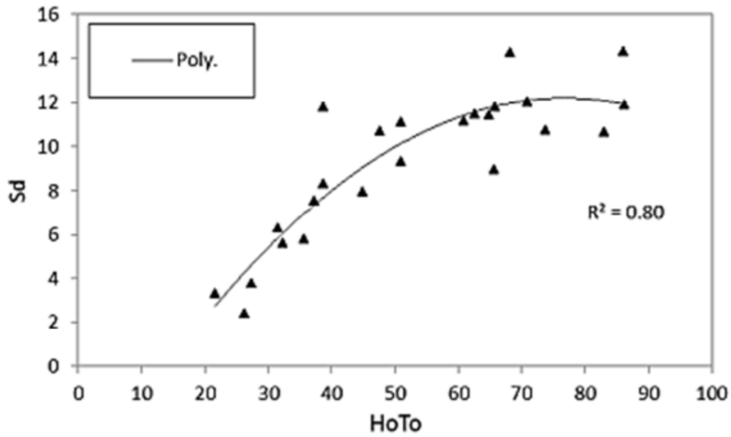

Fig. 8: damage parameter diagram against stability parameter

With increasing dynamical stability parameter, first damage parameter Increase then be fixed.

CONCLUSION

That can be harvested Damage parameters decrease with increasing wave steepness, with wave height and wavelength increases damage parameter increases. Increasing wave height and wavelength, the more energy the structures into which destroyed most of the structure and thus the damage parameter is increased. It can be stated that with increasing wave steepness, wave down before reaching structural damage to the structure is less.

With accordance dimensional analysis was performed, In order to study the effective interaction parameters are extracted on the eroded surface of provide a mathematical relationship between the expected values for the pre of using multivariate linear regression statistical software (Spss 18) was used and the following relationship was obtained after analyzing several.

$$S_d = -0.004(H_oT_o)^2 + 0.59H_oT_o - 2.44f_d$$
$$f_d = -0.16\frac{d}{D_{n50}} + 4 \qquad (4)$$
$$R^2 = 0.87$$

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