Retraction Notice

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Expression of Concern:
☐ yes, date: yyyy-mm-dd
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Correction:
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Comment:

The paper is withdrawn from "Open Journal of Marine Science" due to personal reasons from the corresponding author of this paper.

This article has been retracted to straighten the academic record. In making this decision the Editorial Board follows COPE's Retraction Guidelines. The aim is to promote the circulation of scientific research by offering an ideal research publication platform with due consideration of internationally accepted standards on publication ethics. The Editorial Board would like to extend its sincere apologies for any inconvenience this retraction may have caused.

Editor guiding this retraction: Prof. David Alberto Salas-de-León (EiC of OJMS)

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Wave Run-Up and Surface Stress on a Permeable Coastal Bed

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Abstract

This research aims to consider the permeability effect of shore bed on the wave run-up and Eulerian schematic of the trajectory contours and the fluid movement path in a permeable bed, using experimental method. All experiments have been conducted at the wave laboratory of soil conservation and watershed management research center. As known, the general characteristics of trajectory depend on the kind of bed structure. Based on the bed structure, 3 parameters including: the bed shear tension, velocity profile and the permeation velocity, could be changeable. While, because of the head increasing, the fluid penetrates bed, and consequently the suction phase happens within the bed, through this condition the trajectory contours approach the bed and the mean velocity accelerates near the bed, and then the tension rises about 2.5 times. Because of the head decreasing, the fluid permeates out from the bed and the injection phase happens, so that the trajectory contours get away from the bed and the mean velocity falls down near the bed, so the tension slakes about 70%. To study the permeability effect of shore bed on the wave run-up, 5 waves with a sharpness which ranges from 0.05 to 0.015 in the deep water have been generated orderly. The wave run-up has been measured using the wave height recorders which have been installed on a ramped shore with a constant slop of ¼. By using a camera under water and also coulor injection into the bed, the trajectory contours and movement path of fluid in 3 various permeability ranges have been drawn. Meantime, the flow velocity is estimated in two positions including near the bed surface and the bed deep. Through the relative non-dimensional permeation velocity ($V = W/U$), it is shown that in a given wave frequency, by increasing V_S in the suction phase, the tension imposed on the bed is risen up, whiles by increasing the relative velocity (V_i) in injection phase, the tension imposed on the bed is fallen down.

Keywords

Permeable Bed, Wave Run-Up and Run-Down, Surface Stress, Injection and Suction

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1. Introduction

A Fluid current depends on the bed permeability over a porous surface such as, sandy bed. For calculation of the bed permeability, the hydraulic conductivity of bed sediments and hydraulic gradient of fluid are of high importance. Conley and Inman (1992) [1] have done some field studies about the effects of bed structure on the wave behavior, also they found that the formation of the shore bed depends on the tension variations. The effect of bed permeability on wave characteristics over a shore has been studied by Conley and Inman (1994) [2]. One of the results derived by analysis of water flows over a permeable bed that is conducted by Conley and Inman (1994) [2], has been shown in Figure 1.

Regarding this graphic, it is notable that the high suction velocity could lead to increase the tension imposed on the bed and conversely, through the high injection velocity, the tension could be decreased near the bed. Meantime, the suction velocity indicates a direct connection to the permeability of bed and pressure gradient, whiles there is a converse relation with the fluid viscosity. Conley and Inman's experiment is done on a horizontal bed through fluctuation of the fluid head, with a constant frequency [3].

Antonia *et al.* (1990) [4] conducted some researches on the effect of surface suction to vortex boundary layer and separation event. Villarroel-Lamb *et al.* (2014) [5] conducted the series of experiments through a Hunt-type run up formulation and indicated that there is a clear relationship between bed permeability and the maximum wave run-up. Hughes (2004) [6] developed a study to provide an estimation technique that was as good as existing formulas for breaking wave run-up and better at estimating nonbreaking wave run-up. For irregular waves breaking on the slope, a single formula for the 2% run-up elevation proved sufficient for all slopes in the range $2.3 \le \tan\alpha \le 1.3$.

This experiment investigates the effects of suction and injection phases on the surface tension of a ramped bed affected by run-up and rundown. These effects on the wave run-up also are considered.

According to this fact that in the experimental models to determine the extent of run-up and rundown, and in general the hydraulic reactions of breakwaters and shore

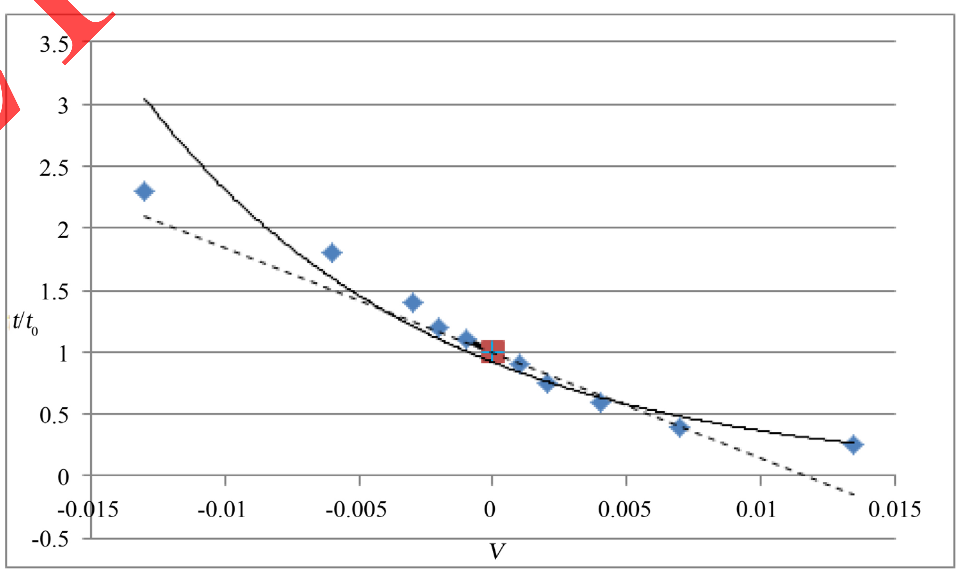

Figure 1. The results derived by Conley's and Inman's research (1994).

structures, the permeability of bed is assumed to be ignorable because of the selection of scales between 30 - 50, thus, conducting such experiments in order to consider the effects of the bed permeability could be necessary.

2. Physical Foundations of Wave Run-Up

While the waves approach to the shallow zone of sea (near the shoreline), they rise and consequently breakdown after collision to the shoreline. Following the wave-break, and the resulted balance with hydrostatic force, the water surface gets raised. The rising of water surface is called a wave event.

Hence, there is a constant Head (π_{wave}) at the shore side versus the water table (Figure 2), in this case, the mean water level gets higher than the water table [7] [8] [9] [10].

The run-up hydraulic reaction of wave occurs during the wave collision to the shoreline. At this moment, the waves-because of having the kinetic energy-climb the ramped shore, and so, the vertical distance of water level fluctuation on top of the water table, is the so called the wave run-up (Figure 3(a)).

When, the kinetic energy fall to zero , by the existing potential energy and the fluid integration, the wave moves downward from shoreline and the hydraulic reaction of wave rundown occurs. The vertical distance of water level fluctuation under the water table, is the so called the wave rundown (Figure 3(b)).

Wave run-up and rundown impose the positive and negative pressure on the shore bed respectively. In the case the bed is permeable, through the wave movement toward shore and the hydraulic reactions of wave run-up and rundown on the ramped shore, some currents could be generated within the shore bed. The above mentioned currents penetrate the bed, but the interactions with the objects over the bed and the consequent damping, limit their penetration by a certain deep. The water pressure gradient is considered the cause of above current, and the generated velocity gradient will be different based on the bed gradation and permeability. Friction of shore currents by the bed permeability leads to lose the wave energy as reduction of run-up and rundown and also manner of wave break.

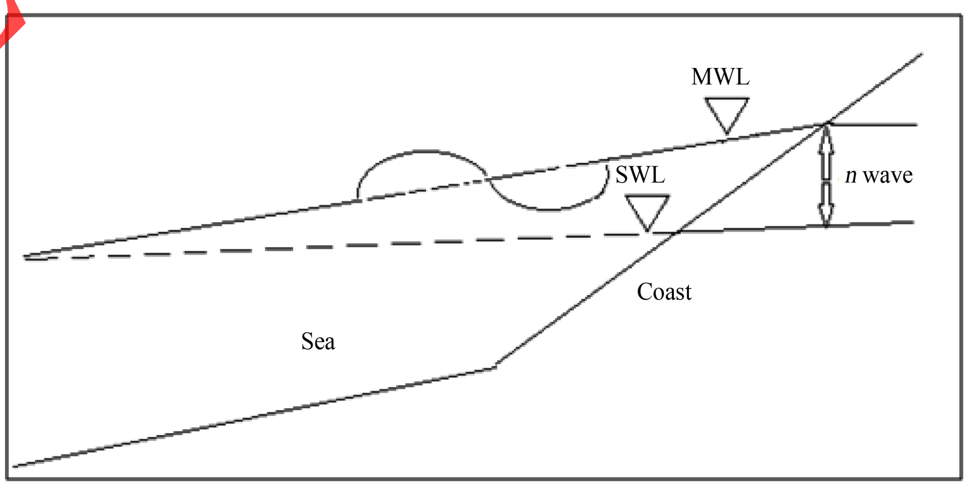

Figure 2. Wave run-up.

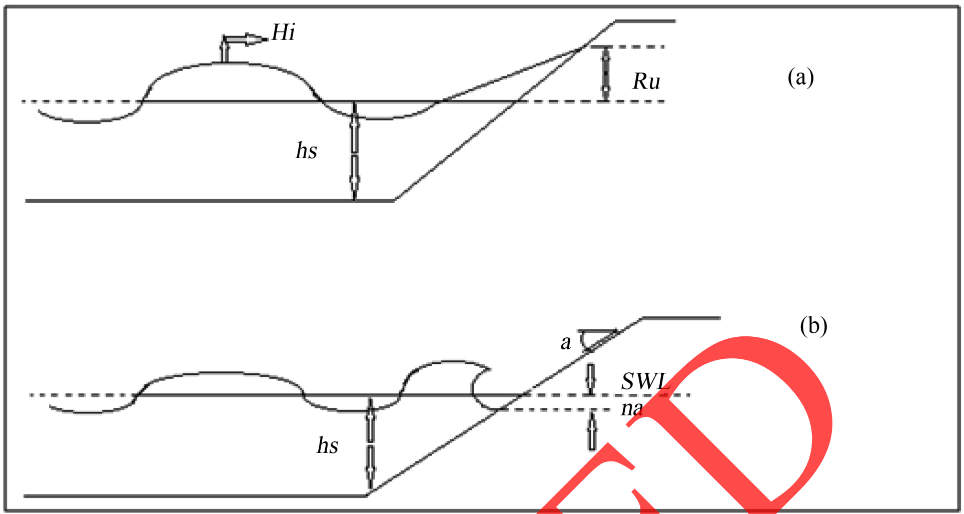

Figure 3. (a) Wave run-up, (b) wave run-down.

To show the manner of wave break and the wave interaction with the ramped shore, the similarity parameter of wave break or the non-dimensional number of Airybaren has been used (Figure 4).

The similarity parameter of break is defined as follows: $\xi = \frac{\tan a}{\sqrt{S}}$.

In the above equation, "S" as the sharpness of wave is defined by the following relation: $S = \frac{H}{L}$, and here "H" is the height of wave and "L" is the length of wave.

3. The Steps of Experiment

To consider the permeability effect of shore bed on hydraulic reactions of wave, the laboratory model has been applied. The experiments have been conducted at the wave laboratory of soil conservation and watershed management research center. The wave flume dimensions are as follows: 35 m length, 5.5 m width and 1m depth. In order to prevent production of the horizontal waves, the flume is divided into 3 sections so that the middle flume has 24 m length, 1 m width and 1 m depth. All exercises have been done on an artificial shore at the outset of middle flume. The waves are generated by using a piston paddle installed at the end of flume. The artificial shore has been made inside a box with dimensions of 2 m length, 1m width and 0.45 m depth and a constant slop of 1/4. This box is filled by the gravels with different permeability as the representative of materials on shore [11] [12]. The sandy and gravel materials are taken in consideration based on the soil mechanic experiments by 3 different permeabilitys (including 3 water conductivity coefficients: 0.083, 0.080 and 0.079 cm/s). Meanwhile, to have a comparison, all experiments have been repeated on the impermeable bed also. During the exercises, 5 waves have been generated and moved towards the artificial shore. The waves which hit the shore have sharpness ranges from 0.015 to 0.05. During the interaction of wave and shore, a camera has been installed under water on the shore bed, to track and record the fluid current which is colored. The velocity of the current has been estimated by measuring the relation between time and distance of the current

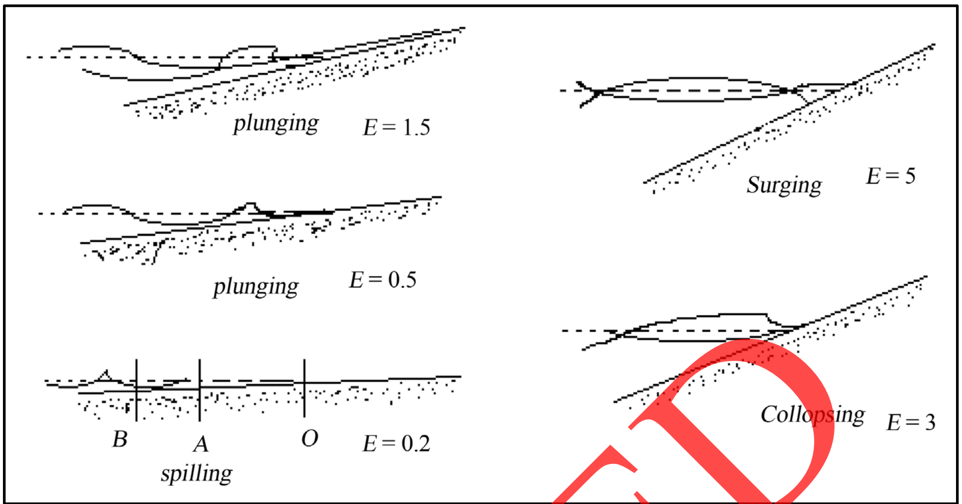

Figure 4. Breaking similarity parameter.

movement. To record the wave run-up and rundown, 2 wave height recorders have been installed on the ramped shore bed. In total about 43 exercises have been done that their outputs are shown by graphics and tables.

Measurement Errors

The measurable parameters through the experiments include: wave run-up, wave height, waves frequency, current velocity within the bed. The measurement errors of above parameters during the experiments have been shown in Table 1.

4. The Findings

4.1. Effect of Bed Permeability on the Wave Run-Up

In this section, the graphics of the wave relative run-up (as non-dimensional, R_u/H) based on the wave sharpness and the similarity break parameter, has been shown. Also, the current velocity of bed and the effects of injection and suction velocity on generated tension have been considered.

By Figure 5, the wave relative run-up according to the wave sharpness is shown, for 3 permeable beaches through the measurement points and their fitting line.

Figure 6 compares the wave relative run-up according to the wave sharpness, between permeable and impermeable beaches by their best fitting lines. The permeability significantly causes high reduction of wave run-up (by 5 times), especially for the waves with poor sharpness. Figure 7 compares the wave relative run-up according to the wave sharpness, between 3 permeability coefficients of a permeable beach (with the following hydraulic conductivities: k1 = 0.083 cm/s, k2 = 0.08 cm/s, k3 = 0.079 cm/s) by their fitting lines. It is found that the wave relative run-up through increasing permeability gets decreased.

4.2. Effect of Bed Permeability on the Bed Currents

Reviewing the film record of the colored water movement, the effect of bed permeability on the current over the bed has been studied. The method used was based on the

Table 1. The errors derived through measurements in the experiments.

The flow speed in the bed at two depths of 3 and 13 cm	The flow speed in the bed (suction and injection)	The flow speed of wave run-up and run-down	Wave period	Wave height	Wave run-up	Parameters
V1, V2	Ws, Wi	Uru, Urd	T	Hs	Ru	variable
cm/s	cm/s	cm/s	s	Cm	cm	Unit
0/05±	0/01±	0/025±	0/01±	0/05±	0/1±	Error

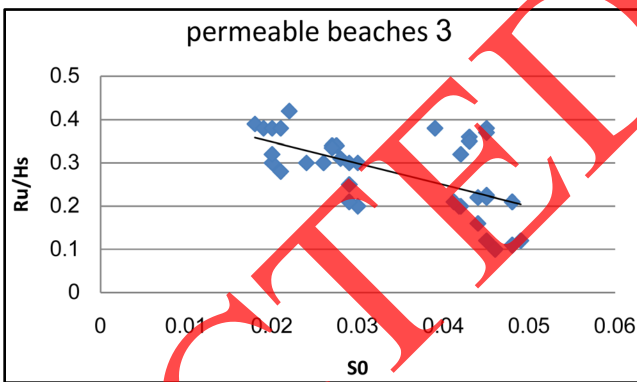

Figure 5. Relative wave run-up according to the wave sharpness for 3 different permeable beaches.

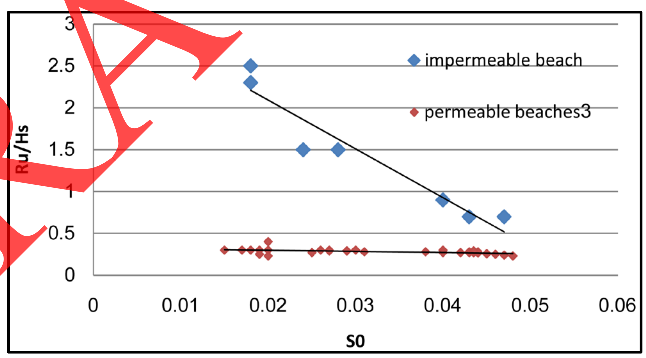

Figure 6. Relative wave run-up according to the wave sharpness over a permeable and impermeable beach.

colored water movement and the calculation of the general current velocity over the bed in two positions near the surface and depth of the bed (Figure 8 and Figure 9). Table 2 includes the waves height and frequency parameters along with the current velocity over the bed. The results derived by film analysis illustrated that by decreasing the radius of curvature in the current track, the bed permeability is getting decreased. Meantime, in the high depth the radius of curvature could be decreased also, as this finding illustrates that the strength of bed versus the fluid movement, gets increased by high depth and poor permeability.

4.3. Effect of Bed Permeability on the Tension Imposed over the Bed

As before mentioned, while the fluid penetrates/transpires the bed respectively a suction/

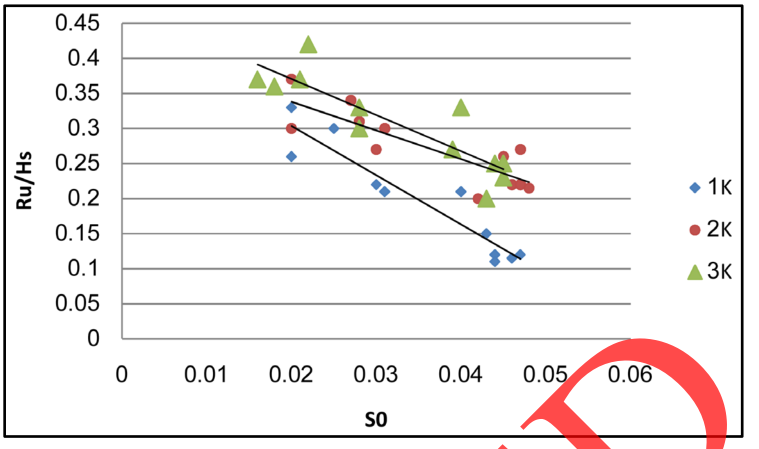

Figure 7. Comparing of relative wave run-up according to the wave sharpness over a beach with different permeability coefficient (k1, k2, k3).

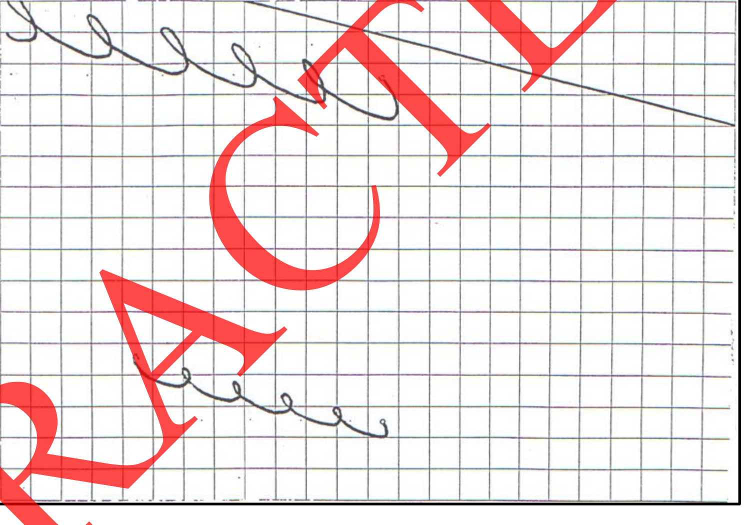

Figure 8. Track of injected color in two points respectively at 4 cm and 12 cm from bed surface. Experiment 3007 (low permeability).

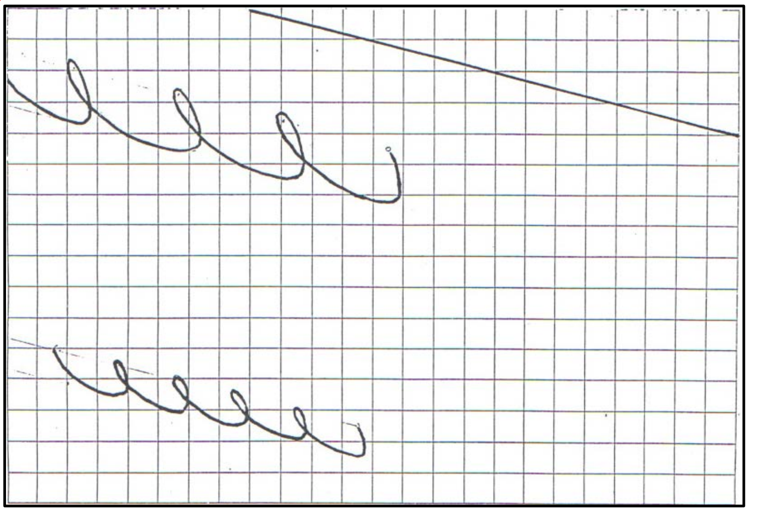

Figure 9. Track of injected color in two points respectively at 4 cm and 12 cm from bed surface. Experiment 3007 (high permeability).

Table 2. The information of measurements of the flow speed within the bed.

Experiment no.	Permeability	Wave height (cm)	Flow speed within the bed	Flow speed within the bed	
				Speed at depth of 3 cm V1 (cm/s)	Speed at depth of 13 cm V1 (cm/s)
1001	K1 (0/084)	10/9	1/96	3/8	2/8
1002		9/2	1/6	3/4	2/6
1003		9/1	1/39	3/6	2/9
1004		9/7	1/24	3/6	2/8
1005		8/8	1/13	3/5	2/5
1006		7/5	1/05	3/6	2/5
3007	K2 (0/081)	11/5	1/96	1/78	1/02
3008		10/6	1/6	1/84	1/06
3009		7/8	1/39	1/83	1/08
3010		10	1/24	1/85	1/13
3011		8/5	1/13	1/86	1/15
3012		8/7	1/05	1/86	1/05
2007	K3 (0/079)	9/8	1/96	1/28	0/87
2008		9/4	1/6	1/31	0/88
2009		8/3	1/39	1/37	0/9
2010		9/5	1/24	1/33	0/97
2011		8/9	1/13	1/33	0/88
2012		9/6	1/05	1/33	0/86

injection process occurs. By studying the current tracks, W-suction and W-injection have been measured through different experiments for 3 permeability coefficients (including: K1, K2 and K3). In the laboratory environment and during wave run-up/ rundown, the horizontal velocity is the same run-up/rundown velocity, as defined the bed suction/injection respectively. Regarding the researchers developed by Conley and Inman (1994) [2], and introducing the non-dimensional parameter ($V = W/U$), this parameter is defined as following relations:

$$V_i = \frac{W_{\text{injection}}}{W_{\text{rundown}}} \quad \text{and} \quad V_s = \frac{W_{\text{suction}}}{W_{\text{runup}}}.$$

For all experiments, it is calculated that V_s and V_i are the same, regarding the absolute values. The findings are presented by Table 3.

Conley and Inman's observations (1994) [2] verified that in a wave with constant frequency, by increasing V_s the bed tension in a permeable condition (t) comparing to the bed tension in a impermeable condition (t_0), namely t/t_0, is getting increased. Whiles, by increasing V_i the relation (t/t_0) gets decreased. In the present investigation this problem has been studied according to 6 constant frequencies for different permeability coefficients, and the results are showed by Figure 10.

5. Results

The comparison between the results derived from Conley and Inman's experiments (Figure 1) and the results of present experiments (Figure 2), about the tension imposed on the bed, indicates that there is a similarity among the tension variations and

Table 3. The measurement of different speed parameters.

Experiment no.	$W_{suction}$ (cm/s)	$W_{injection}$ (cm/s)	U_{runup} (cm/s)	$U_{rundown}$ (cm/s)	$V_s = \frac{W_s}{U_{runup}}$	$V_i = \frac{W_i}{U_{rundown}}$
1001	−7/9874	2/259	66/054	18/2360	−0/1209	+0/1209
1002	−7/8628	2/3239	40/1935	11/8795	−0/1956	+0/1956
1003	−9/3893	2/6114	34/829	9/6869	−0/2696	+0/2696
1004	−9/037	3/35	32/1069	11/9103	−0/2813	+0/2813
1005	−8/5965	3/3774	26/9929	10/6051	−0/3185	+0/3185
1006	−7/1836	3/2309	20/9619	9/4278	−0/3427	+0/3427
3007	−3/6413	1/5181	61/3953	25/5972	−0/05931	+0/05931
3008	−3/4802	1/8608	38/5521	20/6133	−0/0903	+0/0903
3009	−4/182	1/5417	23/5716	12/0011	−0/1285	+0/1285
3010	−4/182	2/2806	27/5881	15/045	−0/1516	+0/1516
3011	−3/9122	2/1123	23/0058	12/4229	−0/17	+0/17
3012	−38995	2/4757	20/8365	13/2285	−0/1872	+0/1872
2007	−1/9925	1/0527	47/3921	25/4484	−0/042	+0/042
2008	−2/159	1/3026	31/863	19/4309	−0/0670	+0/0670
2009	−2/057	1/3640	23/4288	15/5249	−0/0878	+0/0878
2010	−2/5664	1/7956	24/0316	16/8137	−0/1068	+0/1068
2011	−2/505	1/925	20/2215	15/5394	−0/1239	+0/1239
2012	−20/8567	2/2454	21/5071	16/9062	−0/1328	+0/1328

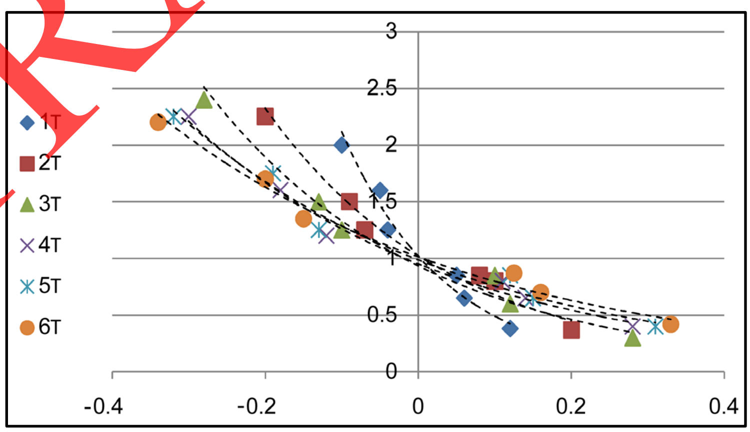

Figure 10. Non-dimensional parameter (V) graphic according to t/t_0.

the non-dimensional velocity through both studies.

Note, Conley and Inman had done the exercises for a horizontal bed, through one wave frequency only, whiles in the present investigation, the exercises have done on the ramped bed through 6 wave frequencies. The results obtained show that the reduction of relative tension up to about 70% in the injection phase was significantly evident, whiles in the suction phase increasing of relative tension is notable by 2.5 times (**Figure 11**). These intense variations illustrate the effect of bed permeability on tension, so that

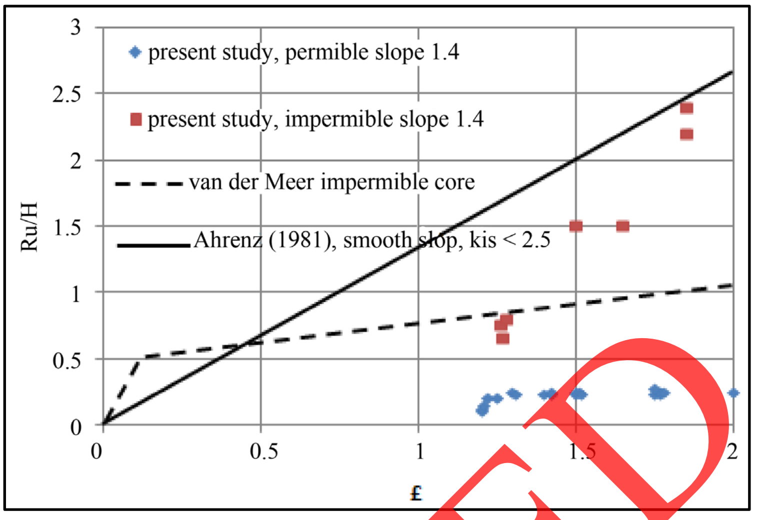

Figure 11. Comparing the results of relative wave run up.

it should be taken into consideration in the natural conditions. It should be noted, the results obtained about wave run-up variations on the impermeable bed are pretty similar with the results of Ahrenz (1981) [7] so that in both of them the wave run-up height over the impermeable bed recorded of high ranks.

6. Conclusions

The increasing of bed permeability led to decrease the wave run-up by 5 times (Figure 6) and higher sharpness of wave also could decrease the wave run-up. Poor permeability increases the wave run-up as it is evident on the impermeable bed. Different permeability in proportion to the wave sharpness increase did not indicate a physical impact on wave run-up decrease.

Wave run-up from the ramped impermeable shore bed indicated of low ranks compared to the impermeable horizontal shore bed [7].

The velocity of the current is getting decreased by poor permeability and deepening of the bed. Based on the observations of this experiment, the velocity of the current within the bed does not relate to the wave frequency and the general line of current within the bed follows the water level.

Vertical track of the fluid movement because of positive and negative imposed pressures on the bed (generated through wave run-up and rundown) completely depends upon the wave height and head. The fluid movement tracks as incomplete spiral lines parallel to the water level move towards outside.

In a wave cycle, the suction and injection phenomena are observed inside the bed. So that, by increasing/decreasing the head in result of wave run-up/rundown and imposing the positive/negative pressure on the bed, the suction/injection occurs respectively. About the effect of permeability on tension imposed on the bed (Figure 10 and Table 2), it should be noted by increasing the suction velocity the tension on the bed is getting increased up to 2.5 times, whiles by increasing the injection velocity the tension on the bed is getting decreased about 70%, both phases (suction/injection) occur through approaching/receding of the vortex boundary layer to the bed. The variations of tension on the vortex boundary layer near the bed have a significant importance [4].

In a given permeability of bed with a specific wave frequency, by changing the wave height there is not any change at V parameter, namely the relation of $V = W/U$, has been considered independent from the wave height. Through a specific wave frequency, it is found that by increasing V_s, the ratio of t/t_0 is getting increased, whiles by increasing V_p the ratio of t/t_0 is getting decreased, such as the obtained results by Conley and Inman (1994) [2]. Thus, regarding the considerable effect of bed permeability on the tension imposed of bed, it is necessary these effects to be taken into consideration through the applied researches.

References

[1] Conley, D.C. and Inman, D.L. (1992) Field Observation of the Fluid Granular Boundary Layer under Near-Breaking. *Journal of Geophysical Research*, **97**, 9631-9643. https:/doi.org/10.1029/92JC00227

[2] Conley, D.C. and Inman, D.L. (1994) Ventilated Oscillatory Boundary Layer. *Journal of Fluid Mechanics*, **273**, 261-284. https:/doi.org/10.1017/S002211209400193X

[3] Battjes, J.A. (1974) Wave Run-Up and Overtopping. Technical Advisory Committee on Protection against Inundation, Hagg.

[4] Antonia, R.A., Bisset, D.K., Fulachisr and Anselmet, F. (1990) Effect of Wall Suction on Bursting in a Turbulent Boundary Layer. *Physics of Fluids A*: *Fluid Dynamics*, **2**, 1241-1247. https:/doi.org/10.1063/1.857624

[5] Villarroel-Lamb, D., Hammeken, A. and Simons, R. (2014) Quantifying the Effect of Bed Permeability on Maximum Wave Runup. 34*th International Conference on Coastal Engineering*, Seoul, South Korea, 15 June 2014.

[6] Hughes, S.A. (2004) Estimation of Wave Run-up on Smooth, Impermeable Slopes Using the Wave Momentum Flux Parameter. *Coastal Engineering*, No. 51, 1085-1104. https:/doi.org/10.1016/j.coastaleng.2004.07.026

[7] Ahrenz, J.P. (1981) Irregular Wave Run up on Smooth Slops. Technical Paper No. 81-17, U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Virginia.

[8] Allsop, N.W.H., Hawkes, P.J., Jackson, F.A. and Franco, L. (1985) Wave Run-Up on Steep Slopes-Model Tests under Random Waves. Report SR2, Hydraulics Research Ltd., Wallingford.

[9] Postma, G.M. (1989) Wave Reflection from Rock Slops under Random Wave Attack. MSc Thesis, Delft University of Technology, Delft.

[10] Seelig, W.N. and Ahrens, J.P. (1981) Estimation of Wave Reflection and Energy Dissipation Coefficient for Beaches, Revetments and Breakwaters. TP 81-1 U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, VA, 40 p.

[11] Soulsby, R. (1997) Dynamics of Marine Sands, a Manual for Practical Applications. Thomas Telford Publications, New York.

[12] Van der Meer, J.W. (1988) Rock Slops and Gravel Beaches under Wave Attack. Doctoral Thesis, Delft University of Technology, The Netherlands.