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The Effect of High Mercu on Water Jump on Type Vlughter (Laboratory Test)

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Abstrac:- Hydraulic jumps are used as energy dampers that cover part or all of the pool called the olak pool. The study of this can be done through a study of the flow in small open channels that pass through the shedding with a model of vlughter type of abundant building. The purpose of this study is to find out the different influences of upstream and downstream height on the length of the water jumping pool in vlughter type buildings with variations in discharge and to find out the effect of changes in the height of the olak pond on the length of the water jumping pool in vlughter type buildings with a fixed discharge. The different influence of height in the temperature and downstream on the length of the spring jumping pool is influenced by the varying height of the lighthouse. The results of the study for the length of the water jumping pool at the lighthouse 0.08 m discharge 0.0015 m^3 / etc. obtained 1.19 m while for theoretical at a discharge of 0.0015 m^3 / stk lighthouse 0.08 m obtained 0.2203 m shows the difference between research in the laboratory with the calculation in theory this is due to the absence of endsill in the olak pool in the laboratory then the length of the water loncar pool that occurs very far.

Keywords:- *High of Lighthouse, Pool of Olak Vlughter, Water Jumping Pool.*

I. BACKGROUND

Flow dams will cause a difference in water level elevation between upstream and downstream weir is quite large, resulting in a plunge and a considerable change in energy when the water passes through the weir lighthouse. As a result the flow will experience a normal shock or hydraulic jump that is a flow that undergoes a supercritical flow change to subcritical [1] in [2]. The free-falling water in the overflow will move slowly until it becomes a supercritical flow, resulting in the formation of hydraulic jumps downstream, hydraulic jumps are changes in flow type from super critical to subcritical. Hydraulic jumps are used as energy dampers covering part or the entire pond called the *olak* pond.

The *olak* pond is a construction that serves as an energy reducer contained in the flow by utilizing hydraulic jumps from a high-speed flow. The *olak* pool is largely determined by the height of the hydraulic jump, which occurs in the flow. Broadly speaking there are several models of olak ponds that can be used as energy reducers in weir, including Bucket type *olak* ponds, Schoklitch, USBR and Vlughter. Broadly speaking there are several models of olak ponds that can be used as energy reducers in weir, including Bucket type *olak* ponds, Schoklitch, USBR and Vlughter.

Energy damper planning (*olak* pond) is indispensable to meet the desired requirements or specifications and adapted to the circumstances and behavior of the flow that occurs. An assessment of this can be done through a study of the flow in a small open channel that passes through the overflow with a Vlughter type overflow building model.

The purpose of this research related to the problems that have been formulated before is as follows:

- knowing the influence of high difference between upstream and downstream to the length of the jumping pool on the wake of the type vlughter pelimpah with variations in discharge.
- valuate how the effect of changes in the height of the olak pond mercu to the length of the jumping pool on the building of the type vlughter pelimpah with variations in discharge.

II. THEORETICAL STUDIES

A. Weir

According to [3], Weir is a building placed across the river, and is useful for regulating the flow of the river. Based on its function weir can be classified in flooding weir, no water retaining weir and eavesdropper weir. In addition depending on its construction weir can be classified in fixed weir and weir motion. Type is weir remains made across the river to produce a minimum water elevation so that the water can be avoided and weir motion can be used to regulate the height and discharge of river water with the opening of the doors contained in the weir.

B. Lighthouse

There are two types of lighthouses that are commonly used, namely the ogee type and the round type as shown in Figure 1

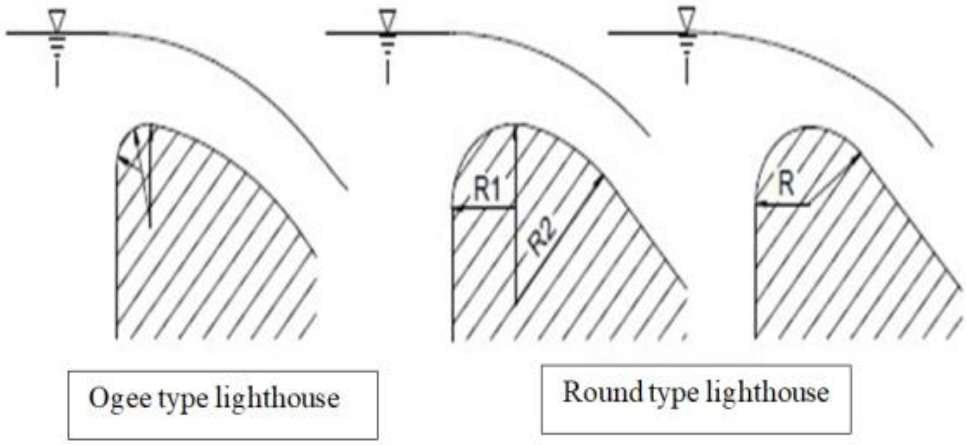


Fig 1:- Shape of weir lighthouse, Source [4]

C. Jump Water

The theory of hydraulic stepping began to be developed and applied in most channels in the field of civil engineering water as an energy reducer in preventing the erosion of downstream weir structures where there is a supercritical flow [5]. Water jumping is a change of flow from a supercritical flow to a subcritical flow that causes water jumping. In open channels jump water can be observed when water passes through measuring buildings. Water jumping occurs due to the influence of flow speed that affects the length of water jump as well as high water jump. If the type of flow in the turbulent channel changes from supercrititcal to subcritical, water jumps will occur. As in figure 2 below.

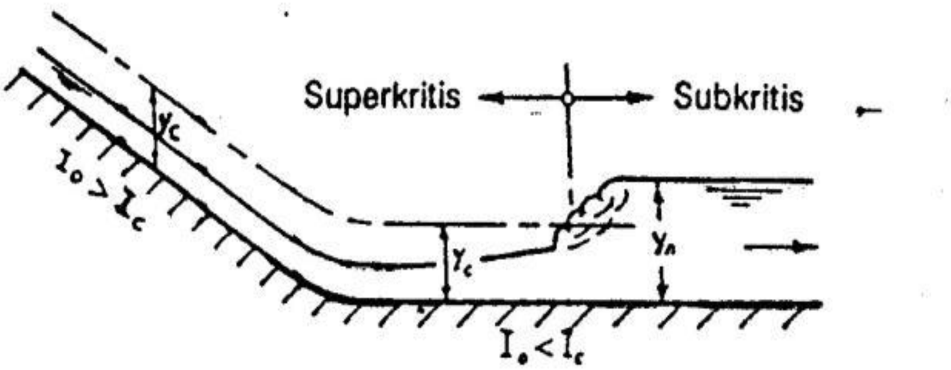


Fig 2:- Water jump, Source [6]

Which shows the elongated look of the channel with the slope changing from a steep slope to a ramp. The upstream flow is subcritical while the downstream flow is supercritical, between the two types of flows there is a transition area.

A hydraulic jump will form on the channel, if the froude number of flow F1, the depth of flow y1, and the depth downstream of y2, fulfill the following equation:

$$V_1 = \sqrt{2\,g(\tfrac{1}{2}h^1 + z\,)} \qquad (1)$$

Information:
v1 = Jump start speed, (m/s)
g = Acceleration of gravity, (m/s2) (= 9,8)
H1 = High energy above the threshold,(m)
z = High fall, (m)

$$\frac{y_2}{y_1} = \frac{1}{2}\left(\sqrt{1+8fr_1^2} - 1\right) \qquad (2)$$

With:

$$Fr = \frac{V_1}{\sqrt{g\,y_1}} \qquad (3)$$

Information:
y2 = Water depth above the tip threshold, (m)
y1 = The initial depth of the water jump, (m)
Fr = Froude Numbers
v1 = Jump start speed, (m/s)
g = Acceleration of gravity, (m/s2)

D. Pool Lenght

The length of the water jump pool behind the U piece (figure 3) is usually less than the free length of the jump there is an endsill. The threshold that serves to solidify this flow is generally placed at a distance. [7] in [4]

$$L_j = 5\ (n + y_2) \quad (4)$$

Information:
Lj = Length of Olak Pond, (m)
n = Tip threshold height, (m)
y2 = Water depth above the threshold, (m) behind the U. Piece of Height required this tip threshold as a function of froude number (Fr), the depth of water entering yu, and the height of downstream water level.

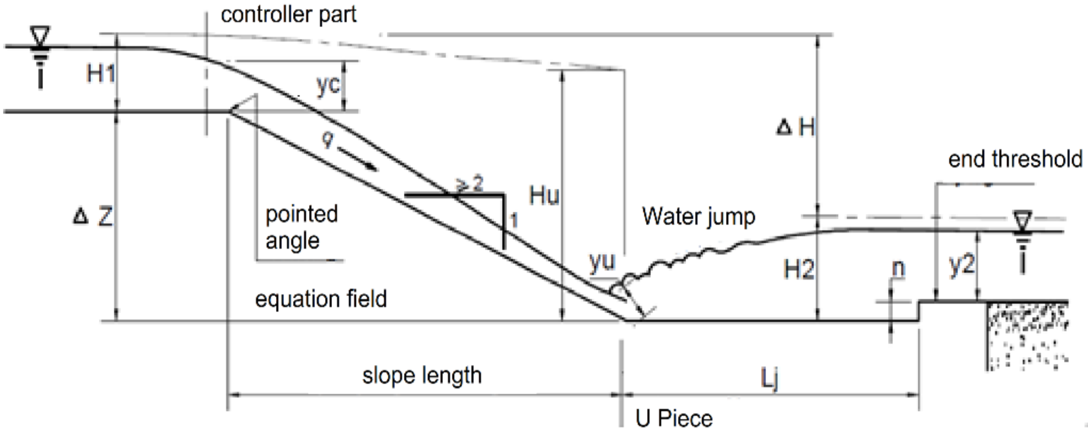
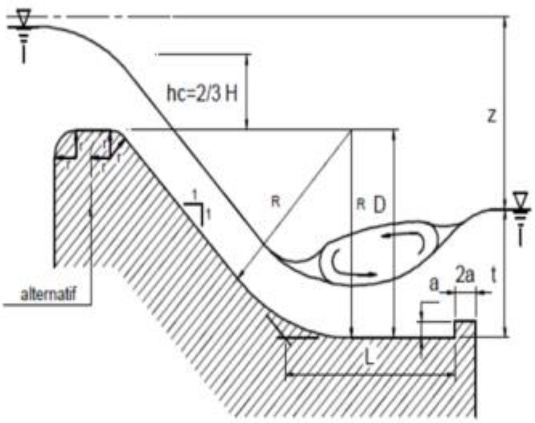


Fig 3:- Water jump parameters

The hydrolyzed form of this pond will be influenced by the high energy upstream above the lighthouse (He), and the difference in energy upstream with the downstream flood water level (Z). For the calculation of vlughter type energy reducer dimensions using the formula as shown in figure 4.



$$hc = \sqrt{\frac{g^2}{g}}\ if\ 0.5 < \frac{z}{hc} \le 2.0$$

$$t = 2.4\ hc + 0.4\ z\ (1)\ if\ 0.2 < \frac{z}{hc} \le 15.0$$

$$t = 3.0\ hc + 0.1\ z\ (2)$$

$$a = 0.28\ hc \sqrt{\frac{hc}{z}}\ (3)$$

$$D = R = L\ (4)$$

(size in m)

Fig 4:- Olak pond according to Vlughter

Information:
Hc = critical water level, (m)
R = radius of the pool, with the center in parallel to the elevation of the lighthouse, (m)
D = the depth of the pond is measured from the top of the lighthouse to the surface of the pond, (m)
a = end sill
t = downstream water depth, (m)
z = height difference, (m)
L= pool length measured from intersection of slope and Horizontal, (m)

III. RESEARCH METHODS

The research was conducted in the Hydraulic Laboratory of the Faculty of Engineering, Civil Department of the Muslim University of Indonesia. This study uses laboratory research methods that include observation or measurement of the length of hydraulic jump and the depth of the olak pond against the discharge of Vlughter type by using a variety of discharges in the open channel. Tools and materials used in supporting this research consist of: 1). Channels open; 2). Overflow type vlughter (0,080 m, 0,100 m, 0,120 m); 3). Silicon glue as an adhesive tool; 4). Current meter to measure flow speed; 5). The ball is a way to measure speed; 6). Ruler to measure the water level; 7). Stopwatch To measure the time used on discharge flow; and 8). Medium pertition

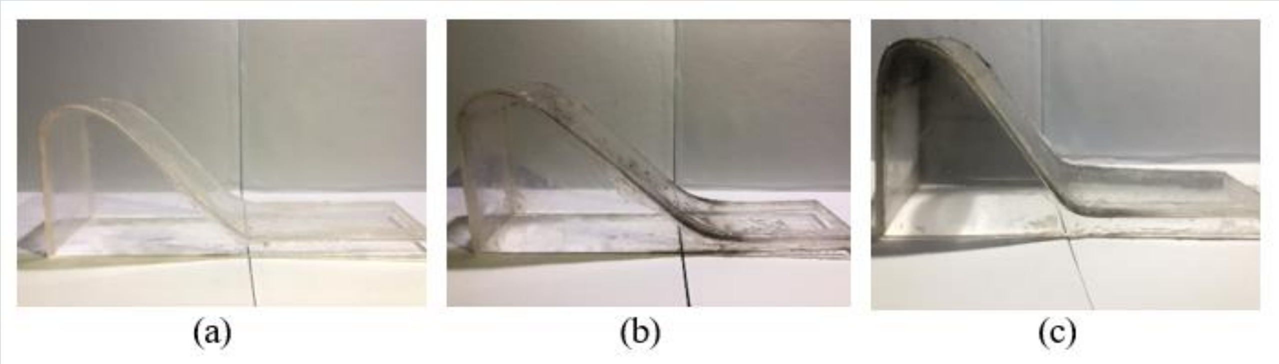


Fig 5:- Three kinds of shape of weir lighthouse

IV. RESULT OF RESEARCH AND DISCUSSION

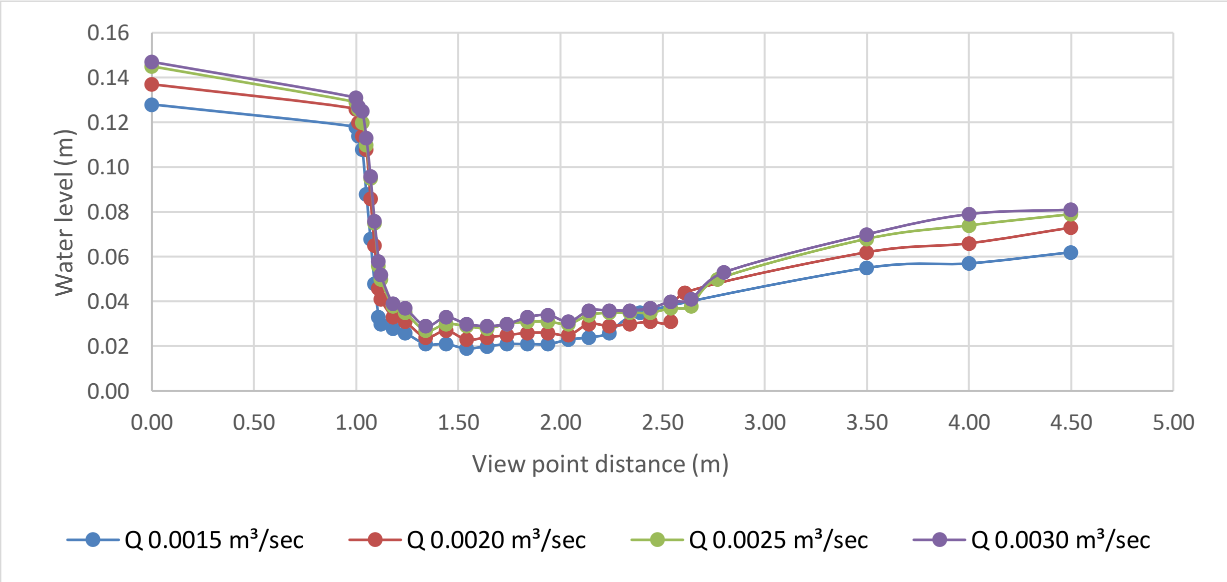


Fig 6:- Graph of the relationship between the height of the water level and the review distance at a height of 0.080 m against the variation in discharge.

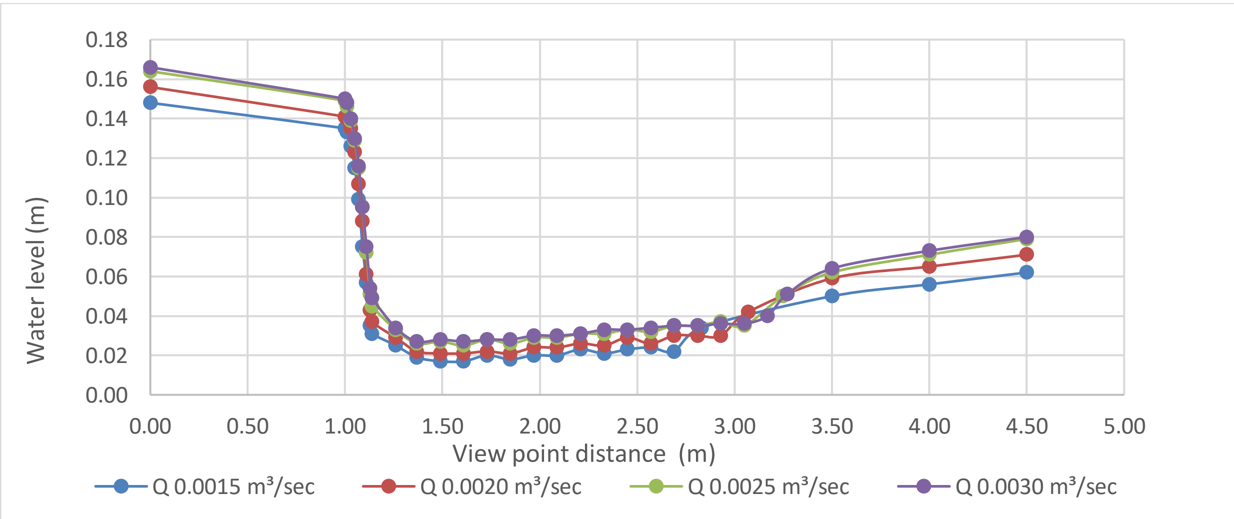


Fig 7:- Graph of the relationship between the height of the water level and the review distance at a height of 0.100 m against the variation in discharge.

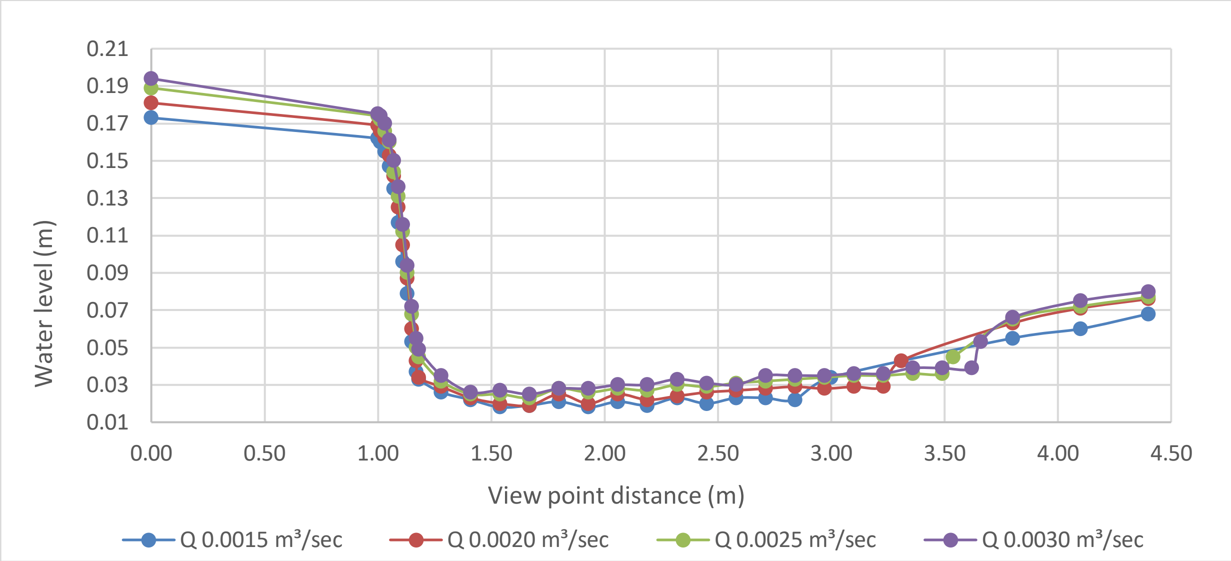


Fig 8:- Graph of the relationship between the height of the water level dihulu with the review distance at a height of 0.120 m against the variation of discharge.

A. Height Difference

The difference in water level upstream and downstream against hydraulic jump can be seen in Table 1 with discharge of 0.0015m^3/s, 0.0020 m^3/s, 0.0025m^3/s, and 0.0030m^3/s.

No	Debit (m^3/sec)	Height of the lighthouse (m)	H upstream (m)	H downstream (m)	Z (m)
1	0.0015	0.080	0.1250	0.1057	0.0193
2	0.0020		0.1414	0.1264	0.0150
3	0.0025		0.1504	0.1375	0.0129
4	0.0030		0.1540	0.1420	0.0120
5	0.0015	0.100	0.1455	0.1233	0.0232
6	0.0020		0.1591	0.1385	0.0206
7	0.0025		0.1633	0.1423	0.0178
8	0.0030		0.1685	0.1517	0.0168
9	0.0015	0.120	0.1686	0.1354	0.0332
10	0.0020		0.1772	0.1471	0.0301
11	0.0025		0.1885	0.1622	0.0263
12	0.0030		0.2036	0.1796	0.0240

Table 1:- Table Result Qstatistic & Q arithmetic in 2009-2019

Based on Figures 6, 7, and 8, and also Table 1 shows an increase in the flow height at 0.08 m with a discharge of 0.0015 m^3/s resulting in 0.073 m and at the highest discharge of 0.0030 m^3/s resulting in 0.077 m, and at a high of 0.100 m with a discharge of 0.0015 m^3/s resulting in 0.098 m and at the highest discharge of 0.0030 m^3/s producing 0.102 m, and at a high of 0.120 m with a discharge of 0.0015 m^3/s resulting in 0.117 m and at the highest discharge of 0.0030m^3/s producing 0.128 m.

B. Water Jumping Pool

Calculations for water jumping ponds for high inland 0.080 m, 0.100 m, and 0.120 m for various variations of discharge can be seen in Table 2 as follows.

No.	Q (m^3/s)	Height of the lighthouse (m)	V_1 (m/s)	Fr	Y_2 (m)	Information
1	0.0015	0.080	0.906	2.361	0.0431	super critical
2	0.0020		0.947	2.319	0.0479	super critical
3	0.0025		0.971	2.193	0.0528	super critical
4	0.0030		0.980	1.980	0.0586	super critical
5	0.0015	0.100	0.955	2.272	0.0495	super critical
6	0.0020		0.992	2.239	0.0541	super critical
7	0.0025		0.985	2.120	0.0559	super critical
8	0.0030		1.001	1.945	0.0620	super critical
9	0.0015	0.120	1.062	2.460	0.0573	super critical
10	0.0020		1.073	2.310	0.0617	super critical
11	0.0025		1.090	2.246	0.0652	super critical
12	0.0030		1.136	2.130	0.0741	super critical

Table 2:- Water jumping pool calculation

Based on Table 2 shows that the fr value that occurs is caused by the flow speed and high ingesti. The lowest Froude value can be seen at 0.0030 m^3/s discharge and 0.080 m high of 1,980 m and froude's highest value can be seen at 0.0015 m^3/s discharge and 0.12 m high of 2,460

No	Q (m^3/s)	Height of the lighthouse (m)	Z (m)	Hc (m)	Z/Hc (m)	t (m)	a (m)	D=R=L (m)
1	0.0015	0.080	0.0193	0.0061	3.2	0.1057	0.000960	0.0800
2	0.0020		0.0150	0.0082	1.8	0.1264	0.001698	0.0800
3	0.0025		0.0129	0.0102	1.3	0.1375	0.002540	0.0800
4	0.0030		0.0120	0.0123	1.0	0.142	0.003487	0.0800
5	0.0015	0.100	0.0232	0.0061	3.8	0.1233	0.000876	0.1000
6	0.0020		0.0206	0.0082	2.5	0.1385	0.001449	0.1000
7	0.0025		0.0178	0.0102	1.7	0.1455	0.002163	0.1000
8	0.0030		0.0168	0.0123	1.4	0.1517	0.002947	0.1000
9	0.0015	0.120	0.0332	0.0061	5.4	0.1354	0.000732	0.1200
10	0.0020		0.0301	0.0082	3.7	0.1471	0.001198	0.1200
11	0.0025		0.0263	0.0102	2.6	0.1622	0.001779	0.1200
12	0.0030		0.0240	0.0123	2.0	0.1796	0.002466	0.1200

Table 3:- Calculation of olak pond type vlughter

Based on Table 3 shows that the value of olak pool at the height of the lighthouse 0,080 m, 0,100 m, and 0,120 m for the debit varies is the same.

No	Q (m^3/s)	Height of the lighthouse (m)	a (m)	Y2 (m)	Lj Theoretical (m)	Lj Laboratory (m)
1	0.0015	0.080	0.000960	0.0431	0.2203	1.19
2	0.0020		0.001698	0.0479	0.2480	1.61
3	0.0025		0.002540	0.0528	0.2767	1.68
4	0.0030		0.003487	0.0586	0.3104	1.74
5	0.0015	0.100	0.000876	0.0495	0.2519	1.60
6	0.0020		0.001449	0.0541	0.2777	2.00
7	0.0025		0.002163	0.0559	0.2903	2.21
8	0.0030		0.002947	0.0620	0.3247	2.29
9	0.0015	0.120	0.000732	0.0573	0.2902	1.96
10	0.0020		0.001198	0.0617	0.3145	2.23
11	0.0025		0.001779	0.0652	0.3349	2.43
12	0.0030		0.002466	0.0741	0.3828	2.54

Table 4:- Calculation of the length of the water jumping pool

Based on Table 4 shows the length of the lowest water jumping pool can be seen at the discharge of 0.0015 m^3/s and the height of 0.08 m which is 2.29 m and the length of the highest water jumping pool is at the discharge of 0.0030 m^3/s and the height of 0.120 m which is 3.54 m, while at the length of the water jumping pool theoretically the lowest can be seen at the discharge of 0.0015 m^3/s and the height of 0.080 m which is 0.377 m and the length of the highest water jumping pool is at the discharge of 0.0030 m^3/s and the height of 0.120 m is 0.640 m.

V. CONCLUSION

Based on the results of analysis and discussion, we can conclude:

- The influence of high differences in the head and downstream on the length of the water jump pool is influenced by the height of the weir that varies with the change in discharge where the higher the rake and the greater the flow discharge, the longer the pool of water that occurs and the value of the difference in the height of upstream and downstream the smaller it is caused by the form of a cross-section of channels and a fixed slope
- The results of the study for the length of the water jump pool at the lighthouse 0.08 m discharge 0.0015m^3/s obtained 1.19 m while for theoretical at discharge 0.0015 m^3/s mercu 0.08 m obtained 0.2203 m shows the difference between research in the laboratory and the calculation of theory this is due to the absence of end sill in the *olak* pond in the laboratory then the length of the pool of water that occurs very far.

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