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Modeling of Sluice Gate Operational Patterns with Two Openings and Free Flow Condition in Retention Ponds as Flood Controllers

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Abstract: Retention ponds function as flood control stabilizers. This pond is built on river bodies equipped with release gates and spillways. The spillway is used to drain water that exceeds the water level which is planned to be used for the release gate using a sluice gate that manages the discharge. So that it does not exceed the capacity of the downstream of the pond. The sluice gate is a flow rate meter on the open channel used in the retention pool mentioned above. The amount of discharge that passes through the sluice gate is influenced by the difference in height of the water upstream and downstream of the gate, because the water passing through the gate is not equal to the discharge formula equal to the speed multiplied by the wet fender but there is a reduction in flow due to flow discharge (Cd) coefficient on the gate. The discharge arrangement by using a sluice gate function properly if the amount of inflow discharge calculated accurately. to get these results, it is necessary to analyze the discharge coefficient correctly by testing the sluice gate with two openings in free flow conditions. The aim of the study was to obtain a Cd coefficient value that corresponds to the gate with two openings. The research method was an experiment conducted by the in laboratory of hydraulics the of Indonesia Muslim University using flume. The Cd equation which was a function of the water level upstream (yo) and the gate opening (yg) obtained from the experimental results. The Cd value was 0.6055 $e\text{-}^{(yg/yo)}$ which then the sluice gate operation pattern can be planned.

Keywords: Sluice gate, Coefficient, Debit, High Water.

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I. INTRODUCTION

Water management in retention ponds for irrigation and flood control requires measurement of water discharge to downstream as desired [1]. Sluice gate serves to control the water discharge coming out of the retention pond.

The amount of discharge that passes through the sluice gate is determined by several factors: the height of gate opening, upstream water level, gate width and discharge coefficient (Cd). Among of the factors, the discharge coefficients are most difficult to determine accurately. Therefore, a suitable formula for field conditions is needed. Determination of the discharge coefficient in this study was carried out in the laboratory by simulating the number of gates with the number of gates planned to be installed in the retention pond, in this case the number of gates planned was two, the Cd equation obtained from the experiment was calibrated with previous studies.

After the Cd coefficient above is obtained, then a gate operation pattern model is created in the retention pond so that the pool functions as a stabilizer of water entering and leaving the pool or controlling the flood. Setting the discharge that comes out through the sluice gate must remain in accordance with the capacity of the downstream of the gate. So that the inflow and outflow discharges must remain equal as the capacity of the river hence the flood can be prevented.

A study was carried out by the experimental method using a rectangular flume, 0.457 m wide, 0.914 m deep, and 4.88 m long examined the relationship of changes in discharge of free flow and sinks on sluice gates [2]. The sluice gate was made of an aluminum plate, 6.3 mm thick, with a sharp bottom edge on the part of the water supply pipe installed through the discharge measuring gate. The experiment was carried out 57 times consisting of 37 times for sinking and 20 times in free flow conditions. It should be noted that the sluice gate used in the previous experiment has similarities and without contraction on the cross section of the channel. Saudia, utilizing multi-sluice gates in drowning conditions by empirically confirming the parameters that affect flowrate, the research method is experimental in the laboratory using flume [3]. Shayan and Farhoudi, conducted a study of the parameters on the discharge coefficient of sluice gates in the free and sink flow conditions based on the energy equations in the upstream and downstream of the gate to estimate the energy loss coefficients for free flow conditions to be applied to determine the discharge coefficient, also used to estimate the discharge coefficient for sinking flow [4]. Henry conducted a sluice gate to obtain a discharge coefficient under conditions of free and submerged flow [5]. Rajaratnam and Subramanya present the discharge coefficient based on the formula for sluice gate discharge from the results of studies in conditions of free flow and sinkin [6] the hydraulics of the sluice gate which is parallel to the condition of free flow and sinking, with the condition of the gate symmetrical and not symmetrical with the experimental method [7]. This experiment conducted a study of the use of a single sluice gate formula on a parallel gate under conditions of free flow and sinking. The equation of the discharge coefficient from previous studies can be seen in Table 1 below.

Table 1. The Equations of Discharge Coefficient of Sluice Gate from Previous studies

Studies	DC equation	Studies	DC equation
Rajaratnam [6]	$Cd = \frac{0.611}{\sqrt{1 - 0.611^2 (\frac{yg}{yo})^2}}$	Larsen [11]	$Cd = 0.489 \left(\frac{yg}{yo}\right)^{0.075}$
Swamee [8]	$Cd = 0.611 \left(\frac{yo - yg}{yo + 15yg}\right)^{0.072}$	Alhamid [12]	$Cd = 0.6113 \left(\frac{yo - yg}{yo + 15yg}\right)^{0.0849}$
Garbrecht [9]	$Cd = 0.6848 - 0.1641 \sqrt{\frac{yg}{yo}}$	Nago [13]	$Cd = 0.6 \exp(-0.3 \frac{yg}{yo})$
Noutsopoulos [10]	$Cd = 0.62 - 0.15 \sqrt{\frac{yg}{yo}}$	Rady [14]	$Cd = (0{,}042\,\theta + 0.433) \left(\frac{Y_o}{b}\right)^{0{,}11}$

II. LITERATURE REVIEW

2.1 Retention pool

Retention pool is a tub or pond that can hold or absorb water temporarily in it. Retention ponds are planned for river beds equipped with sluice gates from sluice gates (2 x 5 m) and the following spillway channels are pool drawings. Retention.

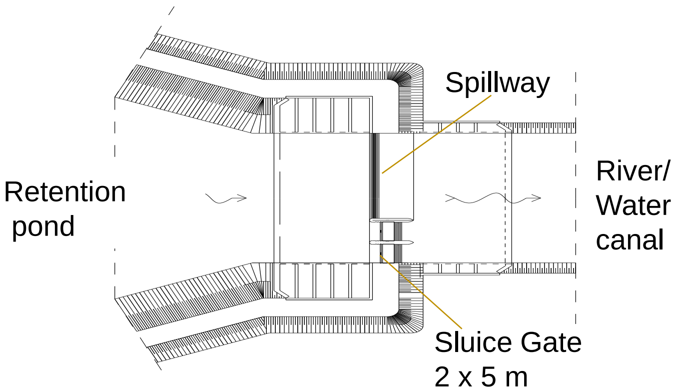

Figure 1. Sluice gate position

2.2 Sluice gates

Gate planning must pay attention to two main things that need to be considered, namely the relationship of the high release energy with the pressure distribution on the sluice surface for various gate positions and gate edge shapes, using energy equations can be shown that the magnitude of the discharge pass [15] was shown in Figure 2.

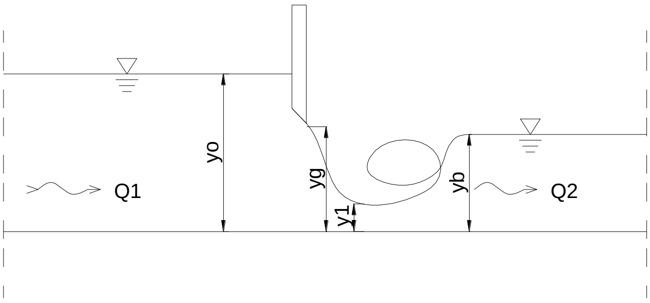

Figure 2. Submerged flow under the sluice gate

$$Q = Cd\, b\, h \sqrt{2g\,(y_0 + \alpha \frac{V_1^2}{2g})} \qquad (1)$$

Where :

$\alpha \frac{V_1^2}{2g}$ = high energy speed

There are two possibilities upstream water level in the gate: free conditions and drowning conditions, so that the water level at the front gate yo in the sinking condition is the effective height or difference in water depth in the upstream and water depth down the gate. The high energy speed of the experiment can be combined with the discharge coefficient, so the formula above becomes:

$$Q = Cd\, b\, yg \sqrt{2g\, y_0} \qquad (2)$$

In addition to equation 2, it can also be calculated based on the Bernoulli theoretical discharge (Qt) with the following equation:

$$Qt = \frac{b\ y_1 \sqrt{2\ g\ y_0}}{\sqrt{\frac{y_1}{y_0} + 1}} \qquad (3)$$

Actual discharge (Qa) is obtained from observations in the laboratory using equations

Qa = V A (4)

Cc and Cv are calculated by the following states:

$$Cc = \frac{y_1}{y_g} \qquad (5)$$

$$Cv = \frac{Q_a}{Q_t} \qquad (6)$$

And the discharge coefficient is multiplication between Cc and Cv

$$Cd = Cc \times Cv \qquad (7)$$

The flow conditions through the sluice gate are known by two conditions, namely free flow conditions and sinking conditions, to distinguish these two flow conditions Swamee specifies the formula as a condition [8]:

Free flow

$$h_o \geq 0.81\ y_b\ (\frac{yb}{q})^{0,72} \qquad (8)$$

The sinking flow

$$h_o < h_o < 0.81\ y_b\ (\frac{yb}{q})^{0,72} \qquad (9)$$

Where :

Cd = discharge coefficient
Cc = contraction coefficient
Cv = flow coefficient
b = gate width
y_o = upstream flow depth
y_1 = thickness of the vena contraction
y_b = tailwater depth
y_g = gate opening

Qt = theoretical discharge
QA = actual discharge
V = downstream velocity
A = cross section area of the channel downstream
θ = the slope of the gate
g = acceleration due to gravity

The magnitude of the Cd depends on the geometric structure, the depth of the water upstream and downstream and the results of laboratory testing will be calibrated with the discharge coefficient equation found by several studies (Table 1).

III. RESEARCH METHODS

The research method was experimental in the Hydraulics laboratory of the Faculty of Engineering, Indonesia Muslim University by using a flume size of 0.4 m in width, 0.40 in height and 5 m in length while the sluice gate size consisted of two openings with a width of 0.05 m with the first step doing speed meter calibration and second sluice gate discharge coefficient testing, each test treatment was carried out five times.

The variables in the test were the water level upstream and the height of the gate openings The treatment carried out on the sluice gate test is the condition of the water level at the top of the gate changing with 3 gate opening conditions which are also variables from this test, the following was the third picture of the observation gate condition.

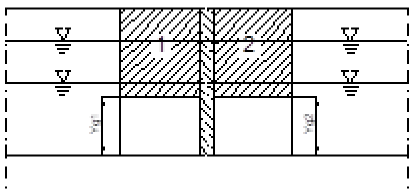

Figure 3: All openings $y_{g1} = y_{g2}$

Figure 3 above is the condition of one gate openings equal to the height of two gate openings and in testing a change of water level was carried out five times with the opening of gates one and two fixed.

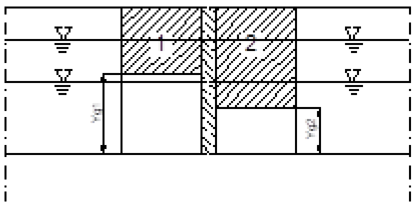

Figure 4. Gate openings position in which the $y_{g1} \neq y_{g2}$

Figure 4 shows the difference in the height of one gate opening and the second gate and was tested by changing the left gate height five times and the right gate opening was still while the water level was changing.

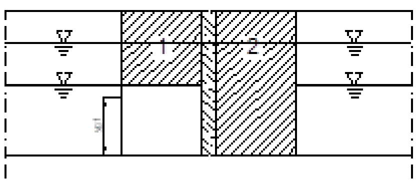

Figure 5. One gate openings

Figure 5 was a one-gate test with changes in water level and gate openings as many as five times. The three simulation conditions above will produce an equation of the relationship between the coefficient of Cd and the height of the gate openings (Y_g) and the water level in the gate (Y_o). Then the results obtained from these observations are illustrated in terms of the relationship between the water level upstream and the height of the openings with a fixed discharge (according to the capacity of the river downstream of the gate), also illustrated the relationship of Cd and opening height/water level upstream with a fixed discharge. Based on the two graphs, a regression count can be made so that the Cd equation was obtained.

Furthermore, the results of the Cd equation obtained were then calibrated with a graph of the relationship between w/yo and Cd based on the previous studies. After the Cd was obtained, then the operational pattern of the gate was made using the equation.

IV. ANALYSIS OF RESULTS

4.1 Flow Circulation Coefficient Analysis

CD flow coefficient was calculated based on observation data in the laboratory using equations 3 to 7 and data and results of calculations with the 3 conditions above can be seen in the following tables and graphs. Tables 2 and 3 were laboratory observational data and the results of the calculation of Qa and Cd in condition 1. The results of table 2 calculations were presented in Figure 6 and 7, while those of Table 3 were presented in figure 8 and 9.

Table 2 Data and calculation of Cd with condition 1 as $Y_{g1} = Y_2$ for Left gate

yo m	Yg m	b m	y_1 m	y_b m	V m/s	A m^2	Qa m^3/s	Qtr m^3/s	Cv = Qa/Qtr	Cc = Y_1/Y_g	Cd = Cv * Cc	y_g/y_o
0.143	0.100	0.050	0.066	0.101	0.671	0.005	0.0034	0.0046	0.742	0.660	0.490	0.699
0.140	0.100	0.050	0.064	0.103	0.642	0.005	0.0033	0.0044	0.753	0.640	0.482	0.714
0.132	0.100	0.050	0.062	0.098	0.642	0.005	0.0031	0.0041	0.765	0.620	0.474	0.758
0.122	0.100	0.050	0.058	0.093	0.642	0.005	0.0030	0.0037	0.809	0.580	0.469	0.820
0.112	0.100	0.050	0.057	0.086	0.642	0.004	0.0028	0.0034	0.803	0.570	0.458	0.893

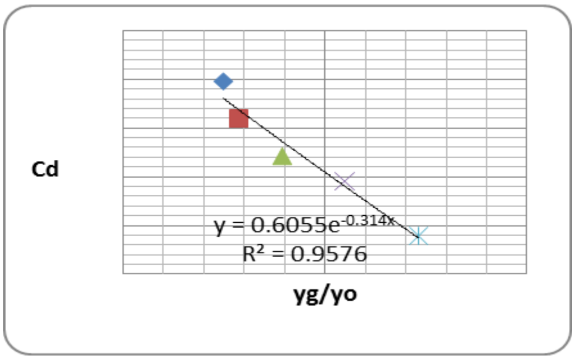

Figure 6. Relationships yg1/yowith Cd with condition 1 as yg1=yg2 for Left gate

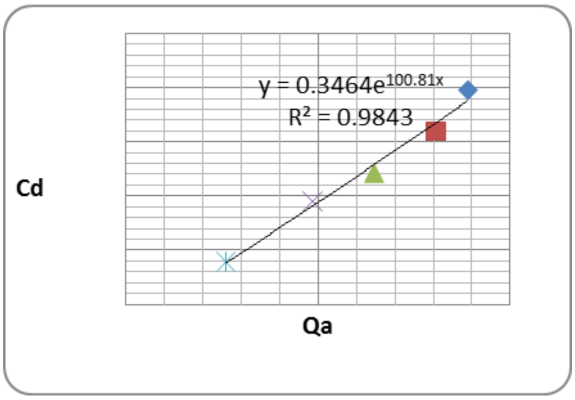

Figure 7. Relationships between Qa and Cd with condition 1 as yg1=yg2 for Left gate

Tabel 3. Data and Calculation of Cd with condition 1 as yg1 =yg2 on Right gate

Yo m	Yg m	b m	y1 m	yb m	V m/dt	A m^2	Qa m^3/dtk	Qtr m^3/dtk	Cv = Qa/Qtr	Cc = Y1/Yg	Cd = Cv * Cc	yg/yo
0.143	0.100	0.050	0.066	0.101	0.671	0.005	0.0034	0.0046	0.742	0.660	0.490	0.699
0.140	0.100	0.050	0.064	0.103	0.642	0.005	0.0033	0.0044	0.753	0.640	0.482	0.714
0.132	0.100	0.050	0.062	0.098	0.642	0.005	0.0031	0.0041	0.765	0.620	0.474	0.758
0.122	0.100	0.050	0.059	0.096	0.613	0.005	0.0029	0.0037	0.786	0.590	0.463	0.820
0.112	0.100	0.050	0.058	0.086	0.642	0.004	0.0028	0.0035	0.792	0.580	0.459	0.893

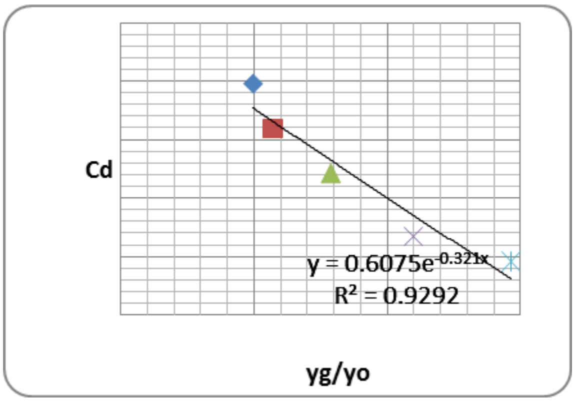

Figure 8. Relationships yg/yo with Cd with condition 1 as yg1=yg2 on Right gate

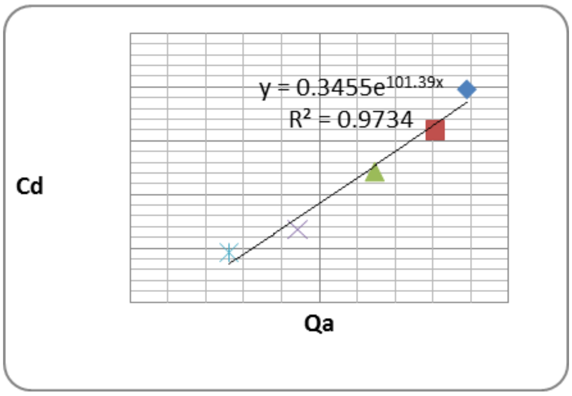

Figure 9. Relationships between Qa and Cd with condition 1 as yg1=yg2 on Right gate

Figures 6 and 8 showed that Cd and yg / yo was inversely proportional. That meant the larger Cd lead to the smaller yg/yo; was while the pictures 7 and 9 the value of Cd was directly proportional to Qa, meaning that the larger Cd lead to bigger the Qa.

Table 4 and 5 showed observation of condition 2. Tables 4 and 5 were laboratory observational data and the results of the calculation of Qa and Cd in condition 2. Figure 10 and 11 were presented from the results of calculations in table 4, while figures 12 and 13 were presented from those of table 5. Figures 10 and 12 showed that Cd and yg/yo was inversely proportional. Figure 12 showed that the relationship between Cd and Qa was directly proportional.

Table 4 Data and Calculation of Cd with condition 2 as Yg1 ≠ Yg2 for Left gate

yo m	Yg m	b m	y_1 m	y_b m	V m/s	A m^2	Qa m^3/s	Qtr m^3/s	Cv = Qa/Qtr	Cc = Y1/Yg	Cd = Cv * Cc	y_g/y_o
0.116	0.090	0.050	0.052	0.075	0.700	0.004	0.0026	0.0033	0.806	0.578	0.466	0.776
0.118	0.080	0.050	0.043	0.071	0.700	0.004	0.0025	0.0028	0.891	0.538	0.479	0.681
0.122	0.070	0.050	0.041	0.061	0.759	0.003	0.0023	0.0027	0.844	0.586	0.494	0.574
0.126	0.060	0.050	0.038	0.055	0.759	0.003	0.0021	0.0026	0.797	0.633	0.505	0.476
0.131	0.050	0.050	0.033	0.046	0.817	0.002	0.0019	0.0024	0.795	0.660	0.525	0.382

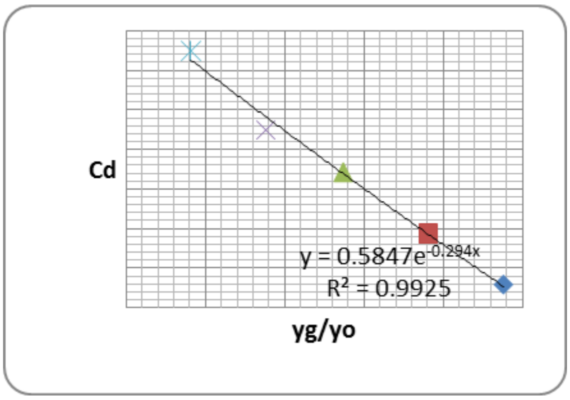

Figure 10. Relationships of yg/yo with Cd with condition 2 as yg1>yg2 for Left gate

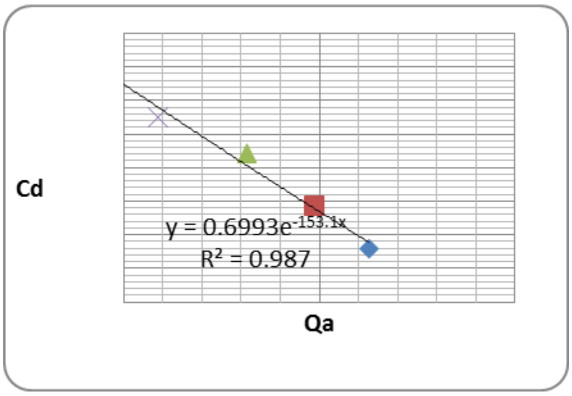

Figure 11. Relationships between Qa and CD with condition 2 as yg1≠yg2 for Left gate

Table 5 Data and Calculation of Cd with Condition 2 as Yg1> Yg2 for Right gate

yo m	yg m	b m	y1 m	yb m	V m/dt	A m^2	Qa m^3/dtk	Qtr m^3/dtk	Cv = Qa/Qtr	Cc = Y1/Yg	Cd = Cv * Cc	yg/yo
0.116	0.100	0.050	0.073	0.076	0.700	0.004	0.0027	0.0043	0.617	0.730	0.451	0.862
0.118	0.100	0.050	0.057	0.078	0.730	0.004	0.0028	0.0035	0.802	0.570	0.457	0.851
0.122	0.100	0.050	0.056	0.081	0.730	0.004	0.0030	0.0036	0.824	0.560	0.462	0.820
0.126	0.100	0.050	0.049	0.085	0.730	0.004	0.0031	0.0033	0.949	0.490	0.465	0.794
0.131	0.100	0.050	0.046	0.085	0.759	0.004	0.0032	0.0032	1.017	0.460	0.468	0.763

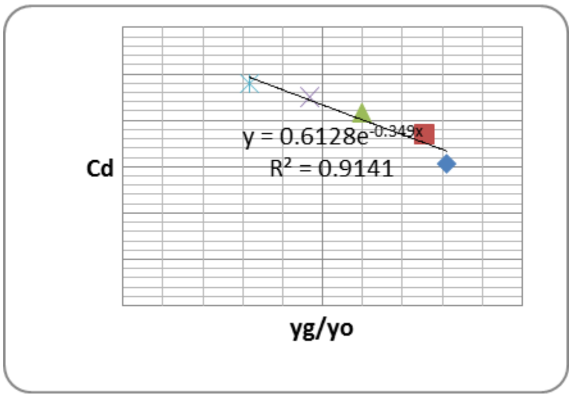

Figure 12. Relationships of yg/yo with Cd with condition 2 as yg1≠yg2 on the Right gate

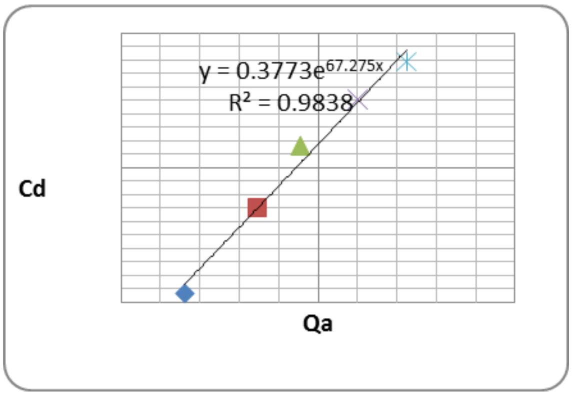

Figure 13. Relationships between Qa and CD with condition 2 as yg1≠yg2 on the Right

Table 6 displayed data from laboratory observations and calculation of Qa and Cd with condition 3 in single gate, Figure 14 was a graph of the relationship Cd with yg/yo and Figure 15 was a graph of the relationship of CDs with Qa. Both figures showed the Cd value inversely proportional to yg/yo.

Table 6. Data and Calculation of Cd with Condition 3 as single gate

y_0 m	Yg m	b m	y_1 m	y_b M	V m/dt	A m^2	Qa m^3/dtk	Qtr m^3/dtk	Cv = Qa/Qtr	Cc = Y1/Yg	Cd = Cv * Cc	y_g/y_o
0.121	0.100	0.050	0.059	0.079	0.730	0.004	0.00288	0.00373	0.774	0.590	0.457	0.826
0.122	0.090	0.050	0.058	0.073	0.730	0.004	0.00266	0.00369	0.722	0.644	0.465	0.738
0.127	0.080	0.050	0.052	0.066	0.759	0.003	0.00250	0.00346	0.725	0.650	0.471	0.630
0.136	0.070	0.050	0.046	0.051	0.963	0.003	0.00246	0.00323	0.760	0.654	0.497	0.515
0.140	0.060	0.050	0.043	0.045	0.992	0.002	0.0022	0.0031	0.715	0.719	0.514	0.429

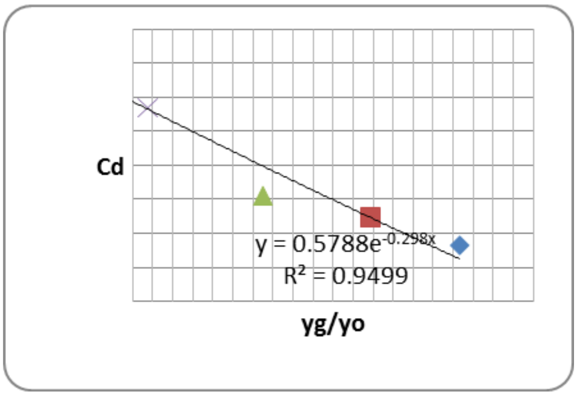

Figure 14. Relationships of Cd with yg/yo with Condition 1 as single gate

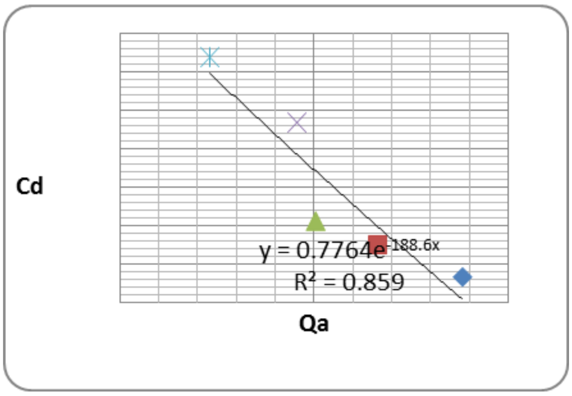

Figure 15. Relationships between Qa and CD with condition 1 as single gate

Testing the three conditions above can be seen that the relationship Cd with yg/yo all states that the value of Cd was inversely proportional to yg/yo, while the relationship graphs with Qa were inconsistent, because in condition 1 both left and right gates and condition 2 at the right gate the value of Cd was directly proportional to Qa while in condition 2 the opening of the left gate and condition 3 of the Cd value was inversely proportional to the value of Qa. Based on these results, it can be stated that the value of Cd depends on the value of yg/yo, so that this relationship can be made a Cd equation. The relationship of the value of Cd with the value of yg/yo in figure 6, 8, 10, and 12 each produced a Cd regression equation which can be seen in table 7.

Table 7 Equations Cd base on laboratory data

Treatment of gate	Equation Cd
Condition 1 as yg1 = yg2	$Cd = 0.605\ e^{(-0.31\ yg/yo)}$
Condition 2 as yg1≠yg2 for Left gate	$Cd = 0.584\ e^{(-0.29\ yg/yo)}$
Condition 2 as yg1≠ yg2 for Right Gate	$Cd = 0.612\ e^{(-0.34\ yg/yo)}$
Condition 3 as one gate opening	$Cd = 0.776\ e^{(-188\ yg/yo)}$

Furthermore, the equation of the Cd in table 7 was verified by the Cd equation of the results of the previous researchers in table 1 above.

4.2 Calibration of Test Results Cd

Verification of the results of testing the Cd equation with the Cd equation from the previous research by comparing the two results of the equation. Comparison of the values of the eight previous studies in table 1 was then compared with the Cd equation of the research results in Table 5. The data used in verification was assumed to be the same data, namely water upstream (yo), gate opening height (yg) and gravity acceleration (g) so that it produces a Cd value that was almost the same using the equation of each of the following was the result of the calculation and graph (Table 8).

Table 8. Discharge Coefficient Value Based on the equation of previous studies

yg/yo	Value of Cd Results of Previous studies							
	Rajaratnam	Swamee	garbrecht	Noutsopoulus	Larsen	Alhamid	Nago	Rady
0.99	0.49	0.36	0.52	0.47	0.49	0.38	0.45	0.43
0.91	0.51	0.42	0.53	0.48	0.49	0.44	0.46	0.44
0.84	0.52	0.44	0.53	0.48	0.48	0.46	0.47	0.44
0.78	0.54	0.46	0.54	0.49	0.48	0.47	0.47	0.45
0.73	0.55	0.47	0.55	0.49	0.48	0.48	0.48	0.45
0.68	0.56	0.47	0.55	0.50	0.47	0.49	0.49	0.45
0.63	0.56	0.48	0.55	0.50	0.47	0.49	0.50	0.46
0.60	0.57	0.49	0.56	0.50	0.47	0.50	0.50	0.46
0.56	0.57	0.49	0.56	0.51	0.47	0.50	0.51	0.46
0.53	0.58	0.49	0.57	0.51	0.47	0.50	0.51	0.46
0.50	0.58	0.50	0.57	0.51	0.46	0.51	0.52	0.47

The Cd value in table 8 can see that the eight researchers produce Cd values between 0.36 to 0.58. The smallest Cd value was found by Swamee study [8] and the largest was Rajaratman study [6] and other studies who had almost the same Cd values were six researchers [8,10,11,12,13,14]. Table 9 showed the Cd value using the equation of the test results in Table 3.

Table 9. The Discharge Coefficient Value Based on the on the equation of previous studies

yg/yo	Value of Cd Research Results			
	$y_{gki} = y_{gka}$	Condition 2 as yg1≠yg2 for left gate	Condition 2 as yg1≠yg2 for right gate	Single gate opening
0.990	0.444	0.437	0.433	0.434
0.910	0.455	0.448	0.446	0.444
0.840	0.465	0.457	0.457	0.453
0.779	0.474	0.465	0.466	0.461
0.725	0.482	0.472	0.475	0.468
0.677	0.490	0.479	0.483	0.475
0.635	0.496	0.485	0.490	0.481
0.597	0.502	0.491	0.497	0.486
0.562	0.508	0.496	0.503	0.491
0.531	0.513	0.500	0.508	0.496
0.503	0.517	0.504	0.514	0.500

The value of Cd from the test results in table 9 showed a value between 0.433 to 0.517 which was close to the Cd value based on the previous studies' equations and for clarity the comparison between the values of Cd in Table 8 and Table 9 was illustrated in the following graph.

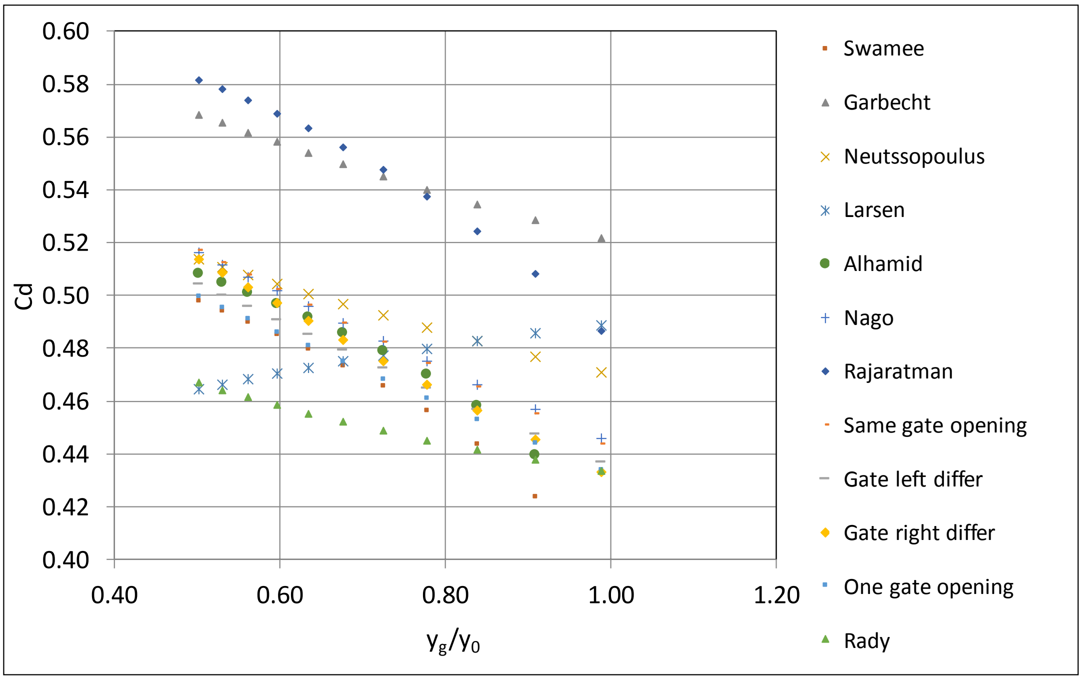

Figure 16. Graph of Relationships between yg/yo with Cd from this study compared to previous studies

Figure 16 showed that the Cd value of this research approached the previous studies or that between the studies carried out by Swamee, Noutsopoulus and Nago, then the calculation of the results of the research on symmetrical gate openings or high conditions yg1 = yg2, namely Cd = 0.6055 $e^{-(yg/yo)}$ [8,10,13].

Figure 16 showed the calibration of the study with the results of 8 previous studies and it appeared that this study obtained a smaller Cd value from the Rajaratnam and Garbrecht [6,9], and greater than that [8,12] while the others cut each other. The Cd values that had a smaller difference of 0.05 were Swamee, Noutsopoulus, Larsen, Alhamid, Nago and Rady [8,10,11,12,13,15] while differences greater than 0.05 were [6][9]. So eight previous researchers 6 researchers had a difference below 0.05 and only 2 researchers above 0.05, so it was concluded that the research conducted was acceptable. Furthermore, the three tested conditions have a Cd value that was close to each other, namely the difference between 0.004 to 0.017 and in condition one has the same Cd value as the Nago study [13], so for the planning of the gate operating pattern the Cd condition of the gate opening was symmetrical or high yg1 = yg2 with the following equation:

$$Cd = 0.6055\, e^{-(yg/yo)} \quad (10)$$

4.3 Gate Operation Pattern

After determining the equation used in calculating Cd, the gate operation can be planned. The number of gates planned to be installed was 2 pieces, the width of each gate was 5.00 meters with the maximum water height upstream of the 8.50 m gate in Q10 and then it was determined that the maximum discharge that exits through the retention pool gate was 25 m^3/sec. The formula used in calculating the discharge that passes through the sliding gate was a simulation as seen in table 10 and figure 17.

Table 10. Gate Operation in relation with yg and yo

No	Upstream height	Gate opening (yg)		Gate width	Gravity	Cd1	Cd2	Q		Qt0t
		I	II	Pintu	g			Gate I	Gate II	
	yo	m	m	m	m/s^2			m^3/s	m^3/s	m^3/s
1	1.20	1.152	1.152	5.00	9.80	0.448	0.448	12.50	12.50	25.00
2	1.30	1.152	0.966	5.00	9.80	0.458	0.479	13.32	11.68	25.00
3	1.40	1.152	0.829	5.00	9.80	0.467	0.502	14.10	10.90	25.00
4	1.50	1.152	0.720	5.00	9.80	0.475	0.520	14.85	10.15	25.00
5	2.00	1.152	0.381	5.00	9.80	0.505	0.570	18.21	6.79	25.00
6	2.50	1.152	0.188	5.00	9.80	0.524	0.591	21.11	3.89	25.00
7	3.00	1.157	0.053	5.00	9.80	0.536	0.602	23.78	1.22	25.00
8	3.50	1.102	0.000	5.00	9.80	0.548	0.605	25.00	0.00	25.00
9	4.00	1.010	0.000	5.00	9.80	0.559	0.605	25.00	0.00	25.00
10	4.50	0.940	0.000	5.00	9.80	0.567	0.605	25.00	0.00	25.00

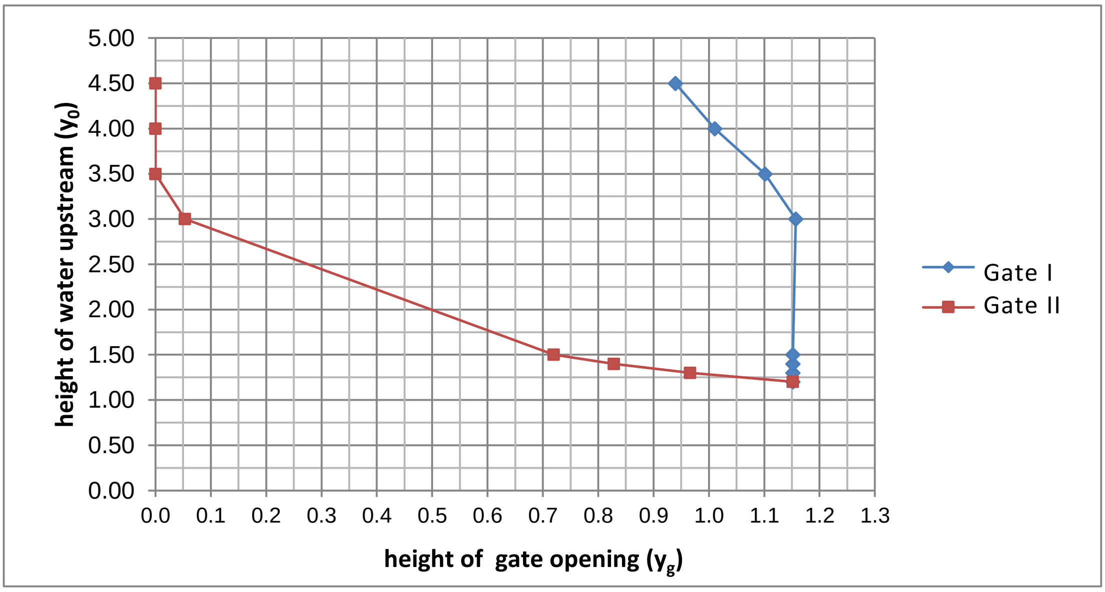

Figure 17. Graph Relationship between yg and yo

The operation of the gate based on table 6 was as follows:

1. Incoming discharge was 25 m3 / sec or water level was upstream (yo) 20 1.20 m, both gates are fully opened as high as 1.152 m from the pool floor
2. The height of water upstream from 1.20 m to 2.50 m, the height of gate openings 1 (yg1) remains = 1.152 m, only gate 2 (yg2) was lowered or decreases if yo > 1.20 m, and yo = 1.30 m, then yg2 = 0.966 m; yo = 1.40 m then yg2 = 0.829 m; yo = 1.50 m then yg2 = 0.720 m; yo = 2.00 m then yg2 = 0.381 m; yo = 2.50 m then yg2 = 0.188 m.
3. If yo = 3.00 m then yg2 = 0.053 m
4. Starting from yo = 3.50 m to yo = 4.50 m (equivalent to face elevation + 8.50 m in a pool) and yg2 was closed or equal to 0, only yg1 was lowered, if yo = 3.50 then yg1 = 1.102 m; yo = 4.00 then yg 1 = 1.010 m: and finally yo = 4.50 m, then yg 1 = 0.940 m
5. If yo> 4.50 m, the water was diluted through a spillway.
6. If the condition of the entry water begins to decrease, the operation returns to points 4, 3, 2 and so on the position of the gate at first point 1, for clear operation of the gate movement in relation to the height of water in the pool can be seen in table 6. with the one below.

Information on the use of the graph above was that if the height of the water in the pond was known, it can be known that the gate openings one and two are high by drawing a horizontal line from the water level to the Qgate I and Qgate lines.

Gate operation I

If yo = 0.00 m - 2.50 m then the height of the gate openings was = 1.152 m

If yo> 2.50 m then the height of the gate opening was calculated by the = 0.1488 yo + 1.61

Gate operation II
If yo = 0.00 m - 3.50 then the one calculated by was = 0.3304yo2 - 1.9485yo + 2.9483
If yo> 3.50 m then gate 2 was closed or that = 0.00.

V. DISCUSSION

The sliding gate operation was the higher the water was upstream (yo) the smaller the opening height (which is) because if yo was large then the discharge that gets out was greater so as to maintain the outflow that was minimized.

The calculation results illustrated in Figures 6, 8, 10, 12 and 14 show the relationship Cd with yg/yo with the following discussion:

If Q, yo decreased and the gate openings was fixed, then the yg/yo increased and Cd decreased because the speed below the gate decreased causing Cc to shrink. The Cd was the result of multiplication of Cv and Cc so that if the Cc directly proportionate to Cd. If Q was fixed and yo changed then yg/yo decreased and Cd was incresed because of the speed below the big gate increasing that causes the Cc to also larger, then Cd was also increased as explained before.

The increase in the value of Cd was not always accompanied by an increase in Q discharge because the magnitude of the value of Q was strongly influenced by the height of the gate opening and the height of the water upstream. Debit Q only increases by increasing the value of Cd if the height of the water was fluctuating and the height of the gate open was constant, whereas if the height of the opening changes then the magnitude of Q was inversely proportional to the value of Cd. Based on these analyses, the result of calculation must take into account when design the sluice gate. Improved water management and efficient investment in the modernization of irrigation schemes were essential to satisfy the increasing demand for water [16].

VI. CONCLUSION

1. The coefficient of Cd was influenced by the ratio of which and yo the greater the / yo, the Cd gets smaller and vice versa.
2. If the gate opening was open and the water level was upstream, then the Cd coefficient will be directly proportional to the incoming discharge and if the gate openings change then Cd was inversely proportional to the inlet discharge.
3. The amount of the discharge that passes on the gate depends on the height of the water at the top of the gate, the height of the openings and the width of the gate.
4. The smaller the openings with the water upstream remain, the greater the flow velocity below the gate causes the depth of y_1 to be smaller and the contraction coefficient to increase

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