Building Calibration Analysis Measure Ayung River Irrigation Area Case Study of Kedewatan Dam

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Abstract: Measuring building is a building that is very important in the accuracy of the distribution of irrigation water. Through this building, the amount of debit given can be adjusted according to needs. The existence of a measuring building in the Ayung River Irrigation Area in the Kedewatan Weir is more than 25 years old, but it still functions as a measuring building that distributes water to the rice fields. The current problem is that the flow rate formula does not take into account the flow coefficient because the cross-sectional shape of the building has changed. Therefore it is necessary to calibrate to analyze the flow coefficient according to the flow characteristics. This research was conducted using a comparison method between actual and theoretical debits. The actual debit is obtained by measuring the debit directly. Based on the measurement results, it shows that the current condition of the canal has undergone several changes due to sedimentation and changes in the shape of the measuring structure so that the flow coefficient has changed.

1 INTRODUCTION

The provision of sufficient water to rice plants has the effect of increasing agricultural production significantly. The provision of water to rice plants is given for approximately 70 days starting from the planting period until before harvest with water needs in Indonesia ranging from 1-2 liters/sec/Ha (Shock, Barnum, and Seddigh 1998), (Lisa Guppy; Kelsey Anderson; Mehta; P.; Nagabhatla;. 2017). The water drainage system in the irrigation network is distributed through intakes located on each weir, while the flow from the int to the weir passes through several channels ranging from primary, secondary, and tertiary which are directly connected to farmers' fields. Likewise, the flow of water from the weir to the rice fields is equipped with several buildings ranging from share buildings, tapping buildings, plunge buildings as well as measuring buildings, and other buildings (Ahmed 2020).

The existence of a measuring building in the Ayung river irrigation area has the main function of measuring the amount of water discharge released from the channel to the rice fields. This measuring building determines the amount of water that is in accordance with the water needs of each plot of rice terraces. As time goes by and the age of the measuring building which is more than 25 years, the physical condition of the building and the condition of the channel flow upstream and downstream of the measuring building have changed. The current problem related to the measuring building is the mismatch between the resulting discharge and the flow formula used in the current measuring building. This condition affects the accuracy of water availability in the paddy fields which results in a decrease in farmers' grain production. The basic formula for the flow of water from the existing measuring building does not take into account the coefficient of flow either caused by the velocity of the water or caused by the cross-sectional shape of the building.

Given the problem with the inaccuracy of the debit recording, it is necessary to carry out an analysis to correct/calibrate the measuring building to obtain the formula that is most appropriate to the current condition of the measuring building. The results of this calibration analysis are expected to have an effect on the efficiency of drainage that can be carried out in the entire Ayung river irrigation area. Furthermore, the results of this calibration can be used as guidelines in the implementation of water supply operations throughout the Ayung river

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irrigation area. Based on the background above, the problems that can be conveyed are what is the current condition of drainage and what is the flow formula that should be in accordance with the current condition of the building?

2 METHODS

2.1 Research Design

The research implementation is generally carried out in the form of instantaneous discharge measurements and calibration implementation. The instantaneous discharge measurement is carried out by using the one-point method into the water with several drains. The determination of the number and width of the drain is adjusted to the width of the existing channel in the field. The density of the inter-pias point determines the level of accuracy of the discharge measurement, but in this study the width is satisfied every 20 cm. Instantaneous discharge measurements were carried out 10 times with different discharge variations. While the calibration analysis is carried out by determining the average coefficient value of each measurement produced. From the 10 times the flow coefficient, the trendline analysis was analyzed to get the average flow coefficient value.

The research work steps are outlined in the form of a research flow chart that describes the complete stages from beginning to end sequentially to the end with a duration of one year of research

2.2 Data Collection

The source of data for calibration activities is carried out at the agency that is the goal in providing calibration results, in this case the Bali Provincial PUPR Service and other agencies that provide similar data in the operational field of measuring buildings for irrigation, namely the Bali Penida River council.

In conducting the survey, several activities were carried out related to the current operating and maintenance system for measuring buildings. Searched data

a. Location of the building measure
b. Physical condition of the measuring building
c. Current flow formula
d. Building accuracy problems
e. The current measuring building OP system manual
f. Policy of irrigation building management system

Pictures of the current condition of the building can be seen in the figure 1.2 and 3.

Figure 1: BLG 1.

Figure 2: BLG 2.

Figure 3: BM 1A.

2.3 Necessary Equipment

The equipment needed to support calibration activities consists of several equipment, namely:
1. Meter

The meter needed is a short 5 m meter and a 50 m long meter. This meter is needed to measure the dimensions of the measuring building as well as to measure the depth of the water.

Figure 4: Meter (source: Onda).

2. Measuring sign
Measuring signs are needed to determine the water depth in the measuring building.

Figure 5: Measuring sign (source: Indogeotech Darma).

3. Geographic Information System (GPS)/Mobile
GPS is a tool used to determine the geographical position of measuring buildings in accordance with existing coordinates.

Figure 6: GPS (Source: Garmin).

4. Survey Form
The survey form is a tool for recording depth and water, the amount of water, weather information, recording staff and special conditions in the field when taking measurements.

5. Current Meter
The current meter is the main tool used to measure the speed of water in meters/second.

Figure 7: Current meter (source: Seba Hydrometrie).

2.4 Calibration Stage

Calibration is an activity to test the current ar flow formula by comparing the factual discharge with the theoretical discharge (Shock, Barnum, and Seddigh 1998), (Asmiwyati et al. 2015), (Jaiswal et al. 2012), (Kroc and Zumbo 2018), (Xu et al. 2021).

1. Instantaneous discharge measurement
Measurement of instantaneous discharge is a very important activity to determine the amount of discharge that exists at a certain time. At the time of measurement can be done with the method of one point, two points or three points according to the depth of the water.

2. Flow coefficient value
The flow coefficient is sought to obtain the true value of C by comparing the factual discharge with the theoretical discharge. To obtain maximum results, the instantaneous discharge data should be sought with a longer or more duration (Collectives n.d.), (Vermillion et al. 1999), (Akkuzu, Ünal, and Karataş 2007), (Badan standar Nasional Indonesia 1992)

3. Regression analysis
Regression analysis was carried out to obtain the coefficient value that most closely matched the distribution of the discharge measurements that had been carried out (Armstrong 2012), (et al. 2017)

4. Pairing with the old streaming formula
Pairing can be done when the actual discharge data has been compared with the theoretical discharge compared to the existing formula. From the formula used today, it is compared with the formula obtained.

5. Calibration
Calibration is the final step to obtain the most suitable C value after several tests. This calibration number becomes a benchmark in determining the actual value of C.

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3 RESULTS AND DISCUSSION

3.1 Existing Condition of Building Measure

There are six measuring buildings in the Kedewatan dam which are spread over the irrigation network. Kedewatan irrigation area Measurement Buildings are located in six locations, namely in Kedewatan Village BLG 1 (left), BLB 1 (right), BLK, BLM, BS1 and BS3 in Lambing Mambal Village. In general the condition of the building is very well maintained and can operate well. The problem in general is the presence of sediment in the channel which affects the flow. This sedimentation is caused by the remnants of the downstream building that enter the channel which causes disturbances upstream.

3.2 Instantaneous Discharge Measurement

Instantaneous discharge measurement is carried out to determine the amount of discharge that occurs factually. This discharge measurement was carried out repeatedly with 10 measurement trials. The results of the instantaneous discharge measurements in each building can be seen in Table 1 to Table 6.

3.3 Calibration

Calibration is carried out based on the results of the calculation of the instantaneous discharge to obtain the coefficient of flow (Cd) and the coefficient of water velocity (Cv). Based on the values of Cd and Cv, regression analysis was performed to determine the distribution of Cd and Cv values compared to the debit values.

Regression analysis was conducted to determine the relationship between discharge on the horizontal axis with a value of 1.705 $Bh^{3/2}$ on the vertical axis. This analysis provides equations and trendlines for all existing relationships. With this regression analysis, it can be seen the closeness of the distribution of the data that we get during the 10 experiments carried out. If inconsistent data is found, it must be re-checked until a uniform distribution is obtained and an equation can be drawn. Regression analysis is shown in the figure 8-13. The coefficient analysis is determined from two components, namely the result of the shape of the building (Cd) and the effect of the speed (Cv). Of the 10 times the experiment was carried out, 1 value of Cd and Cv was obtained. Then from the values of cd and cv that have been collected, calibration analysis is carried out. The analysis of Cd and Cv is shown in Table 1-6. Calibration Result Recapitulation show in Table 7.

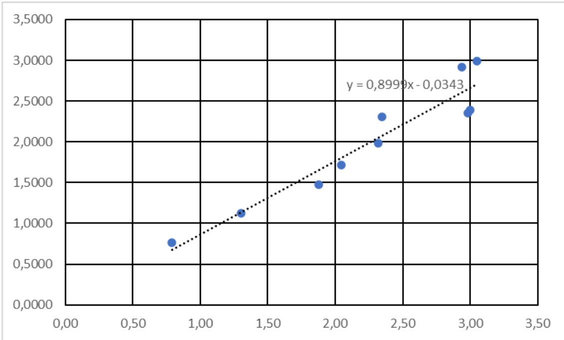

Figure 8: Regression analysis for BLG 1.

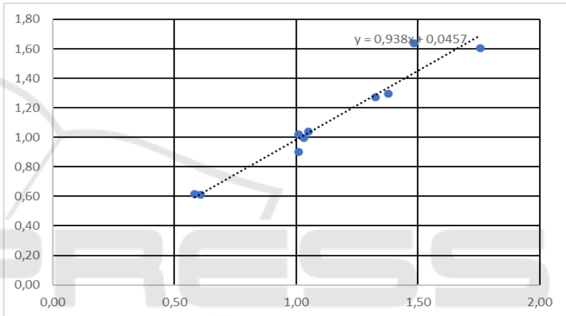

Figure 9: Regression analysis for BLB 1.

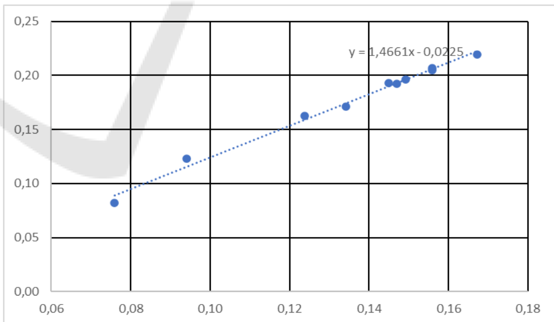

Figure 10: Regression analysis for BLK.

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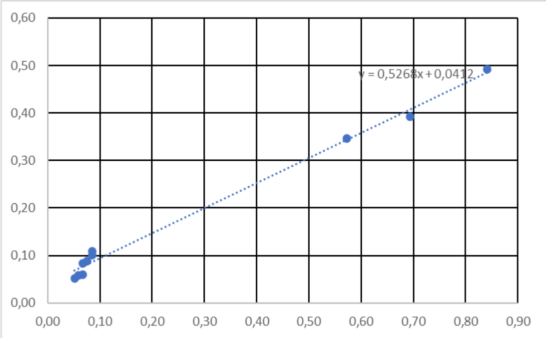

Figure 11: Regression analysis for BLM.

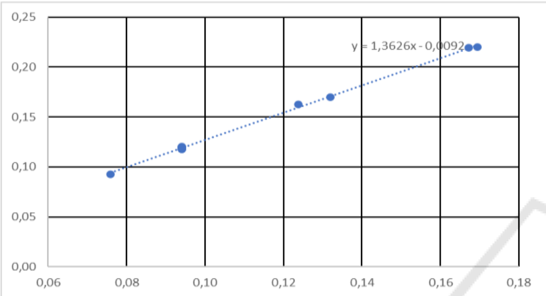

Figure 12: Regression analysis for BS1.

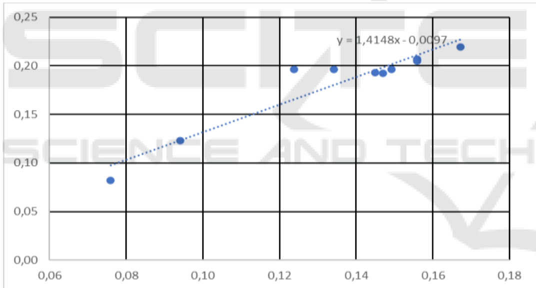

Figure 13: Regression analysis for BS3.

Table 1: Cd and Cv for BLG 1.

No	Experiment	Q (m³/dt)	Cd, Cv
1	1	0.79	1.03
2	2	1.30	1.16
3	3	1.88	1.27
4	4	2.32	1.17
5	5	3.00	1.25
6	6	3.05	1.02
7	7	2.35	1.02
8	8	2.04	1.18
9	9	2.98	1.27
10	10	2.94	1.01

Table 2: Cd and Cv for BLB 1.

No	Experiment	Q (m³/dt)	Cd, Cv
1	1	1.76	1.09
2	2	1.36	1.06
3	3	1.03	1.04
4	4	0.61	0.99
5	5	0,58	0.95
6	6	1.33	1.04
7	7	1.01	0.99
8	8	1.01	1.12
9	9	1.48	0.91
10	10	1.05	1.01

Table 3: Cd and Cv For BLK.

No	Experiment	Q (m³/dt)	Cd, Cv
1	1	0.17	1.28
2	2	0.16	1.31
3	3	0.09	1.08
4	4	0.12	1.31
5	5	0.22	1.31
6	6	0.19	1.33
7	7	0.21	1.33
8	8	0.21	1.32
9	9	0.20	1.32
10	10	0.19	1.31

Table 4: Cd and Cv for BLM.

No	Experiment	Q (m³/dt)	Cd, Cv
1	1	0.10	1.19
2	2	0.06	0.88
3	3	0.05	1.01
4	4	0.08	1.24
5	5	0.09	1.15
6	6	0.06	0.98
7	7	0.35	0.61
8	8	0.49	0,5900
9	9	0.39	0.57
10	10	0.11	1.28

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Table 5: Cd and Cv for BS1.

No	Experiment	Q (m^3/dt)	Cd, Cv
1	1	0.17	1.29
2	2	0.16	1.31
3	3	0.09	1.22
4	4	0.12	1.28
5	5	0.22	1.31
6	6	0.22	1.30
7	7	0.12	1.27
8	8	0.12	1.28
9	9	0.12	1.25
10	10	0.12	1.25

Table 6: Cd and Cv For BS3.

No	Experiment	Q (m^3/dt)	Cd, Cv
1	1	0.19	1.46
2	2	0.19	1.59
3	3	0.08	1.08
4	4	0.12	1.31
5	5	0.22	1.31
6	6	0.19	1.33
7	7	0.21	1.33
8	8	0.21	1.32
9	9	0.20	1.32
10	10	0.19	1.31

Table 7: Calibration Result Recapitulation.

No	Name	Old Formula	New Formula
1	BLG 1	$Q = 1{,}71\ b\ h^{1,5}$	$Q = 1{,}53\ b\ h^{3/2}$
2	BLB 1	$Q = 1{,}71\ b\ h^{1,5}$	$Q = 1{,}60\ b\ h^{3/2}$
3	BLK	$Q = 1{,}71\ b\ h^{1,5}$	$Q = 1{,}26\ b\ h^{3/2}$
4	BLM	$Q = 1{,}71\ b\ h^{1,5}$	$Q = 0{,}9\ b\ h^{3/2}$
5	BS 1	$Q = 1{,}71\ b\ h^{1,5}$	$Q = 2{,}31\ b\ h^{3/2}$
6	BS 3	$Q = 1{,}71\ b\ h^{1,5}$	$Q = 2{,}40\ b\ h^{3/2}$

4 CONCLUSSION

Based on the results of measurements that have been carried out in the field, it shows that the current condition of the drainage has undergone several changes due to sediment and changes in the shape of the measuring building. In more detail, the following conclusions can be drawn:

1. The flow has been using the flow formula with the same formula, namely $Q = 1.705\ B\ H^{3/2}$ while the measurement results show that there is a coefficient of C whose value varies as the influence of the speed and shape of the building. The formula obtained from the measurement results $Q = 1.705\ C\ B\ H^{3/2}$

2. Based on the calibration results, a new formula is obtained from the flow with the following formula: BLG 1A has the formula $Q = 1.53\ b\ h^{3/2}$, BLB 1a has the formula $Q = 1.60\ b\ h^{3/2}$, BM 1a = $Q = 0.9\ b\ h^{3/2}$, BLK has the formula $Q = 1.26\ b\ h^{3/2}$, BS 1 has the formula $Q = 2.31\ b\ h^{3/2}$, BS 3 has the formula $Q = 2.40\ b\ h^{3/2}$, BLK 2 has the formula = $Q = 2,\ 51\ b\ h^{1,5}$, the overflow formula is $0.17\ B\ H^{3/2}$

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