Calibration of Irrigation Gates in Punggur Utara

WORD COUNT 1953
TIME SUBMITTED 11-MAR-2021 09:10AM
PAPER ID 69833090

CALIBRATION OF IRRIGATION GATES IN PUNGGUR UTARA IRRIGATION AREA

DYAH INDRIANA KUSUMASTUTI
Lampung University, Bandar Lampung, Indonesia, kusumast@gmail.com

DWI JOKOWINARNO
Lampung University, Bandar Lampung, Indonesia, d.jokowinarno@gmail.com

ABSTRACT

Sekampung irrigation system consists of seven irrigation areas, which are supported by two feeder canals. Feeder Canal I serves Sekampung Bunut, Sekampung Batanghari, Raman Utara, and Batanghari Utara drainage areas. Feeder Canal II serves North Punggur, Bekri and Rumbia irrigation areas. Land use, climate and social economic changes impact on supply and demand of irrigation in Sekampung Irrigation System. Significant decrease of discharge of Sekampung river impacts on discharge for irrigation released from Argoguruh Weir. As a result, distribution and irrigation efficiencies decrease. In order to improve operational of water distribution it needs to calibrate irrigation gates so that the amount of water to be divided and distributed is the same as the amount of water in the downstream of the gates. Research method includes measuring discharge and corresponding elevation in the canal for certain opening gate. Analysis used includes constructing rating curves, comparing the observed rating curves to the empiric ones, and calculating the gate coefficients. Results from calibration of more than 400 gates in Punggur Utara irrigation area show that the gate coefficients vary between 0,4 to 1,1 is around 61%. These results will be useful for water managers to better match supply and demand so that enabling delivery of the optimum amount of water to crops.

Keywords: Sekampung irrigation system, North Punggur irrigation area, calibration, gate

1. INTRODUCTION

Irrigation system by utilizing Sekampung river as water resources through Argoguruh weir is known as Irrigation Sekampung System. Irrigation Sekampung System is divided into seven irrigation areas including Sekampung Bunut, Sekampung Batanghari, North Raman, North Batanghari, North Punggur, Bekri and West Rumbia. The division of the irrigation areas are based on related Feeder Canals. Feeder Canal I serves Sekampung Bunut, Sekampung Batanghari, North Raman, North Batanghari Irrigation Areas, while Feeder Canal II serves North Punggur, Bekri and West Rumbia.

Argoguruh Weir was constucted in Sekampung river in 1935 in Tegineneng village South Lampung Regency with irrigation target area 20,600 Ha. By now to reach the target the irrigation project of Way Sekampung conducted capacity improvement of Feeder Canal I to have discharge of 41 m3/s, the increase of capacity of Feeder Canal II from 15 m3/s to 72.5 m3/s, and the increase of primary canal in North Punggur from 26 m3/s to 64 m3/s.

Researches which had been done in Sekampung irrigation system include optimation of cropping pattern (Setiawan and Anwar, 2017), evaluation of irrigation network performance at tertiary level in Sekampung Batanghari irrigation area (Viqhy et. al., 2012), optimation of providing water irrigation in Sekampung Batanghari area (Asnaning et. al., 2017), study of cropping pattern in Sekampung irrigation system (Aprizal and Yuniar, 2017) and water resources management of Way Sekampung catchment area between Batutegi Dam to Argoguruh Weir to develop operational pettern of daily storage (Ridwan et.al, 2013). It seems that there is no study about gate callibration in Sekampung irrigation system before. Therefore it is important to conduct research on gate calibration for Sekampung Irrigation system.

Among other irrigation areas in Sekampung Irrigation System, North Punggur has the largest paddy field area to serve, the longest primary and secondary canals., and the largest number of gates with more than 400 gates (Sembiring, 2015). This study aims to calibrate irrigation gates in North Punggur irrigation area. Irrigation network scheme for North Punggur irrigation area is presented in Figure 1 and 2, where Figure 1shows the irrigation network from BPU 1 – BPU 15 and Figure 2 shows the irrigation network from BPU 16 – BPU 26.

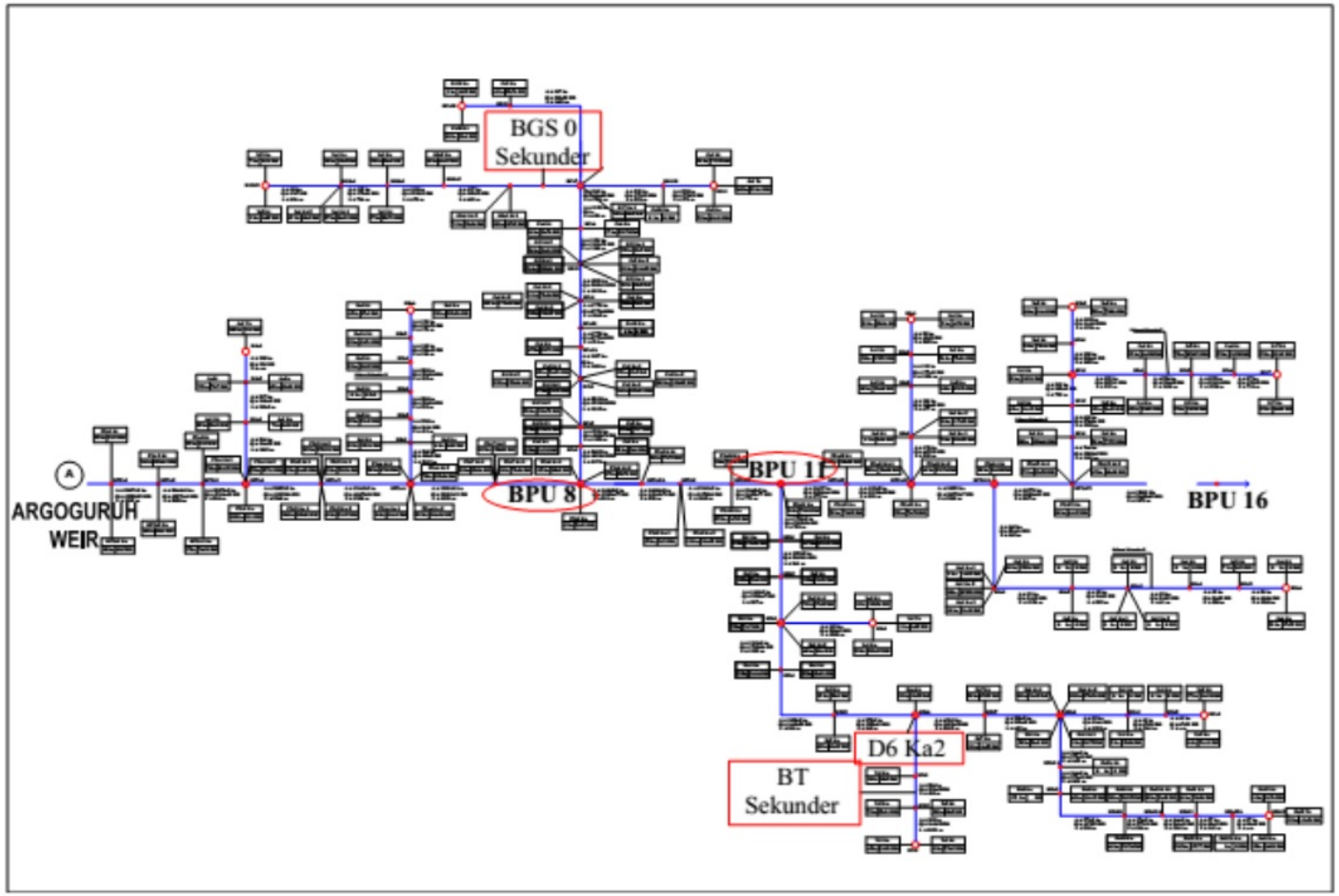


Figure 1. Irrigation network scheme for North Punggur irrigation area BPU 1 – BPU 15

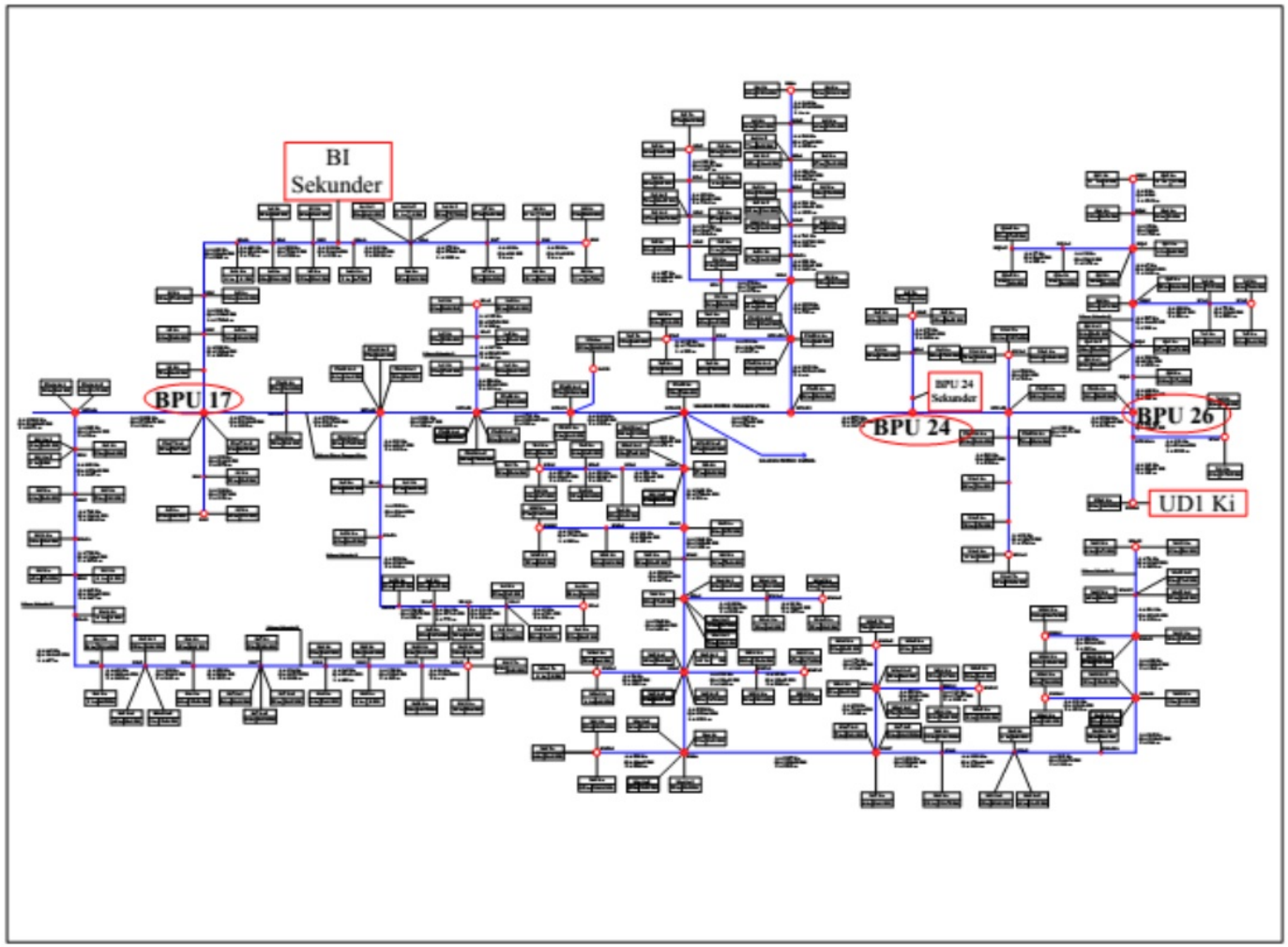


Figure 2. Irrigation network scheme for North Punggur irrigation area BPU 16 – BPU 26

2. METHOD

Analysis which had been done for this study includes :

1. producing rating curve relating discharge and gate opening relation,
2. producing rating curve relating discharge and water elevation in canal located after the gate. This type of rating curve can be useful to estimate discharge in the canal if water elevation is known.
3. estimating suitability of measured discharge compared to discharge as in empirical rating curve. Empirical rating curve is a curve that was drawn from empirical study for a certain gate width, i.e. 30, 50, 75, 100, 125 and 150 cm. Rehabilitation of north Punggur irrigation system was supported by European Economic Society and they had done laboratory research for those gate width and resulted rating curves was attached to most gates in this irrigation area.
4. calculating gate coeffficient using equation

$$Q = C_d . a . b \sqrt{2 . g . z} \quad (2)$$

where Q is discharge (m^3/s), Cd is gate coefficient, a is gate opening (m), b is gate width (m), g is gravity acceleration (m2/s) and z is the difference between water elevation at upstream gate and gate opening (for Crump de Gruyter gate) or the difference between water elevation at upstream and downstream gate (for Sluice Gate). (3)

5. producing discharge table for each gate based on gate coefficient received from calibration.

3. RESULT AND DISCUSSION

Some of the analysis results on rating curves and coefficient of gates are presented in Figures 3 and 4. Figure 3 shows the picture of the gate, rating curve to relate discharge and gate opening, rating curve to relate discharge and water elevation in canal downstream of gate, plotting of discharge on empiric rating curve, and resulting gate coefficient for gate D6 Ka2, UD1 Ki and BT Sub Sekunder which have gate width 30, 50 and 75 cm respectively. While Figure 4 shows the same item results for gate BI (Sekunder), BPU24 Sekunder and BGS 0 Sekunder which have gate width 100, 125 and 150 cm respectively. The locations of the gates can be seen in Figure 1 and 2 as their locations are marked.

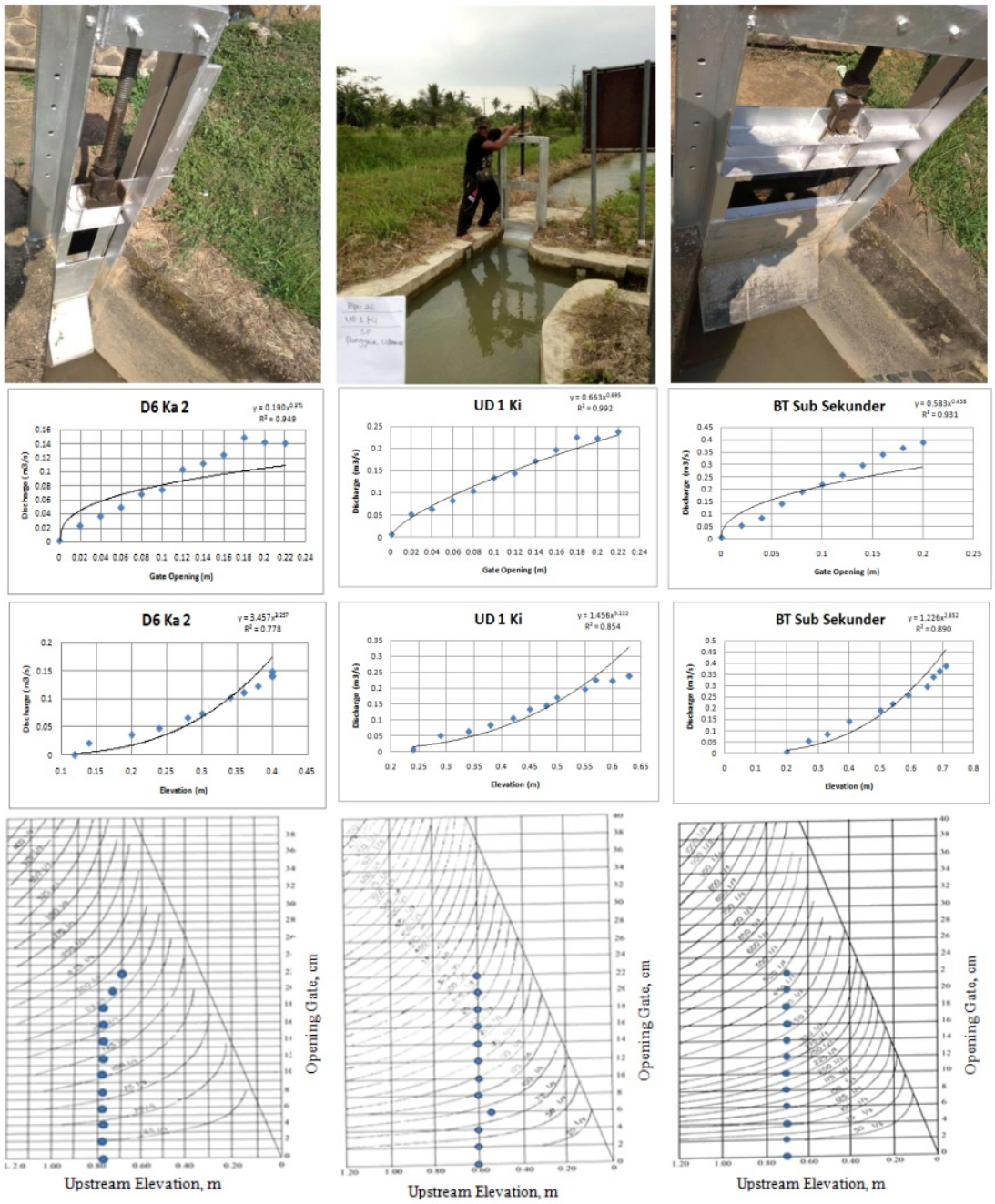
The result shows that gate coefficients for D6 Ka2, UD1 Ki, BT Sub Sekunder, BI (Sekunder), BPU24 Sekunder and BGS 0 Sekunder are 0.7606, 0.8986, 0.8631, 0.8535, 0.7099 and 0.8076 respectively. Among those six gates, only one gate (D6 Ka2) is Sluice gate type while others are Crump de Gryuter type. From the survey it was found that the percentage number of Crump de Gruyter type gate in North Punggur irrigation area is 83.45% and the percentage number of Sluice Gate type gate is 16.55%.

Analysis of gate coefficient which were done on 425 gates in North Punggur irrigation area can be summarized in Table 1 below.

Table 1. Percentage of number of calibrated gated and gate coefficient relation

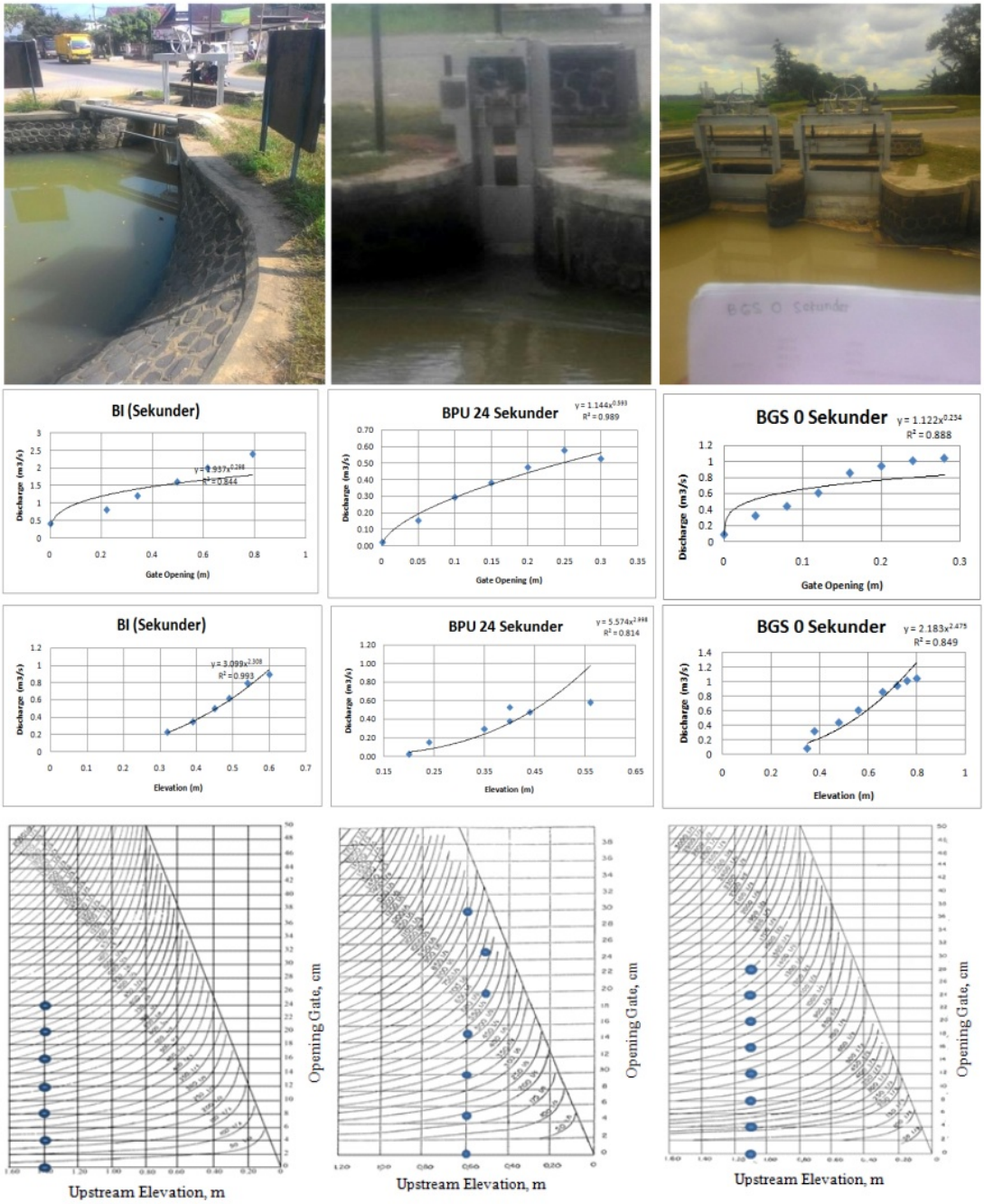
Cd	Percentage of Number of Calibrated Gates
Cd > 1	17.687
0.4 ≤ Cd ≤ 1	61.224
Cd < 0.4	21.089

It implies from Table 1 that gates which are in good condition is 61.224 percents. From the survey forms it can be learned that several gates cannot work properly as the bottom part of the gates were cut, or there is hole under the gate so that water will always flow although the gate is closed. This situation is not normal and therefore calculated gate coefficient from the calibration is greater than 1. Conversely, when there are lots of sediment in canal and water flow very slowly, it affects the measured discharge and results in low gate coefficient, which may fall below 0.4.



Gate name	: D6 Ka2	Gate name	: UD 1 Ki	Gate name	: BT Sub Sekunder
Location	: BPU11	Location	:BPU26	Location	: BPU11
Gate Type	: *Sluice Gate*	Gate Type	: Crump de Gruyter	Gate Type	: *Crump de Gruyter*
Dimension	: 30 x 110 cm	Dimension	: L x T = 50 x 60 cm	Dimension	: 75 x 110 cm
Coordinate	: S 05° 02' 15.27"	Coordinate	: S 04° 53' 48.4332"	Coordinate	: S 05° 02' 15.11"
	E 105° 19' 42.83"		E 105 ° 23' 13.6788		E 105° 19' 42.81"
Cd	0,7606	Cd	: 0.8986	Cd	: 0.8631

Figure 3. Analysis result for rating curves and gate coefficient for gate width of 30, 50 and 75 cm



Gate name	: BI Sekunder	Gate name	: BPU24 Sekunder	Gate name	BGS 0 Sekunder
Location	: BPU17	Location	: BPU24	Location	: BPU8
Gate Type	: Crump de Gruyter	Gate Type	: *Crump de Gruyter*	Gate Type	: Crump de Gruyter
Dimension	: L x T = 100 x 180 cm	Dimension	: L x T = 125 x 90 cm	Dimension	: 150 x 130 cm
Coordinate	: S 04° 59' 16.242"	Coordinate	: S 04° 55' 29.00"	Coordinate	: 48 M 0546229
	E 105° 19' 13.9584"		E 105o 21' 15.00"		UTM 9464801
Cd	: 0.8535	Cd	: 0.7099	Cd	: 0.8076

Figure 4. Analysis result for rating curves and gate coefficient for gate width of 100, 125 and 150 cm

Gate coefficient which was calculated is used to make discharge table which is easy to use for the gate operator to define how much he has to open the gate to release a certain discharge. Table 2 presents the example of discharge table for gate BT Sekunder which is located in BPU 11.

Table 2. Discharge table for gate BT Sub Sekunder

Gate : BT Sub Sekunder
Gate width (b) : 0.75 m
Gate Coefficient (Cd) : 0.8631

Water Elevation Upstream Gate (cm)	Gate Opening (cm) - a														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
30	30.3	58.5	84.3	107.6	128.2	146.0	160.6	171.7	178.8	181.3	178.4	168.6	149.1	113.5	0.0
35	32.9	63.9	92.6	119.2	143.4	165.0	184.0	200.0	212.8	222.1	227.4	228.2	223.6	212.4	192.3
40	35.4	68.8	100.3	129.8	157.0	182.1	204.7	224.7	242.1	256.5	267.6	275.3	278.9	278.1	272.0
45	37.6	73.4	107.4	139.5	169.6	197.7	223.5	247.1	268.2	286.7	302.5	315.3	325.0	331.0	333.1
50	39.7	77.8	114.1	148.7	181.3	212.1	240.9	267.5	292.0	314.1	333.8	350.9	365.2	376.6	384.7
55	41.7	81.9	120.4	157.3	192.3	225.6	257.0	286.5	313.9	339.3	362.4	383.1	401.5	417.2	430.1
60	43.7	85.8	126.4	165.4	202.7	238.4	272.3	304.3	334.5	362.7	388.9	412.9	434.7	454.2	471.1
65	45.5	89.6	132.1	173.2	212.6	250.5	286.7	321.1	353.8	384.7	413.6	440.6	465.6	488.3	508.9
70	47.3	93.2	137.6	180.6	222.1	262.0	300.4	337.1	372.2	405.5	437.0	466.7	494.5	520.3	544.0
75	49.0	96.6	142.9	187.8	231.2	273.1	313.5	352.4	389.7	425.3	459.2	491.4	521.8	550.4	577.0
80	50.6	100.0	148.0	194.6	239.9	283.7	326.1	367.0	406.4	444.2	480.4	515.0	547.8	578.9	608.2
85	52.2	103.2	152.9	201.3	248.3	294.0	338.2	381.1	422.5	462.3	500.7	537.5	572.6	606.1	637.9
90	53.8	106.4	157.7	207.7	256.5	303.9	350.0	394.6	437.9	479.8	520.2	559.1	596.4	632.2	666.3
95	55.3	109.4	162.3	214.0	264.4	313.5	361.3	407.8	452.9	496.6	539.0	579.8	619.3	657.2	693.5
100	56.8	112.4	166.8	220.0	272.0	322.8	372.3	420.5	467.4	512.9	557.1	599.9	641.3	681.2	719.7
105	58.2	115.3	171.2	225.9	279.5	331.8	382.9	432.8	481.4	528.7	574.7	619.3	662.6	704.5	744.9
110	59.6	118.1	175.4	231.7	286.7	340.6	393.3	444.8	495.0	544.0	591.7	638.2	683.3	727.0	769.4
115	61.0	120.8	179.6	237.3	293.8	349.2	403.4	456.5	508.3	558.9	608.3	656.5	703.3	748.8	793.1
120	62.3	123.5	183.7	242.8	300.7	357.6	413.3	467.9	521.2	573.5	624.5	674.2	722.8	770.1	816.0
125	63.6	126.2	187.7	248.1	307.5	365.8	422.9	479.0	533.9	587.6	640.2	691.6	741.8	790.7	838.4
130	64.9	128.7	191.6	253.4	314.1	373.8	432.3	489.8	546.2	601.4	655.6	708.5	760.3	810.8	860.2
135	66.1	131.3	195.4	258.5	320.6	381.6	441.6	500.5	558.3	615.0	670.6	725.0	778.3	830.5	881.4
140	67.4	133.8	199.1	263.5	326.9	389.3	450.6	510.9	570.1	628.2	685.2	741.2	796.0	849.6	902.2

4. CONCLUSIONS

Calibration of irrigation gates is useful for management and operation of gates, canals and irrigation network. In Punggur Utara irrigation area 61.224% of the gates have acceptable gate coefficient and the rest need reparation or improvement either on the gate itself or on the canal.

ACKNOWLEDGMENTS

The authors thank to Balai Besar Wilayah Sungai Mesuji Sekampung for providing funding for this work.

REFERENCES

Aprizal and Yuniar, M.F.N. (2017). Study of Cropping Pattern in Irrigation Sekampung System Lampung Province. Jurnal Teknik Sipil UBL. 8(1): 1105-1145.

Asnaning, A.R., Idrus, M., Istanto, K. (2017). Optimation of Irrigation water providing based on the shift of cropping schedule towards maximum cropping area. *Wahana Teknik Sipil*. 22(1): 50-57.

Ridwan, Sudira, P., Susanto, S. And Sutiarso, L. 2013. Water resources management in river basin among the Batutegi and the Argoguruh Weir, lampung Province: Analytical framework for the preparation of the daily operational patterns of reservoir. *Agritech*. 33(2): 226-233

Sembiring, C.E. (2015). Analysis of Irrigation Discharge (Supply and Demand) in Sekampung System. *Thesis*. Lampung University. Bandar Lampung.

Setiawan, A.H. and Anwar, N. Optimation of Cropping Pattern using Linear Programming (The Batu Tegi Dam, Way Sekampung catchment area, Lampung). Jurnal Teknik ITS. 6 (1) : 1-6.

Viqhi, N.Z., Rosadi, R.A.B., Haryono, N. and Oktafri. (2012). Evaluation of Tertiary Level Irrigation Performance Metro City Technical Unit of Irrigation Sekampung Batanghari Irrigation Areas. Jurnal teknik Pertanian Lampung. 1 (1) : 37-42.

Calibration of Irrigation Gates in Punggur Utara

ORIGINALITY REPORT

2%

SIMILARITY INDEX

PRIMARY SOURCES

1	Tony L. Wahl. "Issues and Problems with Calibration of Canal Gates", Critical Transitions in Water and Environmental Resources Management, 2004 Crossref	19 words — 1%
2	Guo Qiang Liu, Chang De Wang, Guang Hua Guan, Yi Bo Yan. "Modeling, Simulation and Automatic Control of Long Distance Water Transfer in Winter", Advanced Materials Research, 2011 Crossref	15 words — 1%
3	Changkuan Zhang, Hongwu Tang. "Advances in Water Resources and Hydraulic Engineering", Springer Science and Business Media LLC, 2009 Crossref	7 words — < 1%

EXCLUDE QUOTES	OFF	EXCLUDE MATCHES	OFF
EXCLUDE BIBLIOGRAPHY	ON		