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Cipolletti Was Not Recommended as Discharge Measurer For Research at Laboratory

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ABSTRACT

This paper studied the accuracy of Cipolletti discharge measurer at laboratory. The methodology consisted of experiment the relative error of Cipoletty at Laboratory. This research was conducted at Hydraulic Laboratory, Department of Water Resources-Faculty of Engineering- University of Brawijaya. Result was used as a recommendation for using Cipolletti discharge measurer at laboratory.

Key words: Cipolletti, discharge measurer, laboratory

INTRODUCTION

Natural rivers generally included of meandering regions. Curvature-induced secondary currents were formed at all stages of deposition proves. It was due to the centripetal forces acting in region of significant river like this [1], A primary goal of hydraulics modeling physical process in the hydraulic sciences were the prediction of a variable in time and/ or space from a given set of input [1]. How well a model fits the observed data usually was determined by pair wise comparisons of model predicted valued with observation [2].

The equations of channel geometry that related discharge to the channel cross section were considered to be the most reliable. Some previous researchers developed regression analysis relating discharge to channel cross section, it was hoped to produce satisfactory results [3]. Laboratory experiments involved collection of channel geometry and hydraulic model test data.

The investigations of flow physics at river confluences relay primarily on laboratory experiments [1]. In many cases, the use of such methods has involved substantial errors in the calculations of discharge and length of the curb-opening inlets [4] Control of water level, discharge regulator and measurement were the main problems which had to be considered in irrigation, water conservation, flood control etc. Regulation of water with measured structure or tool was very important for irrigation. Water structures could have function as discharge regulator such as movable gate, sharp crested weir.

Water structure could be functioned as regulation of discharge, such as moveable gate, sharp crested weir, broad crested weir, throated flume, etc [5]. Weber [5] said that control of water level regulation of discharge was an important thing. Regulation of discharge in water resources was very important due to irrigation, water conservation, flood control, and water supply. For irrigation, regulation of discharge was needed at square of irrigated rice field.

MATERIALS AND METHODS

Water discharge was as function of water height above measurer tool. Flow discharge could be expressed as Q = f(h), h (in unit of m, could be read at peilschaal or measurer ruler which was installed in the certain distance at upstream of measurer tool. Available error of reading was < .2.5 mm and generally reading mistake of peilschaal or measurer ruler was at about 1.5 mm or 0.0015 .m. Measurer of water height was described as in Figure 1 below.

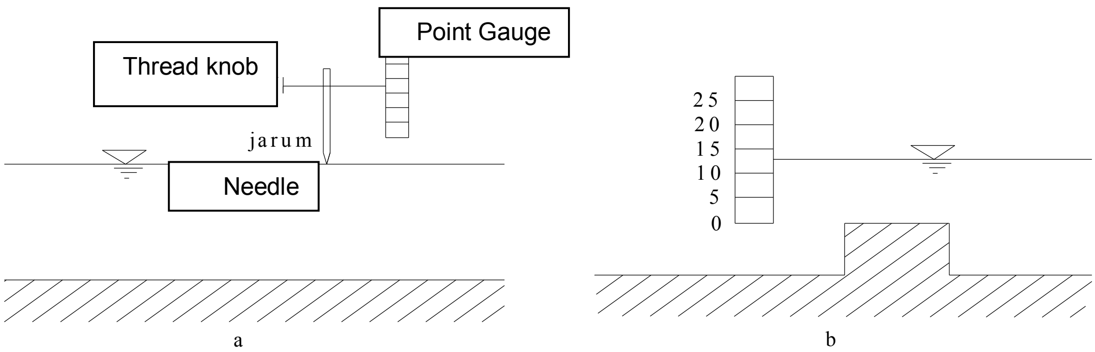

Figure 1 Measurer of water height

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Note for Figure 1:

1. Point gauge was installed above the edge of channel, so that could move along the channel for measuring the level and height of water.
2. Peilschaal was installed at the wall of channel (upright pr sloping) with the upright scale of 1 cm.

General formula of measurer discharge was as follow

$Q = C\,w\,h^{3/2}$. .... (1)

Specification of any kind of formula was as follow:

1 Tompson (triangular weir): $Q = 1.39\,h^{5/2}$. ………………………………….……… (2)

2 Rehbock: (rectangular-weir) $Q = C\,w\,h^{3/2}$,

C adalah koefisien alat ukur Rehbock,

$$C = 107.1 + \frac{0.177}{h} + 14.2\frac{h}{p} - 25.7\sqrt{\frac{(B-b)h}{pB} + 2.04\sqrt{\frac{B}{p}}} \quad (3)$$

....

Tinggi p adalah tinggi ambang alat ukur dari dasar saluran bagian hulu (*US*)

.

3 Cipolletti (trapezoidal weir) : $Q = 1.86\,w\,h^{3/2}$. …………………………………… (4)

4 Drempel (broad crested weir): $Q = 1.71\,w\,h^{3/2}$. ……………....…………………….. (5)

5 Romijn (movable gate) $Q = 1.71\,w\,h^{3/2}$……………………...……………. (6)

Note:
Q = discharge
C = constant
w = weight factor
h = height of water

Some of measurer tools were described as in Figure 2, 3, 4, and 5.

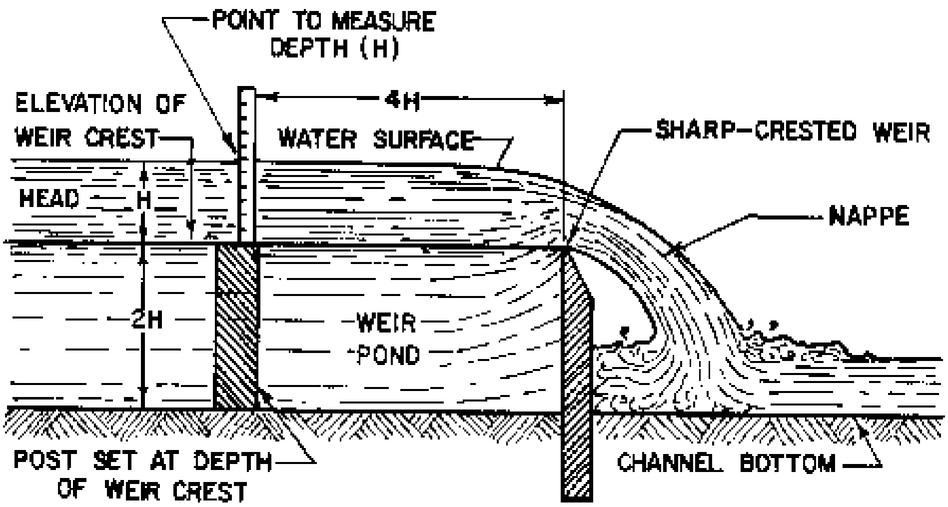

Figure 2 Sharp Crested Weir with long section of Triangular, Rectangular, and Trapezoidal Weir

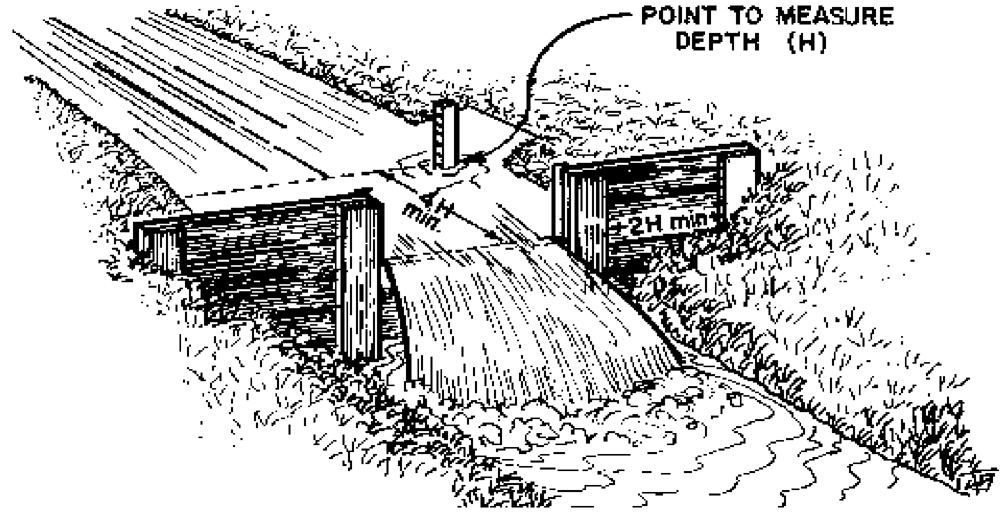

Figure 3 Sharp Crested Weir with long section of: Rectangular Weir

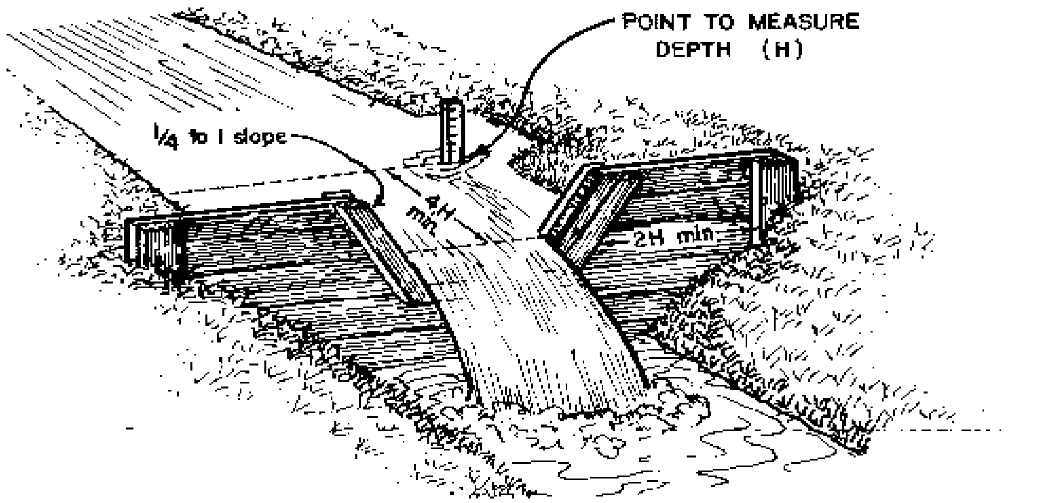

Figure4 Sharp Crested Weir with long section of: Trapezoidal Weir

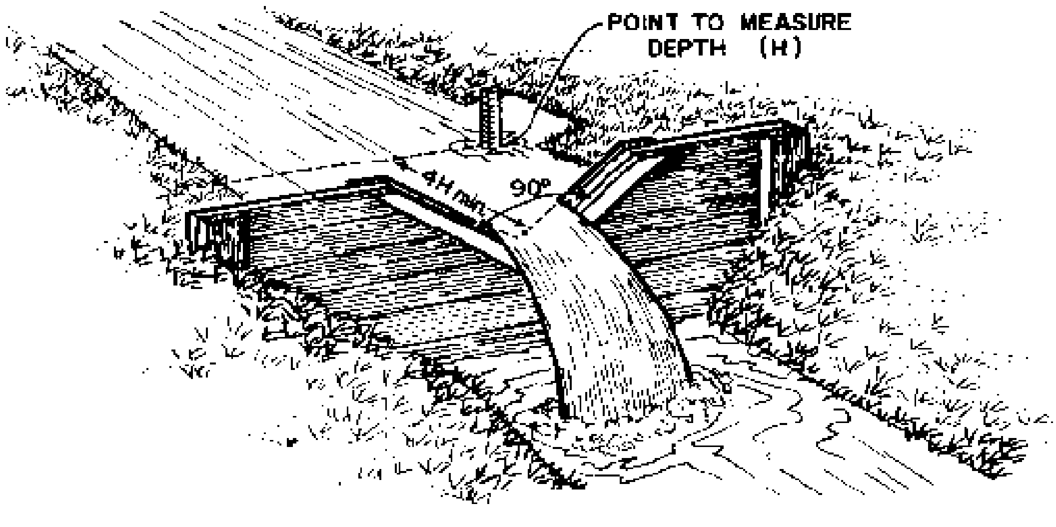

Figure 5 Sharp Crested Weir with long section of: Triangular Weir

RESULTS AND DISCUSSION

Debit measurer in Indonesia generally was as crested weir with sharp and width shaped. The selection kind of discharge measurer was based on accuracy, availability oh measuring, press list,, easy reading, simplification of reading, and life time of using. Error of measuring at sharp and width shaped was described as in Table 1. This research was conducted at Hydraulic Laboratory, Department of Water Resources, Faculty of Engineering, University of Brawijaya, Malang of Indonesia..

Table 1 Error of measuring at sharp and width shaped

V-Notch	**Q=1.38 h^5/2**		**dh = (m)**	**0,0015**		
Q	h^5/2	H	dh	1+dQ/Q	dQ/Q	dQ/Q
m3/dt		m				(%)
0,0799	0,057898551	0,319939	0,0015	1,011762	0,011762	1,2
0,02	0,014492754	0,183849	0,0015	1,020522	0,020522	2
0,03	0,02173913	0,216221	0,0015	1,017434	0,017434	1,7
0,04	0,028985507	0,24259	0,0015	1,01553	0,01553	1,5
0,05	0,036231884	0,265238	0,0015	1,014198	0,014198	1,4
0,06	0,043478261	0,285305	0,0015	1,013196	0,013196	1,3
0,07	0,050724638	0,30345	0,0015	1,012404	0,012404	1,24
0,08	0,057971014	0,320099	0,0015	1,011756	0,011756	1,2
0,09	0,065217391	0,335541	0,0015	1,011213	0,011213	1,1
0,1	0,072463768	0,349984	0,0015	1,010749	0,010749	1,07

The error of measuring (dQ) for Thompson measurer or V-Notch was at the range of 1 to 2%. It was due to maximum discharge of V-Notch was 100 l/s.

Determination of installing discharge measurer for irrigation was due to pressure head losses between upstream and downstream. Selection the kind of this kind of measurer was based on the topography of installing. Measurer tool with sharp shaped like Cipolletti (trapezoidal weir), Thomson (triangular weir) and Rehbock (rectangular weir) had pressure head loss more than 60 cm. Thomson had error of ± 1 – 2 % and Rehbock had error of ± 1.8 %. But the error of Cipolletti was about 5% mainly for high discharge. Therefore Thomson and Rehbock was often used for some research at laboratory and Cipolletti was used at irrigation channel with the error approximate 5%,

Table 2 Cipolletti Measuring at Tertiary Channel

Cipolletti	**Q=1.86*h^3/2**		**dh = (m)**	**0,0015**	**Tertiary Channel**	
					dQ/Q up to 10%	
Q	h^3/2	h	dh	1+dQ/Q	dQ/Q	dQ/Q
m3/s		m	m			(%)
0,0799	0,042957	0,122656	0,0015	1,0184	0,0184	1,8
0,02	0,010753	0,048717	0,0015	1,046539	0,046539	4,7
0,03	0,016129	0,063837	0,0015	1,035452	0,035452	3,5
0,04	0,021505	0,077333	0,0015	1,029236	0,029236	2,9
0,05	0,026882	0,089737	0,0015	1,025178	0,025178	2,5
0,06	0,032258	0,101335	0,0015	1,022286	0,022286	2,2
0,07	0,037634	0,112303	0,0015	1,020102	0,020102	2
0,08	0,043011	0,122758	0,0015	1,018385	0,018385	1,8
0,09	0,048387	0,132786	0,0015	1,016992	0,016992	1,7
0,1	0,053763	0,142449	0,0015	1,015837	0,015837	1,6
0,2	0,107527	0,226123	0,0015	1,009967	0,009967	1
0,3	0,16129	0,296305	0,0015	1,007603	0,007603	0,76
0,4	0,215054	0,358948	0,0015	1,006275	0,006275	0,63

Table 3 Measuring with drempel

Drempel	**Q=1.71*h^3/2**		**dh = (m)**	**0,0015**	**dQ/Q hingga ± 10%**	
Q	h^3/2	h	dh	1+dQ/Q	dQ/Q	dQ/Q
m3/dt		m	m		m3/dt	(%)
0,0799	0,042957	0,283931	0,0015	1,007935	0,007935	0,79
0,02	0,010753	0,163157	0,0015	1,013822	0,013822	1,4
0,03	0,016129	0,191886	0,0015	1,011749	0,011749	1,2
0,04	0,021505	0,215288	0,0015	1,010469	0,010469	1,05
0,05	0,026882	0,235387	0,0015	1,009574	0,009574	0,95
0,06	0,032258	0,253195	0,0015	1,0089	0,0089	0,89
0,07	0,037634	0,269299	0,0015	1,008367	0,008367	0,84
0,08	0,043011	0,284074	0,0015	1,007931	0,007931	0,79
0,09	0,048387	0,297777	0,0015	1,007565	0,007565	0,76
0,1	0,053763	0,310595	0,0015	1,007253	0,007253	0,73
0,2	0,107527	0,409833	0,0015	1,005495	0,005495	0,55
0,3	0,16129	0,481996	0,0015	1,004672	0,004672	0,47

Table 2 described the error of Cipolletti measurer and it showed that the error was 4.5% for little discharge. Table 3 expressed the error of drempel was 1.5%

Conclusion

1. Cipolletti (trapezoidal weir) had the error of ± 5 % and it was due to reading mistake. Reading mistake of water height with point gauge or peilschaal was 1.5 mm or 0.0015 m
2. Cipolletti had relative big error, so this measure was not recommended to be used for research at laboratory. Thomson and Rehbock had little error and it was recommended to be used at laboratory.

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