International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 14 (2015) pp 34401-34404

Conservation Of Broad Crested Weir Simulation Under A Height And Slope Alteration On A Weir Hump

EndangPurwati

Brawijaya University, Water Resources Engineering Department, Engineering Faculty, 65145, Malang Indonesia
endang_p@ub.ac.id

Abstract
Broad crested weir discharge gauges are simple and easy in construction and building requirements. Elevation threshold (p) erect or so-called threshold slope of 1: 0, with p ≥ 0:20 m. Such requirements in order to discharge formula broad crested weir can be met. Discharge Q = 1.71 L_{weir} $y^{3/2}$.y is the height of water in front of the weir. L is the width of the weir to the transverse direction of the channel, with the width of the L weir ≤ L channel. 3/2 is the exponent for the height y in the discharge formula. 1.71 is the weir constant. Height measurement at a particular location which is the water inflow comes into the brink, or right on the subcritical flow before the flow decreased due to the flow meets the threshold. On the y measurement location a height bar gauge was mounted as a completion of a measure building.The discharge measurement using a broad crested weir will be impaired when there is a deposit of sediment on the upstream. Deposit sediments would resultsan incorrect bar gauge measurement, the measurement result change because of the sediment height. Deposit sedimentsshould be avoided, because either it would be disrupt the measurement result or it would also be brake the threshold body.Action taken to secure the measurements and the threshold damage is by revising the threshold height by giving a slope of 1: n on the threshold site. The upstream slope is set to 1: 4, while the downstream slope 1: n is sought by a research on the n value which can result a small as possible sediment on the upstream. The research on the n value is done by using a Surface-Water Modeling System software and experimental test models (physical models of buildings) to find a new weir discharge formula.

Key word: Broad crested weir, downstream slope, Surface-Water Modeling System (SMS) and Model test.

Introduction
Broad crested weir is a hydro construction on tertiary canals with an elevated threshold/ hump [2]. Broad crested weir is generally used as a flow or discharge measuring building in am^3/sec unit. The broad crested weir construction is an elevated threshold which is mounted on the weir transversely and the body upright or slope of 1: 0, either on the threshold upstream or on the threshold downstream [1].
Broad crested weir as a discharge measure is relatively simple and very thorough discharge measurements [2]. Threshold elevation in the form of an upright, resulting in sediment becomes stuck in the hump upstream [3]. The sediment accumulation in the upstream elevation of the threshold could affect the measurement accuracy, because at that location the bar gauge is mounted. The measure ruler is aimed to measure the water level (y), so that the discharge Q = 1,71 L $(y')^{3/2}$. L is the measuring instrument width which is mounted transverse to the water channel, with L ≤ the channel width [2, 4, 5, 6, 7].
The construction often got into trouble, namely the threshold raise which disturbed by the sediment, so that there is a split-shaped rupture due to the sediment accumulation in front of the building. When the building got stuck in the sediment problem raising the threshold should be revised and modified by finding another form that can overcome the problems occur [8].
Problems that exist on the broad crested weir as a discharge measuring construction, is the rupture on the elevation threshold building part (Figure 1). The weir elevation would rupture because of the sediment pressure retained on the upstream elevation threshold [6]. Therefore, there should no sediment pursued stuck in exaltation, by changing the slope of 1: 0 into a slope of 1: n, which is a ratio of 1 unit of vertical with horizontal unit n. The upstream slope threshold elevation 1: n should be 1: 4, which is the ratio of 1 unit of vertical and 4 units of horizontal, this ratio is a slightly slope type, so that the threshold could be passed by the sediment. A too much high p elevation would result a sediment flow difficulties to follow the water stream, so it should be reduced to be 0.075 m.

Figure 1: Broad Crested Weir in Tertiary channel with the Rupture Threshold

The body slope elevation / hump determination was just done to look for the downstream slope, because the upstream slope was determineas 1: 4. The use of Surface-Water Modeling System (SMS) is just used to determine the downstream slope of 1: n, with n 1 as the vertical and n as the horizontal. The n values were tested with 2, 2½, 3, 4 and 5 respectively [8].

MATERIAL AND METHODS

Broad crested weir as a discharge measuring building has an upright threshold elevation heightening.Allegedly high upright threshold could cause sedimentation. This study will change the upright threshold elevation slope with 1: 0, became a slope of 1: n. The n value would be determined, to get the smallest sedimentation. The objective of this strategy is to reduce the channel sediment dredging activity.The n value determination is done by using Surface-Water Modeling System (SMS) software to find the n value with a smallest sediment result [8].

The Surface-water Modeling System aims for looking the smallest sediment that accumulates in front of the threshold [9, 10]. By running SMS two slopes could be found with the smallest sedimentation result,and would then be examined in the physical models. From the physical building test models to be searched one of which has a slope with a smaller sediments. The SMS results indicated a slope of 1: 3 and 1: 5 and followed by a physical model tested. Furthermore the physical model test shows the downstream slope of 1: 3 which is showing the smallest sediment. After a certain threshold slope that is at the upstream which is on the 1: 4 and on the downstream of 1: 3, then the appropriate discharge formula could be found for a new broad-crested weir.

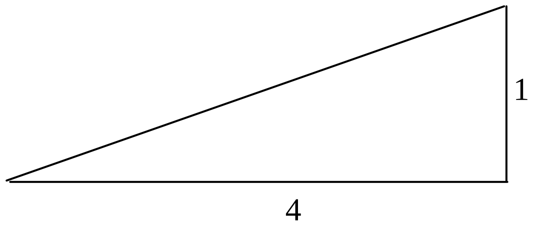

Figure 2: Expected slope changes for the upstream slope 1: 4

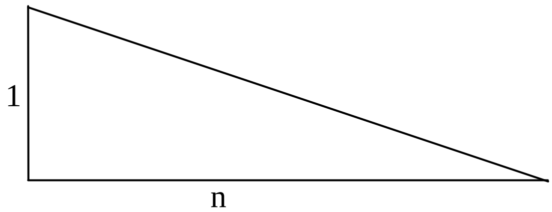

Figure 3: Downstream slope 1: n, where n is determined throughsimulation using SMS.

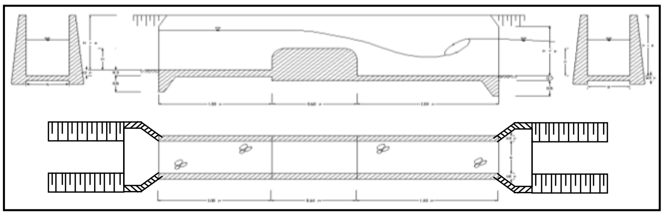

Figure 4: Broad Crested Weir Longitudinal Cross Section and Transversal Cross Section withupstream and downstream threshold Elevation [11]

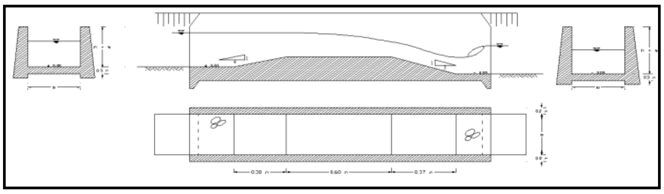

Figure 5: Broad Crested Weir with a 1: n elevation Slope Threshold [11]

RESULT AND DISCUSSIONS

There are two kinds test results with SMS

a. Is shown with graphic images and
b. The data tabulation.

(1) Graphs / Running SMS.

Three types of the tertiary channel, namely: b = 0.30, 0.50 and 0.60 m. The downstream slope 1: n, where n = 2, 2½, 3, 4 and 5. Water flow with discharge 0.01, 0.02, 0.03 and 0.04 m^3/sec, and displayed on a slope of m = 3 and m = 5 (Appendix 1).

(2) Data Tabulation as a SMS Results Running (Appendix 2)

(3) Sediment recapitulation (gram units), on the model test at each width (b) and discharge (Q) with Downstream Slope values m = 3 and m = 5.

(4) The sediment accumulation in the upper stream after running on a physical building model (Appendix 3)

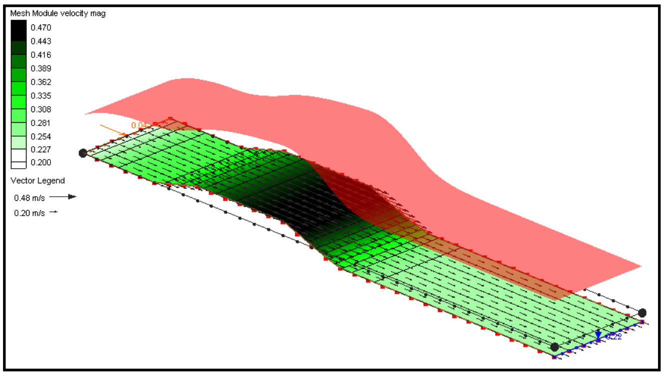

Figure 6: Water level and water velocity result on SMS Running at B = 0.60 m, Q = 0.02 m^3/secand slope of m = 3.

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 14 (2015) pp 34401-34404
© Research India Publications. http://www.ripublication.com

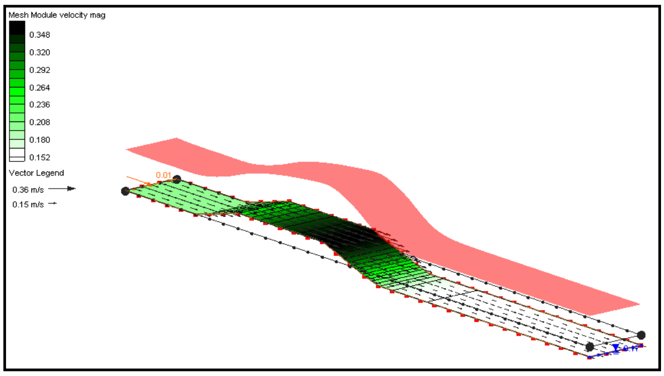

Figure 7: Water level and water velocity result on SMS Running at B = 0.30 m, Q = 0.01 m^3/sec and slope of m = 3.

Table 1: Sedimentation value (in units of grams) for each width (B), Discharge of (Q); a downstream slope value m = 3 and m = 5 (Simulation Building Model)

Debit (Q) (L.sec^{-1})	Width (B) (m)	Sedimentation on *US*, m=3 (g)	Sedimentation on US, m=5 (g)	Sedimentation on DS, m=3 (g)	Sedimentation on DS, m=5 (g)	Information
10	0,30	204,7	346,3	656,9	553,9	Sediment US at m = 5> sediment US at m = 3, while sediment DS at m = 5 <sediments DS at m = 3
20	0,30	257,7	326,6	702,9	572,6	
30	0,30	156,6	248,98	738,4	716,5	
40	0,30	66,1	127,3	529,2	606,0	
10	0,50	250,4	352,9	736,3	561,9	
20	0,50	211,4	360,1	702,9	609,1	
30	0,50	160,9	251,4	662,5	691,3	
40	0,50	137,5	157,6	662,5	731,9	
10	0,60	236,8	384,0	669,2	521,5	
20	0,60	266,7	377,9	693,9	596,4	
30	0,60	188,8	284,9	607,4	692,7	
40	0,60	155,4	229,5	528,8	661,2	

Source: Observations Model Building in the US and DS Threshold.

The purpose of the calculation is to remove the sediment on the US (upstream) as restrained and accumulates in front of the threshold so that the results of the calculation of sediment for m = 3 and m = 5, the best is at m = 3.

Table 2: The water velocity data conclusions and sediment thickness for 2.3 mm big granules from the Surface Water Modeling Systemprogram

No	Water Flow rate (m^3/dt)	Channel Width (m)	Down-stream Slope (1 : m)	Water velocity on point: 1 (m/dt)	2 (m/dt)	3 (m/dt)	4 (m/dt)	5 (m/dt)	Sediment concentration value at simulation end (ppm)
1	0.01	0.3	m = 2	0.00167	0.00145	0.00241	0.00150	0.00109	0.00230
			m = 2,5	0.00183	0.00155	0.00259	0.00191	0.00115	0.00055
			m = 3	0.00138	0.00135	0.00224	0.00123	0.00104	0.00000
			m = 4	0.00123	0.00135	0.00224	0.00118	0.00104	0.00000
			m = 5	0.00128	0.00135	0.00223	0.00115	0.00104	0.00000
		0.5	m = 2	0.00088	0.00098	0.00185	0.00094	0.00073	0.00000
			m = 2,5	0.00109	0.00106	0.00202	0.00129	0.00077	0.00000
			m = 3	0.00091	0.00091	0.00206	0.00069	0.00069	0.00000
			m = 4	0.00102	0.00098	0.00185	0.00082	0.00073	0.00000
			m = 5	0.00112	0.00099	0.00185	0.00079	0.00073	0.00000
		0.6	m = 2	0.00096	0.00088	0.00175	0.00085	0.00064	0.00000
			m = 2,5	0.00092	0.00082	0.00159	0.00080	0.00060	0.00000
			m = 3	0.00101	0.00096	0.00193	0.00219	0.00068	0.00000
			m = 4	0.00078	0.00095	0.00193	0.00087	0.00068	0.00000
			m = 5	0.00106	0.00096	0.00193	0.00081	0.00068	0.00000

Table 3: The water velocity data conclusions and sediment thickness for 2.3 mm big granules from the Surface Water Modeling System program (continuation)

No	Water Flow rate (m^3/dt)	Channel Width (m)	Down-stream Slope (1 : m)	Water velocity on point: 1 (m/dt)	2 (m/dt)	3 (m/dt)	4 (m/dt)	5 (m/dt)	Sediment concentration value at simulation end (ppm)
2	0.02	0.3	m = 2	0.00197	0.00217	0.00321	0.00229	0.00177	0.02277
			m = 2,5	0.00075	0.00212	0.00338	0.00268	0.00184	0.80660
			m = 3	0.00209	0.00229	0.00339	0.00239	0.00184	0.02268
			m = 4	0.00352	0.00270	0.00383	0.00287	0.00200	0.00519
			m = 5	0.00239	0.00253	0.00380	0.00273	0.00200	0.00018
		0.5	m = 2	0.00118	0.00159	0.00262	0.00171	0.00125	0.00271
			m = 2,5	0.00159	0.00146	0.00229	0.00147	0.00115	0.00000
			m = 3	0.00160	0.00160	0.00337	0.00125	0.00125	0.00000
			m = 4	0.00163	0.00162	0.00262	0.00152	0.00125	0.00000
			m = 5	0.00082	0.00157	0.00261	0.00146	0.00125	0.00000
		0.6	m = 2	0.00146	0.00128	0.00208	0.00118	0.00100	0.00000
			m = 2,5	0.00127	0.00135	0.00224	0.00143	0.00104	0.00000
			m = 3	0.00091	0.00127	0.00208	0.00112	0.00100	0.00000
			m = 4	0.00134	0.00128	0.00208	0.00109	0.00100	0.00000
			m = 5	0.00148	0.00128	0.00208	0.00107	0.00100	0.00000

Conclusion

1. Broad crested weir building which the upright slope was changed with a 1: 0 become 1: n, with an upstream n value of 1: 4, and a downstream n value of 1: 3 to produce the smallest sediment amount. A downstream slope of 1: 3 was taken to avoid the short dredging time range between one dredging activities to the other dredging activity, which would take a great expense.
2. The broad crested weir water flow rate formula was revised, and could applicable either for the channel width (B) or for the channel width (B) taken from the model test (physical) namely:

At a width of B = 0,30 m and water flow rate $Q = 0{,}24\ h^{1{,}149}$
At a width of B = 0,40 mand water flow rate $Q = 0{,}318\ h^{1{,}089}$
At a width of B = 0,50 mand water flow rate $Q = 0{,}24\ h^{1{,}029}$
At a width of B = 0,60 mand water flow rate $Q = 0{,}24\ h^{0{,}966}$

In addition, on a larger channel width, from the model test formula development, it is found that some channel width variation has another water flow rate formula as follows:

Table 4: Threshold width vs Water flow rate (Q)

Channel Width B (m)	Water flow rate formula (m^3.dt-1)
0,70	$Q = 0{,}508 * h^{1{,}075}$
0,80	$Q = 0{,}589 * h^{1{,}080}$
0,90	$Q = 0{,}671 * h^{1{,}084}$
1,00	$Q = 0{,}752 * h^{1{,}087}$
1,10	$Q = 0{,}835 * h^{1{,}091}$
1,20	$Q = 0{,}815 * h^{0{,}952}$
1,30	$Q = 1{,}003 * h^{1{,}099}$
1,40	$Q = 1{,}082 * h^{1{,}100}$
1,50	$Q = 1{,}161 * h^{1{,}105}$

REFERENCES

[1] Blaisdell, W. Fred, Fellow, ASCE, 1994. "Result of Parshall Flume Test", Journal Irrigation and Drainage, 120(2), 278-291
[2] Bos, M.G., 1976."Discharge Measurement Structures", Editor Working Group on Small Hydraulic Structures, Oxford and IBH Publishing Co
[3] Baban, Rozgar. 1995. "Design of Diversion Weirs", New York, John Wiley & Sons.
[4] Bengtson, Harlan. 1992. "Open Channel Flow Measurement with The Broad Crested Weir", Edited by Lamar Stonecypher 6/11/2010.
[5] Hendersopn, F.M., 1966. "Open Channel Flow", Mac-million Publishing Co. Inc. New York.
[6] J. Farhoudi, Shahalami, H. 2005. "Slope Effect on Discharge Efficiency in Rectangular Broad Crested Weir with Slope Upstream Face", International Journal CW Engineering Volume 3 Number 1.
[7] White, Frank M., 1999. "Fluid Mechanics", WCB/ McGraw Hill– Singapore
[8] Nabi, M.A. 2008. "A Model of Detailed Hydrodynamics with Sediment Transport for Simulation of Subaqueous Dunes", Department and Travel Services, Kubaba Congress
[9] Kay, Melvyn, 1998. "Practical Hydraulics", E and FN Spoon
[10] Weber, N.B., 1971. "Fluid Mechanics for Civil Engineers", New York, John Wiley & Sons, Inc
[11] Hick, Faye. 1990. "Open Channel Flow", Civil Eng. Dept. Faculty of Engineering, University of Alberta, Edmonton, Canada.