Discussion of "Discharge Coefficients for Baffle-Sluice Gates" by P. K. Mishra, Wernher Brevis, and Cornelia Lang

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Introduction

The discusser would like to thank the authors for refining the design of baffle-sluice irrigation modules, and would like to draw attention to some points.

To refine the design of the baffle-sluice gates, the authors have tried to model different operation stages of baffle-sluice gates (which was developed by Mishra et al. 1990) using the individual contributions of weir-flow and sluice-flow components. A *standard design procedure* is essential for *refining* the design of a baffle-sluice gate. For this using suitable sluice-gate and weir-discharge equations, an initial head–discharge curve can be considered for the design procedure. Using this head–discharge curve, the baffle-sluice gate can be initially designed, and then experiments can be performed with this module to investigate the variation of its real discharge coefficient with the head. Then, a new discharge coefficient equation for the desired range of the head can be obtained to derive the final optimum dimensions of the baffle-sluice gate using revised head–discharge curve.

Mathematical Modeling of the Design Procedure

In this discussion, two schemes are considered to design the baffle-sluice gates.

Three-Baffle Design Scheme (First Scheme)

Consider a baffle-sluice module with three baffles. The flow conditions and head–discharge curve are shown in Fig. 1 for the first scheme. In this figure, m is the discharge variation coefficient, q_d is the design-unit discharge, $H_{\min}$ and $H_{\max}$ are the minimum and maximum modular limits of the structure, H_1 and H_2 are the height of the first and second baffles, a_1, a_2, and a_3 are the baffle openings, and L_1 and L_2 are the length of the first and second baffles, respectively ($L = H - a$).

As shown in Fig. 1, when the upstream baffle controls the flow, the structure delivers $(1-m)q_d$ and q_d for $H_{\min}$ and H_1 flow depths, respectively. As the upstream flow depth increases above the crest of the first baffle, the combined orifice-weir flow increases sufficiently to submerge the first baffle as shown in the head–discharge curve of Fig. 1. It seems that for a suitable distance between baffles, combined orifice-weir flow for first and second baffles is a brief stage with a very small duration and thus may be ignored in the design procedure. When the second baffle takes over the flow control, the structure delivers a discharge $(1-m)q_d$ for H_1 flow depth and q_d for H_2 flow depth. As the upstream flow depth increases above the crest of the second baffle, the combined orifice-weir flow increases sufficiently to submerge the second baffle as shown in the head–discharge curve of Fig. 1. This brief stage may also be ignored in the design procedure. Finally, when the flow control shifts to the third baffle, the structure should deliver $(1-m)q_d$ for H_2 and $(1+m)q_d$ for $H_{\max}$ flow depths. This scheme is first proposed by Bijankhan and Kouchakzadeh (2012) for which the design steps are obtained on the basis of the variable hydraulic sensitivity. In this discussion, a clear mathematical model for the design procedure will be proposed.

For a sluice gate, the unit discharge relationship can be expressed by the following functional form:

$$q = f(a, H) \tag{1}$$

where a = gate opening and H = flow depth.

Three-Baffle Design Mathematical Model for the First Scheme

For six points of the head–discharge curve shown in Fig. 1, one gets

$$\begin{aligned}(1-m)q_d &= f(a_1, H_{\min})\\ q_d &= f(a_1, H_1)\\ (1-m)q_d &= f(a_2, H_1)\\ q_d &= f(a_2, H_2)\\ (1-m)q_d &= f(a_3, H_2)\\ (1+m)q_d &= f(a_3, H_{\max})\end{aligned} \tag{2}$$

The design-unit discharge, q_d, and minimum and maximum modular limits of the structure $H_{\min}$ and $H_{\max}$ are known values. Thus, this system of equations should be solved simultaneously for unknown values m, a_1, a_2, a_3, H_1, and H_2.

Three-Baffle Design Scheme (New Second Scheme)

The flow conditions and head–discharge curve are shown in Fig. 2 for this scheme. As shown in Fig. 1, when the upstream baffle controls the flow, the structure delivers $(1-m)q_d$ and $(1+m)q_d$ for $H_{\min}$ and H_1 flow depths, respectively. As the upstream flow depth increases above the crest of the first baffle, the combined orifice-weir flow increases sufficiently to submerge the first baffle as shown in the head–discharge curve of Fig. 2. This is a brief stage with a very small duration and thus can be ignored in the design procedure. When the second baffle takes over the flow control, the structure delivers a discharge $(1-m)q_d$ for H_1 flow depth and $(1+m)q_d$ for H_2 flow depth. As the upstream flow depth increases above the crest of the second baffle, the combined orifice-weir flow increases sufficiently to submerge the second baffle as shown in the head–discharge curve of Fig. 2. This brief stage can also be ignored in the design procedure. Finally, when the flow control shifts to the third baffle, the structure should deliver $(1-m)q_d$ for H_2 and $(1+m)q_d$ for $H_{\max}$ flow depths. This scheme is first proposed in this study.