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Discussion

Discharge coefficient for free and submerged flow over Piano Key weirs

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The Authors made an interesting contribution to the assessment of the discharge coefficient of Piano Key weirs (PKW). The Discussers were impressed to read that the Authors conducted some 600 tests thereby producing nearly 3000 data points. Such systematic test series are helpful for a general description of the PKW discharge capacity. Similar investigations are presently conducted at several institutions. The Discussers validated the Authors' Eq. (6) with their own physical model data. Furthermore, the application limits of the tests performed by the Authors are discussed with regard to the characteristics of existing prototype PKWs.

The Laboratory of Engineering Hydraulics, Université de Liège (ULG) and the Laboratory of Hydraulic Constructions, Ecole Polytechnique Fédérale de Lausanne (EPFL) have independently conducted research projects focused on the hydraulic efficiency of PKWs (Machiels 2012, Leite Ribeiro *et al.* 2012). Similar to the Authors' test set-up, both laboratory studies used physical models with channel approach flow conditions. The range of parameters as tested by the Authors and used to derive Eq. (6) is, however, different from that of the Discussers. The Discussers limited their data sets to two scenarios:

- A Tests not respecting the scale effects criterion ($H > 0.03$ m) were ignored while all other tests were considered. The result is shown in Fig. D1(a) and gives a general impression of the coherence regarding individual C_d values. Note that subscript M refers to values derived from ULG and EPFL model tests. As visible, Eq. (6) proposed by the Authors overestimates the measured C_d values with an increasing trend.
- B Only tests respecting *all* limitations of Eq. (6) were considered in scenario B1. Furthermore, scenario B2 includes tests with slightly-adapted limitations as shown in Table D1, which nevertheless remain close to these of the Authors. For B1, Fig. D1(b) indicates that the data essentially collapse with the line of perfect agreement, whereas the aforementioned overestimation of C_d remains for B2.

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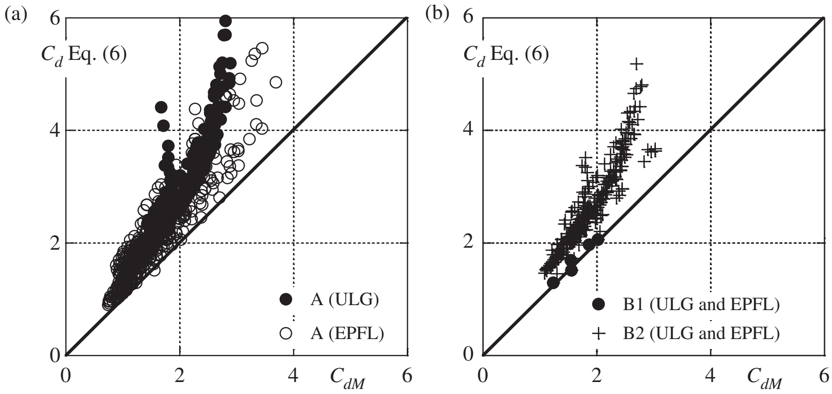

Figure D1 Comparison of C_d values derived from ULG and EPFL model tests with values computed according to Eq. (6) provided by Authors, for scenarios (a) A, (b) B (Table D1)

Table D1 Tested parameter range of Authors' study (scenario B1) and slightly expanded for scenario B2

Term	H	H/P_o and H/P_i	L/W	B/P_o and B/P_i	W_i/W_o	B_o/B and B_i/B
B1: Parameter range of Authors' study	>0.03 m	0.1 … 0.6	2.5 … 7.0	1.0 … 2.5	0.33 … 1.22	0 … 0.26
B2: Expanded limitations	>0.03 m	0.1 … 0.6	2.5 … 7.0	1.0 … 2.6	0.33 … 1.50	0 … 0.35

Table D2 Characteristic parameters of existing prototypes, with *italic* values not complying with Authors' limitations (Erpicum *et al.* 2011)

Dam	Goulours	St Marc	Etroit	Gloriettes	Malarce	Gage	Raviège	Ouldjet Mellegue	Sawara Kuddu	Van Phong
L/W	4.92	4.28	4.17	4.69	*8.10*	*7.81*	6.77	4.78	4.91	6.00
B/P	*3.00*	*3.02*	2.30	*3.33*	*3.06*	2.17	*2.84*	2.38	*2.93*	2.00
W_i/W_o	*1.80*	*1.41*	*1.63*	*1.53*	1.04	*1.23*	*1.50*	*1.37*	1.00	1.00
H/P	0.31	0.32	0.18	0.27	0.34	0.25	0.32	*0.66*	0.30	*0.87*
B_i/B	0.16	*0.31*	0.16	0.26	0.15	0.23	0.24	0.18	*0.33*	0.25
B_o/B	*0.36*	*0.31*	0.26	*0.35*	*0.49*	*0.31*	*0.30*	0.22	0.00	*0.39*

Since only few data from ULG and EPFL tests strictly respect the Authors' limitations, also head-discharge measurements of prototype related case study model tests were taken into account. Then, no data fit the Authors limitations (B1), indicating that the model geometries tested by the Authors do not overlap the characteristics of existing prototypes. As shown in Table D2, each listed prototype ignores at least one limitation so that Eq. (6) is not applicable.

Consequently, the Authors' limitations should strictly be respected, as small discrepancies may result in significant over-estimations of the PKW capacity, typically of the order of 30%. Furthermore, the test set-up as employed by the Authors is different from most existing prototypes. The Discussers thus invite the Authors to participate in the future with the scientific community focusing on PKW research and to share their raw data set. A data exchange was proposed by Boillat *et al.* (2011).

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Closure to "Discharge coefficient for free and submerged flow over Piano Key weirs" by A.R. KABIRI-SAMANI, and A. JAVAHERI, *J. Hydraulic Res.* 50(3), 2012, 114–120.

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The Authors thank the Discussers for their interest in this paper. It is a pleasure to clarify the aspects of our study. Point 1 is that the present PKW models were made of galvanized iron