Discussion: Triangular labyrinth side weirs with one and two cycles

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NOTATION

F_1	Froude number at upstream end of side weir
L	width of side weir
L_{ef}	total weir crest length of labyrinth side weir
p	height of weir crest
Q_1	total discharge in main channel upstream of the side weir
α	labyrinth side weir sidewall angle

Contribution by A. Parvaneh, J. Yang, A. Javaheri and A. Kabiri-Samani

The contributors would like to thank the authors (Borghei *et al.*, 2013) for their investigation into the hydraulic characteristics of triangular labyrinth side weirs with one and two cycles. The contributors, however, would like to add a few points about triangular labyrinth side weirs in comparison with trapezoidal and asymmetric labyrinth side weirs.

According to the literature, the length of trapezoidal, triangular and asymmetric labyrinth side weirs is computed considering Equations 35–37, respectively (Figure 20).

$$35. \quad L_{ef} = 4a + 2b$$

$$36. \quad L_{ef} = \frac{L}{\sin \alpha}$$

$$37. \quad L_{ef} = \frac{L}{\sin \alpha} + \frac{L}{\tan \alpha}$$

In accordance with Emiroglu *et al.* (2014) and the authors' work, the length of triangular labyrinth side weirs and their corresponding trapezoidal and asymmetric labyrinth side weirs are presented in Tables 4 and 5.

Therefore, the length of triangular labyrinth side weirs are, respectively, 16–25% greater than those of trapezoidal labyrinth side weirs, and 34–87% less than asymmetric labyrinth side weirs (Tables 6 and 7).

Based on the data presented by Emiroglu *et al.* (2014) and their equation for trapezoidal labyrinth side weirs, the authors claimed that although the crest length of triangular labyrinth side weirs is 16–25% greater than that of trapezoidal side weirs, the discharge coefficient of trapezoidal labyrinth side weirs is far greater than that of triangular labyrinth side weirs (Table 8).

To perform a better comparison of triangular labyrinth, trapezoidal labyrinth, asymmetric labyrinth and rectangular side weirs, part of the experimental data by Borghei and Parvaneh (2011) and Parvaneh *et al.* (2012) is presented in Table 9.

As illustrated in Figure 21, the discharge coefficient of trapezoidal labyrinth side weirs (presented by Emiroglu *et al.* (2014)) is far greater than that of triangular labyrinth side weirs (investigated in the original paper by Borghei *et al.* (2013)) despite a 16% shorter crest length. They also declared in their previous contributions that the discharge coefficient of triangular and trapezoidal labyrinth side weirs with one cycle is, respectively, 1.5–4.5 and 1.5–5.0 times greater than that of

Figure 20. Comparative plan view of trapezoidal (1), triangular (2), and asymmetric (3) labyrinth side weirs with one cycle

Labyrinth side weir with one or two cycles	L = 25 cm			L = 50 cm			L = 75 cm		
	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$
Trapezoidal	43	54	72	86	108	145	129	162	217
Triangular	50	65	91	100	131	181	150	196	272

Table 4. The crest length of triangular and trapezoidal labyrinth side weirs with the geometry of Emiroglu *et al.* (2014)

Labyrinth side weir with one or two cycles	L = 30 cm				L = 40 cm				L = 60 cm			
	$\alpha = 70^\circ$	$\alpha = 60^\circ$	$\alpha = 45^\circ$	$\alpha = 30^\circ$	$\alpha = 70^\circ$	$\alpha = 60^\circ$	$\alpha = 45^\circ$	$\alpha = 30^\circ$	$\alpha = 70^\circ$	$\alpha = 60^\circ$	$\alpha = 45^\circ$	$\alpha = 30^\circ$
Trapezoidal	32	35	42	60	43	46	57	80	64	69	85	120
Triangular	43	52	72	112	57	69	97	149	86	104	145	223

Table 5. The crest length of triangular and asymmetric labyrinth side weirs with the geometry of the authors' work

Side weir	L = 25, 50, 75 cm		
	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$
Trapezoidal labyrinth	16%	20%	25%

Table 6. Increase in the crest length of triangular labyrinth side weirs compared to the trapezoidal labyrinth side weirs with the geometry of Emiroglu *et al.* (2014)

Side weir	L = 30, 40, 60 cm			
	$\alpha = 70^\circ$	$\alpha = 60^\circ$	$\alpha = 45^\circ$	$\alpha = 30^\circ$
Asymmetric labyrinth	34%	49%	71%	87%

Table 7. Decrease in the crest length of triangular labyrinth side weirs compared to the asymmetric labyrinth side weirs with the geometry of the authors' work

rectangular side weirs (Emiroglu and Kaya, 2011; Emiroglu *et al.*, 2010). Contrary to their declarations, such a significant increase in the discharge coefficient of weirs with a maximum crest length of 2.6 and 2.9 times that of rectangular side weirs seems abnormal (Table 10).

Unlike the very high values assigned by Emiroglu *et al.* (2010) to the discharge coefficient of triangular labyrinth side weirs, the authors have presented more reasonable values of discharge coefficient for the geometries studied. The final results of the current research show that the discharge coefficient of a

	$L = 25$ cm			$L = 50$ cm			$L = 75$ cm		
Side weir with two cycles	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$
Triangular labyrinth	1.84	1.92	2.39	2.05	2.37	—	2.17	2.47	2.65
Trapezoidal labyrinth	4.29	4.85	4.44	4.14	4.50	—	3.48	4.12	5.31

Table 8. Maximum values of the discharge coefficient of triangular and trapezoidal labyrinth side weirs to the rectangular side weir (considering the data presented by Emiroglu *et al.* (2014))

L : cm	p : cm	α : deg	F_1	Q_1 : l/s	Run no.
30	7.5, 10, 15	30	0.20–0.91	19.1–30.0	15

Table 9. Range of variables studied by Borghei and Parvaneh (2011) and Parvaneh *et al.* (2012), used in the present discussion

Figure 21. The discharge coefficient of asymmetric labyrinth, trapezoidal labyrinth, triangular labyrinth and rectangular side weirs ($B = 40$ cm, $L = 30$ cm, $\alpha = 30^\circ$)

triangular labyrinth side weir could rise to more than two times that of a conventional side weir with the same flow and geometric conditions. These results are more consistent for triangular labyrinth side weirs, for which the maximum crest length is 2.0 to 2.6 times larger than that of conventional side weirs (Table 10).

For a given geometry, increasing the flow depth significantly decreases the discharge coefficient of triangular labyrinth side weirs (Parvaneh *et al.*, 2011). According to Figure 21, the

Side weir with one or two cycles	$L = 25, 50, 75$ cm		
	$\alpha = 30.0^\circ$	$\alpha = 22.5^\circ$	$\alpha = 16.0^\circ$
Triangular labyrinth (Emiroglu <i>et al.</i> , 2010)	0.2	2.6	—
Trapezoidal labyrinth (Emiroglu and Kaya, 2011)	1.7	2.1	2.9

Table 10. Ratios of the crest length of triangular and trapezoidal labyrinth side weirs to the crest length of the corresponding rectangular side weirs

discharge coefficient of trapezoidal labyrinth side weirs decreases considerably by increasing the flow depth. A similar conclusion can be offered for trapezoidal weirs.

Authors' reply

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