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Articles

The employment of ogees type WES and elliptical in spillways type labyrinth. Part I

El empleo de cimacios tipo WES y elípticos en vertedores tipo laberinto. Parte I

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Abstract

Labyrinth type weirs are relatively new as their employment started by the middle of the past century. The nineties decade and beginning of the present century have witnessed a great deal of laboratory scale research about this type of weirs. In the present work experimental research results are shown to evaluate the possibilities of employing type WES or elliptic ogees within the labyrinth type weirs given the advantage of a better discharge coefficient as related to other ogee types. Results from two-dimensional laboratory scale models are presented relative to truncating both structures to allow their use in labyrinth spillways.

Keywords: Labyrinth weirs, weir crest types, WES ogees, elliptic ogees, truncated ogees, weir with ventilated sheet, weir with non-ventilated sheet.

Resumen

Los vertedores tipo laberinto son relativamente novedosos, pues su empleo comenzó a mediados del pasado siglo, siendo la década de 1990 y comienzos del presente siglo cuando se han desarrollado la mayor cantidad de investigaciones a escala de laboratorio. En el presente trabajo se muestran los resultados de investigaciones experimentales dirigidas a valorar las posibilidades del empleo de cimacios tipo WES o elípticos en ese tipo de estructuras, dadas sus ventajas en cuanto al coeficiente de gasto, en comparación con otros tipos de estructuras. Se presentan los resultados de estudios a escala de laboratorio en modelo bidimensional relativos al truncado de ambas estructuras para su empleo en los aliviaderos de laberinto.

Palabras clave: vertedores de laberinto, tipos de cresta del vertedor, cimacios WES, cimacios elípticos, truncado del cimacio, vertimiento con lámina ventilada, vertimiento con lámina sin ventilar.

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Introduction

The weir type labyrinth is particularly attractive for when he/she wants himself recover a reservoir (Iñiguez-Covarrubias, Ojeda-Bustamante, & Díaz-Delgado, 2015) because for their configuration they have a great longitude in comparison with any other type of weir (Crookston & Tullis, 2012) for oneself wide of used land band (Lobaina-Fernández, Pardo-Gómez, & Alegret-Breña, 2016). In the Figure 1 an outline is presented in the one that the hydraulic and geometric variables of this type of structures are indicated.

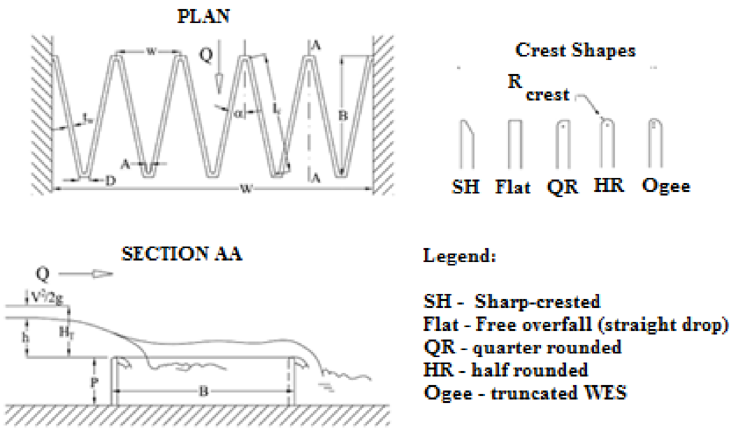

Figure 1. Outline of a weir type labyrinth (Crookston & Tullis, 2012).

In that same one he/she imagines they can appreciate the types of crests that have been employees in these structures until the present, being specifically the crests type half-rounded and a quarter rounded those of more frequent use and consequently with it, those most studied ones.

It is opportune to highlight that those described are among the shown crests as "truncated ogee", but it is very important to consider that in the alone literature a case of systematic investigation is picked up carried out to laboratory scale (Magalhães & Lorena, 1989), but that it presents poor results and in the authors' of the present work opinion with an inadequate focus in the prosecution of the experimental results that you/they take to make little attractiveness of that type of crests.

The ogees employment WES or elliptic in weirs type labyrinth it is attractive for their best expense coefficient, but he/she has an inconvenience that the robustness or wide of the ogee in their base it limits their use in those weird; for it is valued it the convenience of truncating this way those types of even ogees to facilitate their use.

Starting from the considerations expressed in the previous paragraph and taking into account that the ogee type WES and the elliptic ones present coefficients of more expense of values to other weirs types, in the laboratory of physical models of the Center of Hydraulic Researches (CIH) of the Technological University of Havana "José Antonio Echeverría" (CUJAE) a series of experiments has begun to analyze the convenience of the employment of the referred ogees in the weirs type labyrinth.

The first experimental study consisted on identifying the influence of the one truncated in those ogees types in the value of its respective expense coefficients. Their results are shown next.

Detail of the installation of the laboratory

It was employee a rectangular channel with a total longitude of 20.2 m, work longitude 19.6 m, wide 0.60 m, height 1.1 m, fed with a system of pipes that you/they leave of a tank of constant load. In the end of waters up of the channel has a weir of seating capacity triangular type for the mensuration of the flow. In the Figure 2, Figure 3 and Figure 4 are shown details of the installation.

Figure 2. Elliptic ogee waterproofed.

Figure 3. Seating capacity weir seen from downstream.

Figure 4. Soothing of flow waters under the discharge of the seating capacity weir.

For the mensuration of the load hydraulic so much envelope the seating capacity weir like on the ogee study object water level point gauge of precision ± 0.1 mm. was used it is shown images of the same ones and its locations in the Figure 5.

Figure 5. Water level point gauge in the seating capacity weir (a) and on the truncated ogee (b).

Work procedure to analyze the effect of the one truncated on the expense coefficient

This procedure is described of having truncated of the ogee type WES with the aid of the Figure 6.

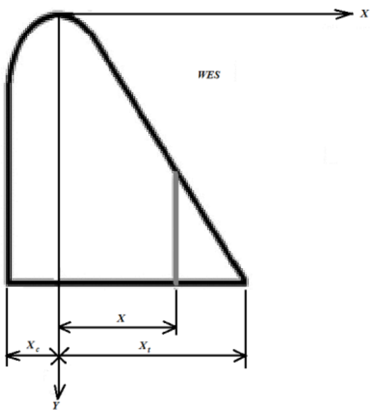

Figure 6. Variables in the truncated ogee WES.

The one truncated was carried out based on the relationship X/X_t, beginning in 0.8, being X the horizontal dimension from the crest to the section of having truncated and X_t the dimension in the same sense of the base of the ogee without truncating and arriving up to 0.1. This way for example X/X_t = 0.8, it means that measuring horizontally below from the crest of the ogee toward waters, it is 80 ogee%, after having been truncated their final portion in 20%. For each grade of having truncated were carried out the corresponding measures of load and flow being obtained the curve of capacity of service and they were compared with those of X/X_t = 1 (complete ogee, not truncated), and in that way you could determine the moment where you begins to affect the curve of capacity of service due to the one truncated. In the carried out observations X_c will be similar to 2.01 cm.

At the same way proceeded for the elliptical ogee being what is indicated in the Figure 7, in the one which X/R_Φ = 1.38 cm.

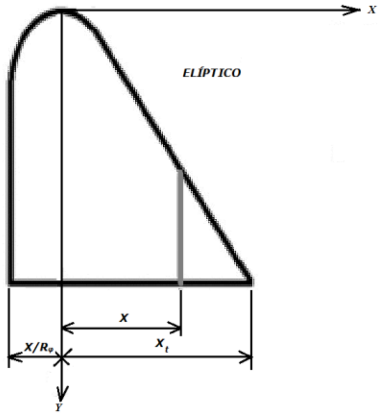

Figure 7. Variables in the truncated elliptic ogee.

To consider the possible influence of the ventilation of the sheet slope, in all the cases of having truncated for the two ogees types two studies were made: one with sheet ventilated slope and another without ventilation. To the ends of the ventilation two hoses of 6 mm of diameter were placed each, in the form that is shown in the Figure 8.

Figure 8. Ogee ventilated by means of hoses.

Experimental results

Following the procedure up described it was possible to obtain for each grade of having truncated of the ogee a graph in which three curves of capacity of service are shown; one for the ogee without having truncated, a second for the truncated ogee and ventilated sheet and a third for truncated ogee and sheet without ventilating. In the Figure 9 and Figure 10 two examples corresponding to ogees WES is shown and elliptic, respectively (Carralero, 2016).

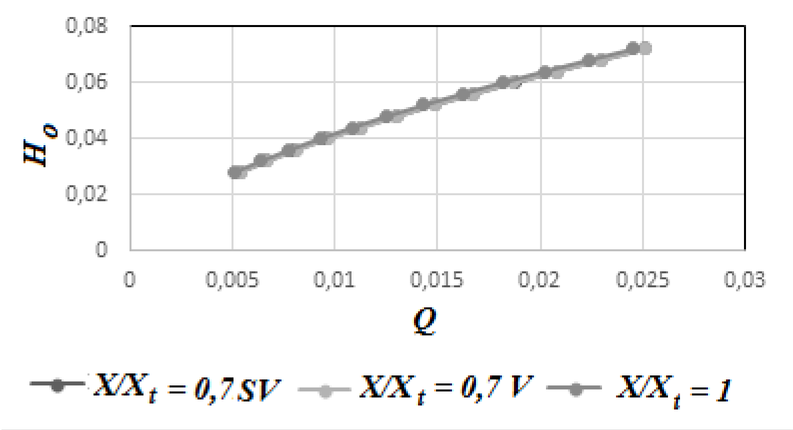

Figure 9. Comparison among the initial curve and the one truncated X/X_t = 0.7, ventilated (*V*) and without ventilating (*SV*) of an ogee WES.

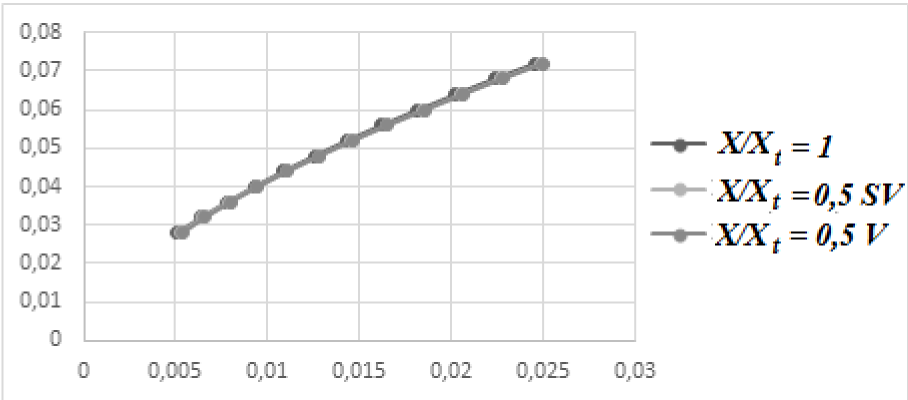

Figure 10. Comparison between the initial curve and the corresponding to a truncated X/X_t = 0.5, ventilated and without ventilation elliptical ogee.

Observe that the ogee WES how there is total coincidence of the curves of capacity of service of the ogee without truncating and the corresponding to the ogee truncated without ventilating, while slight difference is appreciated when the truncated ogee is ventilated, while for the elliptic ogee the curves corresponding to ventilated sheet and sheet without ventilating coincide and they are very next to the corresponding to the ogee without truncating.

With the purpose of not making very extensive this work the presentation of each level is obviated of having truncated and it turns in to aid a comparison summary that is shown in the Table 1 and the Figure 11.

Table 1. They summarize of the percentage differences in ogees WES and elliptic, in each one of those truncated.

	WES		ELLIPTIC	
	SV	V	SV	V
X/X_t	Dif media (%) truncated/without truncated		Dif media (%)truncated/without truncated	
1	0	0	0	0
0.8	1.9	1.9		
0.7	3.5	3.63	4.44	4.44
0.6	1.07	1.68	1.6	1.6
0.5	1.58	2.29	5.39	5.39
0.4	0.57	0.7	4.48	4.47
0.3	1.03	1.03	0.88	1.29
0.2		3.23	3.29	3.11
0.1	4.91	2.31	6.53	5.7

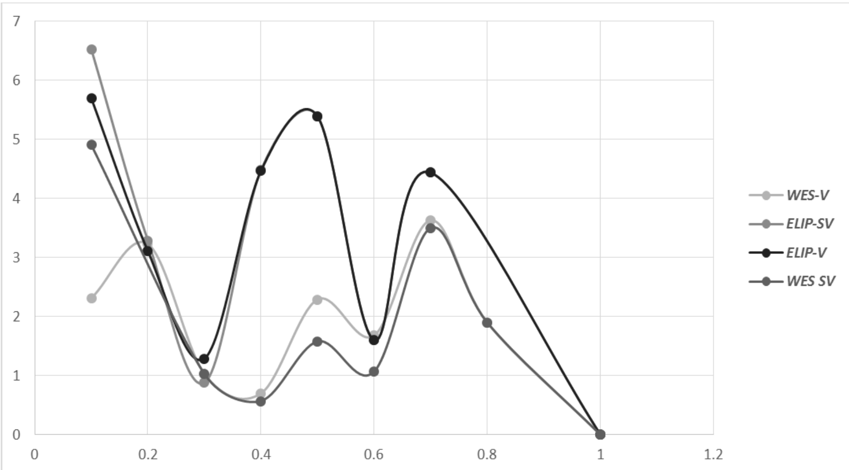

Figure 11. Comparison between of percentage differences curves.

Of the interpretation of the chart one you can conclude:

1. The ogees WES admits truncation grade until X/X_t = 0.2 without differences percentage superiors are made to 3.7%.

2. The elliptic ogees admits truncation grade with acceptable percentage differences until X/X_t = 0.2, except for X/X_t = 0.5.

The curves of the Figure 11 demonstrate that the elliptic ogees suffers high differences for the cases of ventilated truncated ogees when there is high level of having truncated (small X/X_t), that which is completely comprehensible because with the ventilation the rupture of the hole characteristic of these ogees is causing, what bears a fall of the values of the expense coefficient, while the ogees WES and elliptic without ventilating practically they coincide in their results until X/X_t = 0.3 and with little difference for X/X_t = 0.2.

Gratefulness

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