Flow Measurement and Instrumentation 23 (2012) 76–79

Contents lists available at SciVerse ScienceDirect

Flow Measurement and Instrumentation

journal homepage: www.elsevier.com/locate/flowmeasinst

Short communication

Analytical solution for water surface profile along a side weir in a triangular channel

Ali R. Vatankhah

Department of Irrigation and Reclamation Engineering, University College of Agriculture and Natural Resources, University of Tehran, P. O. Box 4111, Karaj, 31587-77871, Iran

ARTICLE INFO

Article history:
Received 19 July 2011
Received in revised form
22 September 2011
Accepted 11 October 2011

Keywords:
Side weirs
Triangular channels
Analytical solution
Water surface profile

ABSTRACT

Side weirs are widely used for water level control in irrigation and drainage systems. These structures are also used to divert excess water from a main channel into a side channel. Computation of water surface profile along the side weir is essential to determine the discharge over the side weir. Estimation of discharge over the side weirs is still an important issue. Most previous research works for side weirs were carried out in channels with rectangular, trapezoidal and circular cross sections. An analytical solution for the water surface profile along a side weir is available in the technical literature only for the special case of a rectangular channel on the basis of a constant specific energy assumption (De Marchi's water surface profile). No analytical solution is available for the case of triangular channel. This research presents an elegant analytical solution for establishing the water surface profile along a side weir in a triangular channel. The solution, which yields a direct computation of the flow profile, should be a useful tool for evaluation and design of side weirs in triangular channels.

1. Introduction

Flow over side weirs is a typical case of spatially varied flow with decreasing discharge. Side weirs are widely used in irrigation, drainage, sewer networks, flood protection and environmental engineering applications. The side weir has received considerable attention and has been the subject of many theoretical and laboratory investigations. Most of the previous experimental work and theoretical analyses are confined to the flow over side weirs in rectangular (among them [1–11]) and circular channels [12–15].

The main focus of current research is on the analytical integration of the dynamic governing equation of the side weir. It is important to note that a *complete* analytical solution of the dynamic governing equation for a side weir in an open channel is not possible due to the many variables involved. However, a direct integration of the governing equation is possible by considering some hypotheses.

De Marchi [1] was the first who obtained an analytical solution for establishing the water surface profile along a side weir in a rectangular channel, which has received considerable attention. This solution is based on the constant specific energy, constant weir coefficient and constant velocity distribution coefficient along the side weir. These assumptions together with further hypotheses allowed De Marchi to obtain an analytical integration of the spatially varying flow equation (with decreasing discharge) for side weirs in rectangular channels. Venutelli [9] also presented a semi-analytical iterative solution for solving the dynamic governing equation for a side weir in a rectangular channel. The solution incorporates the variations along the side weir. The versatility of the solution allows us to compute, for wholly subcritical or wholly supercritical flow profiles, the longitudinal variations of the bottom and energy slope, and the longitudinal variations of the weir coefficient and of the velocity distribution coefficient continuously and step by step, respectively [16]. It should be noted that to improve the solution, the author incorporates the variations along the side weir for different parameters, but for achieving a direct integration of the spatially varied flow equation, these parameters have been assumed constant for the computational weir segments. In this case, the accuracy of the proposed analytical solution may be influenced as shown by Vatankhah and Bijankhan [10].

In spite of numerous investigations for establishing the water surface profile along a side weir, the above literature review reveals that there are analytical and semi-analytical solutions only for rectangular channels. In practice some irrigation and drainage channels have triangular cross sections. The side weirs in triangular channels are used extensively for water level control in irrigation and drainage systems [17]. Therefore, investigation of the water surface profile for a triangular cross section is important for proper estimation of discharge over the side weir. In this study, the dynamic governing equation of the side weir in a triangular channel is analytically integrated.

E-mail addresses: arvatan@ut.ac.ir, alireza_vatankhah@yahoo.com.

0955-5986/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.flowmeasinst.2011.10.001