Two dimensional analyzes of flow structure in vortex settling basin

J. Chapokpour [1], J. Farhoudi [2], M. H. Omid [3]

1- Post Graduate Student, Hyd. Structures, Dept. of Irrigation Eng., Faculty of agricultural technology and engineering, UTCAN, University of Tehran, Iran, Email: jafarchabokpour@yahoo.com
2- Professor, Hyd. Structures, Dept. of Irrigation Eng., Faculty of agricultural technology and engineering., UTCAN, University of Tehran, Iran, E-mail: jfarhoudi@ut.ac.ir
3- Associate Professor, Hyd. Structures, Dept. of Irrigation Eng., Faculty of agricultural technology and engineering., UTCAN, University of Tehran, Iran, E-mail: momid@ut.ac.ir

Corresponding Author's E-mail:jafarchabokpour@yahoo.com

Abstract

This paper presents the results of experimental study that was accomplished in a vortex settling chamber to observe the flow structures as well as hydraulic efficiency. A polar grid of data accusation was designed to trace the velocity characteristics of the flow. An ADV three dimensional velocity measuring equipment was utilized. The experiments were conducted under three different discharges and three dimensional flow velocities were then measured. The results were analyzed by using velocity vectors and streamlines in the superimposed horizontal sections. The secondary currents were also detected in the radial sections of vortex chamber. It was found that flow structure of basin is highly dependent on entrance velocity. Two types of clockwise and anticlockwise vortices and some sink points in combination with each other were observed in radial sections of chamber where their configurations and role were varied with flow discharge.

Keywords: Vortex basin, Flow structure, ADV velocity measuring equipment, velocity distribution

1. INTRODUCTION

Sediment deposition in diversion canals is one of the most severe problems which the designers and operators are often faced with. Sediment laden flows are capable to transport and deposit a considerable rate of sediment loads in the conveyance channels which results in reduction of conveyance capacity of the system. Different types of sediment extractors/excluders, such as tunnel type, vortex tubes, rectangular settling basins and vortex type settling basins are often employed for this purpose. The vortex settling basin (VSB), is a continuous device which applies a certain fraction of flow for flushing the sediment particles out of the diverted stream. VSB utilizes centrifugal forces to generate a vortex motion around its central axis to remove sediment particles from the incoming flow by means of secondary currents in the chamber through the central flushing orifice (Ziaei, 2000). In this device the high velocity flow is introduced tangentially into cylindrical basin having an orifice at the center of its bottom. This gives rise to the combined vortex conditions (Rankine type) having a forced vortex near the orifice and a free vortex at the outer region towards the periphery of the basin. The vortex settling basins have been investigated principally by Vokes and Jenkines (1943), Velioglu (1972), Salakhov (1975), Cecen and Bayazit (1975), Sulivan et al. (1978), Curi et al. (1979), Mashuri (1981,1986), Svarovski (1981), Ogihara and Sakagouchi (1984), Sanmogantan (1985), Zhou et al. (1989, 1997), Paul et al. (1991), Ziaei (2000, 2001), Athar et al. (2002, 2003), Keshavarz and Gheisi (2006).
Most of these investigations were focused on the trap efficiency of basin but this research focused on flow structure and formation of secondary currents in radial sections and flow direction in horizontal sections. Therefore to understand the flow structures, in horizontal and radial sections of the basin, a series of flow measurement using ADV (Acoustic Doppler Velocity Meter) under clear water condition were recorded.