Discharge Estimation of Circular Sewer with a Combined Weir-Sluice Gate Device Using Artificial Neural Networks (ANNs)

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Abstract

The paper presents the application of artificial neural network (ANN) to determine combined weir-sluice gate device discharge relationship. The device was implemented at the brink of a typical circular sewer conduit. Experimental data including hydraulic and geometric information for different amount of discharge in the sewer were used to train and validate a multilayer perceptron network. Comparing result with previous studies shows that ANNs as a modeling tool is a bit more efficient and more accurate compare with conventional nonlinear regression statistical methods in discharge estimation of combined weir-sluice gate device.

Keywords: Sewage, Weir-Sluice Gate, Discharge Measurement, Experimental Data, Artificial Neural Networks

1. INTRODUCTION

Precise measurement of discharge in a sewer conduit always has been one of the main concerns of treatment plants operators. However conventional methods like sluice gates or weir plates are widely used for flow measurement, but this devices because of the nature of sewage that contain sediments or floating objects are not accurate and efficient and need to be serviced in very short intervals. Implementation of combined weir-sluice gate device that allows flow over and under a weir plate simultaneously seems to solve these problems. Few studies were available about the use of these combined devices for flow measurements past to 1985. The first idea of simultaneous flow over the weir and under the gate was introduced by Majcherek [1]. Negm analyzed the characteristics of the combined flow over weirs and below gates of rectangular shape with unequal contractions as a measurement device using dimensional analysis [2, 3]. Alhamid studied combined flow over V-notch weir and below contracted rectangular gate [4]. He proposed an equation for estimation of discharge relationship using non-linear regression analysis. Ferro reported the results of an investigation carried out to establish the stage-discharge relationship for a flow simultaneously discharging over and under a sluice or a broad-crested gate [5]. The stage-discharge relationship was deduced by a theoretical analysis, based on the application of the π-theorem, energy equations, coupled with an experimental investigation carried out by using a laboratory flume. Negm et al. conducted some experiments to study the characteristics of the combined flow over the sharp-edged rectangular weir and below the sharp edged rectangular gate with contractions and introduced a general dimensionless equation [6]. Maghrebi and Rezaeinasab studied the combined system of weir-sluice gate at a cross section of a circular conduit and proposed an equation for discharge coefficient using non-linear regression analysis [7]. Samani and Mazaheri proposed **a** new physically-based approach, capable of estimating the stage-discharge relationship for combined flow over the weir and under the gate for different submergence conditions [8].

The review shows that all previous researches conducted in this regard are based on the dimensional analysis and conventional statistical and mathematical methods. However, little attempt has so far been made to analyze the combined flow over weir and under gate by ANNs.

This paper presents an application of ANN to combined flow over weir and under gate using experimental results for combined weir-sluice gate device installed at the brink of a circular cross section conduit. The back-propagation algorithm was used to train the ANN. Part of experimental data is used to train the ANN and the remaining to validate. The ANN yields the discharge, which are compared with results of Maghrebi and Rezaeinasab[7].