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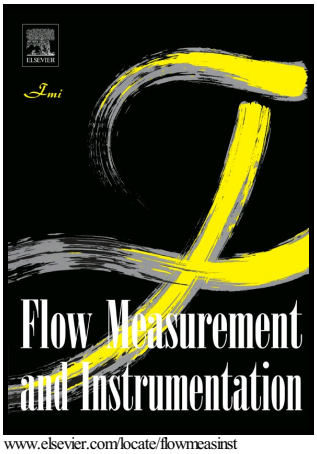

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Improvement of Extreme Learning Machine Using Self-Adaptive Evolutionary Algorithm for Estimating Discharge Capacity of Sharp-Crested Weirs Located on the end of Circular Channels

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Abstract

Weirs are used in different shapes such as rectangular, triangular and circular for controlling and measuring the flow in open channels. In order to proper design of a weir, determining its discharge coefficient is very important. In this study, the discharge coefficient of sharp-crested weirs located on circular channels is modeled using the self-adaptive evolutionary extreme learning algorithm (SaE-ELM). Also, the Monte Carlo simulations (MCs) are used for studying the compatibilities of the SaE-ELM models. However, the k-fold cross validation method (k=5) is used to investigate the abilities of the used numerical models. According to the input parameters, four models of SaE-ELM are introduced. Analyzing the numerical results shows that the superior model simulates the discharge coefficient as a function of the Froude number (*Fr*) and the ratio of the circular channel diameter to the weir crest height (*D/P*) and a relationship is provided for the superior model. The values of mean absolute relative error (*MARE*), root mean square error (*RMSE*) and correlation coefficient (R^2) for the superior model are calculated 0.184, 0.002 and 0.997, respectively. However, the maximum error value for this model is less than 3%. Also, the uncertainty analysis results show that the superior model has an underestimated performance which its 95% prediction error interval is simulated between 0.000314 and -0.000314.

Key words: Circular channel, Discharge coefficient, Extreme learning machine, Self-adaptive evolutionary algorithm

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1. Introduction

Generally, weirs are used for controlling and measuring the flow in open channels. This type of hydraulic structure is used in different shapes such as rectangular, triangular, circular, etc. One of the most important parameters in designing of weirs is the discharge coefficient. Due to the importance and wide application of weirs, many experimental, analytical and numerical studies have been carried out on their hydraulic behavior.

Rehbock (1929) was one of the first ones who studied the hydraulic behavior of sharp-crested weirs. He proposed the discharge coefficient of sharp-crested weirs as a function of the ratio of the flow head (h) over the weir crest height (P) as follows [1]:

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