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Particle Swarm Optimization Algorithm Based Feed Forward Neural Network for Uplift Pressure Estimation in Diversion Dams

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Abstract
In this study a procedure for uplift pressure estimation under a diversion dam using Artificial Neural Network (ANN) and Particle Swarm Optimization (PSO) algorithm is proposed. Firstly the Laplace equation is solved and piezometric head and uplift pressure are computed under the dam. Then ANN is trained based on PSO algorithm for uplift pressure prediction in different points of considered model and the results are compared with actual data. The inputs and outputs of ANN are coordinates of different points under the dam and corresponding uplift pressures, respectively. The test results show the uplift pressure is predicted with good accuracy.

Keywords : artificial neural network, diversion dam, particle swarm optimization algorithm, uplift pressure

1. Introduction
One of the most important hydraulic structures which have significant role in production of hydroelectric energy, supply of drinking water, development of agriculture and etc, are dams. Since dams is built for saving and control waters of river and considerable volume of water is gathered behind of them, so break of them make great floods and damages in cities and industrial facilities. Different factors cause instability in dams such as piping, overtopping, uplift pressure, failure in body of dams and etc. Several studies have been done about dams and effects of different parameters on them. Plizzari [1] studied uplift pressure effects in cracked concrete gravity dams. He investigated influence of uplift pressure on stress intensity factors and crack-propagation angle. Liu et al. [2] used a coupled hydro-mechanical model to study of the uplift mechanism of Tongjiezi dam. They used a numerical model for appraise the representative elementary volume and to investigate related parameters to hydraulic and mechanical properties of the rock mass. They found if hydro-geological conditions at the Tongjiezi dam site are specific, hydro-mechanical coupling during and after the reservoir impoundment is the most important factor to make the uplift, and the rheological behavior of rock masses cause the time-dependent deformation under seepage pressure. Rochon-Cyr and Léger [3] presented a review study about Shake table sliding response of a gravity dam model consist of water uplift pressure. They performed a series of shear tests and shake table sliding tests on a 1.5 m high concrete gravity dam model with a smooth concrete–concrete frictional interface corresponding to a cold lift joint. Javanmardi et al. [4] developed a theoretical model for transient water pressure variations along a tensile seismic concrete crack with known crack wall motion history. They performed Experimental tests to validate the proposed model. Then the proposed model was implemented in a nonlinear discrete crack finite element