« Research Note »

Estimating the Fall Velocity of Sediment Particles Using Artificial Neural Network

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Abstract

The fall velocity of sediment particles is one of the important parameters in the phenomenon of sediment transport, river bed and bank morphology, reservoir sedimentation and designing settling basins of water transport networks. To estimate the sediment fall velocity, many relationships in the literature have been used by scientists and engineers but they have limitations. In this research, using an Artificial Neural Network, a model to estimate the sediment fall velocity is introduced. The model is designed and validated using 115 series of data presented in different researches covering an extensive range of sediment and fluid characteristics. The multi layer perception network with quick back propagation learning scheme is used to estimate the nonlinear mapping between input data, i.e. independent variables, and the output of the network, i.e. dependent variable. This nonlinear mapping is used to estimate the fall velocity. To evaluate prediction accuracy of the model, predictions of the designed network are compared with 14 experimental data set and analytical models of previous researches. Comparisons were made using different error measures and it is found that the prediction accuracy of the artificial network model is better than existing models.

Keywords: Terminal Fall Velocity, Sediment Particles, Artificial Neural Network, River Engineering, Relative Density.

Comparison of 2-D and 1-D Simulations of Water-Hammer Pressure Pulse Damping Using Steady and Unsteady Friction Terms

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Abstract

The condition known as water-hammer problem is in fact, a transient condition which may occur as a result of the worst-case loadings such as pump failures, valve closure in a pipe line system. In such cases, a positive pressure wave travels upstream and a negative wave downstream from the point of interruption. The pressure in the water hammer can vary in such a way that in some cases, it may increase and cause destruction to the hydraulic systems. The experimental evidence of dependence of friction on frequency in oscillating flows induced researchers to propose 1-D models in which this effect is taken into account explicitly. In fact, the velocity profiles in unsteady flows show greater gradients, and thus greater shear stresses, than the corresponding values in steady flows. 1D- model approaches give rise to an under- estimation of the friction forces.

In this work, a 2-D model for unsteady transient flow in a pipeline with a reservoir-pipe-valve system was simulated for laminar and turbulent flows. In turbulent flow, the Prandtl mixing length was used for turbulence modeling. Results of this simulation were compared with the results obtained from the 1-D models with steady and unsteady (Brunone model) friction terms. This simulation shows that the unsteady flow phenomena can be more accurately modeled by means of 2-D models, in which the velocity profiles in the cross section, is taken into account. However, the 2D model is more time consuming than 1D model. Through comparisons with the experimental data, results show that applying 2D model can improve the magnitude of the predicted duration of the pressure pulse.

Keywords: Transient Flow, Unsteady Friction Model, Mixing Length Model, Finite-Difference Method, 2-D, Water-Hammer.

Leak Detection in Pipelines Based on Inverse Transient Modeling and Mixed Integer Nonlinear Programming

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Abstract

For leak detection in a pipeline, transient flows are generated by closing the end control valve. Then the pressure fluctuations are sampled only at the valve location after its full closure. To eliminate undesirable noisy effects and other uncertainties associated with numerical modeling of the valve, a new structure of the method of characteristics (MOC) has been developed independent of the valve type, the method and the duration of closure with no need to impose initial conditions. Using the pressure samples, transient flow through the pipe can be analyzed backward from the downstream end valve to the upstream reservoir. In this condition, the calculated reservoir heads will be functions of leaks parameters containing leaks area as real parameters and the number and location of leaks as integer parameters. In order to find leaks parameters in a pipe an objective function is defined as the sum of squares of differences of the observed and calculated reservoir heads. The Mixed Integer Non Linear Programming (MINLP) is used to minimize nonlinear objective function and determine the integer and real parameters of the leak problem. An optimization method based on genetic algorithm has been developed for this problem. Several examples are solved to show the ability of the presented method. The method was found to be practical, reliable and easy to be used.

Keywords: Leak, Transient Flow, MINLP, GA.

Development of Optimal Design of Flood Control Systems Model Considering Detention Dams Using Genetic Algorithm

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Abstract

Flood conducting and controlling systems are very huge and the construction and operation of these systems are very expensive. Any reduction in the construction cost of these system will lead to a major saving. This paper addresses the problem of optimal design of flood controlling systems using detention dams and proposes a methodology for the optimal design of these systems using evolutionary algorithms. The method uses Genetic Algorithm (GA) as a search engine and the Transport Module of the SWMM as the simulator. The simulator is able to analyze the unsteady flow in open channels and the basin of the dam. It is shown that interfacing GA as the optimizer and SWMM as the simulator leads to an efficient optimization tool for the optimal design of flood controlling systems. The effectiveness and efficiency of the model is tested against a simple analytical problem The applicability of the model for large scale real world problems is verified by solving the flood controlling system of South Pars Project and the results are compared with those proposed by the Consulting Engineers. The results show that proposed optimization model can considerably (about 23%) reduce the total costs of flood controlling systems.

Keywords: Genetic Algorithm, Optimization, SWMM-Transport, Flood Control System.

Effect of Collar on Time Development of Scouring Around Rectangular Bridge Piers

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Abstract

Collars acts as a barrier to the down flow and prevent its direct impingement to the streambed. In the present work collars with 3 different lengths (5B, 7B and 9B, B=pier width) and constant width equal to 3B were installed around a rectangular pier with aspect ratio equal to 1:3. Also, collars were attached at the streambed level and all tests were conducted at the threshold of bed material motion where maximum depth of scour hole is expected. Piers aligned with the flow and skewed at 10^o and 20^o to the flow were tested. Long time tests were carried out to study the development of the scour hole around the pier and efficiency of the collar. Based on experiment results with 9B collar, flow could not penetrate below the upstream edge of the collar after 185 hours. Therefore, scouring at the upstream region of the pier will not occur. In this test maximum depth of scouring occurred at the sides of the collar with 60% reduction of local scouring compared with an unprotected pier. With skewed pier performance of the collar on reducing the rate of scouring was decreased. Results of the experiments showed that at skewed piers, after 50 hours depth of scouring reduced about 30% compared with an unprotected pier. In addition the rate of scouring decreased with 9B collar.

Keywords: Scouring, Bridge Pier, Collar, Time Development of Scouring.