Scour Profiles and Variation of Shear Stresses in Scour Holes Downstream of Adverse Stilling Basins

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Abstract

This research is focused on local scour downstream of adverse stilling basins where the flow jet was issuing from a submerged sluice gate. Totally, 233 tests were performed and 3262 scour profiles were recorded in a wide range of Froude numbers, sediment grain sizes, tail-water depths, stilling basin lengths and bed slopes. The results showed that the scour holes are self-similar at any slopes. A polynomial equation was derived to define the non-dimensional scour profiles at different slopes. In a certain condition of sediment grain Froude number, tail-water depth and length of basin, a change in the slope of basin from 0 to 15.6%, caused a decrease of 15% in maximum depth of scour hole. A theoretical approach was also derived to evaluate the bed shear stress, weight shear stress and shear stress at threshold state along the scour hole. It was found that the weight and bed shear stresses along the scour hole follow a time-dependent similar trend of variation. Finally, the geometry of basin was investigated to examine its effects on the weight and bed shear stresses.

Keywords: Adverse stilling basin, Bed shear stress, Scour profile, Submerged jet, Self similarity.

Application of Least Square Methods in Pipe Network Analysis

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Abstract

In this article, for the first time, the least square methods of Gauss-Newton (GN) and Levenberg-Marquardt (LM) are used for the solution of discharge Q-equations in water distribution networks. The results are compared with the Newton-Raphson method (NR) and global gradient algorithm, (GGA). The GGA is used in the current commercial softwares of Water Gems and Epanet. The Newtonian methods are critically dependent on a suitable initial guess for achieving a desired accuracy to compete with the GGA. To remove this defect, an algorithm is proposed by linearzing the head-loss functions. Thereby, the nonlinear energy equations are linearzed and the whole system is solved. The results are then used as an initial guess for the solution of linear-nonlinear system of discharge-energy equations. Using this algorithm, it is observed that the rate of convergence in the GN method is much faster than the GGA and its accuracy is higher.

Keywords: Gauss-Newton method, Levenberg-Marquardt method, Least square methods, Pipe network analysis.

Sewer Layout Design in Flat Areas Using Growing Spanning Tree Method and Tabu Search Optimization.

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Abstract

In order to optimize sewer networks layout in flat areas, this paper aims at introducing an optimization model based on the growing spanning tree and Tabu search methods. In the beginning, an undirected loop graph named as the base graph is prepared for the network at hand. For extracting a feasible tree-like sewer layout from the base graph, one pipe from each loop must be cut. For this purpose, the method of growing spanning tree from the graphs theory is adopted. Through this method, by defining a root (sewer system's outlet), it is possible to develop a spanning tree from downstream to upstream of the network. Herein, some modifications are added to the method to be used for sewer networks. In flat areas, the number of possible trees exponentially increases with the network size. For finding the optimum layout among too many alternatives, an objective function is defined in terms of sewers length and discharge. The decision variables are the pipes to be cut for opening the base graph's loops plus the cut locations which can be either at the upstream or downstream of the chosen pipes. A Tabu search optimization model is developed for solving the problem. The proposed scheme is then applied against a hypothetical example and a part of Hendijan sewer network. The results manifest that the method is computationally efficient, reliable and capable of solving large-scale problems.

Keywords: Sewer networks layout, Spanning tree, Optimization, Tabu search.

Uncertainty Analysis of Water Surface Profile Computations in Rockfill Structures Using Fuzzy Probabilistic Method

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Abstract

Rockfill is one of the construction materials used in hydraulic structures. Water surface profile computations are required in the design and performance evaluation of many rockfill structures. In water surface profile computations in rockfill structures, some physical parameters cannot be accurately measured and are uncertain. Uncertainty analysis can be used to estimate the uncertainty in the output of a model due to uncertainty in its input parameters. In this study, uncertainty analysis of water surface profile computation in rockfill structures is conducted using a hybrid approach which is a fuzzy probabilistic method. This is done for Wilkins and Stephenson empirical equations and the results are compared with those of a physical model. Results indicate that the Stephenson equation shows a better agreement with the experimental data. Also, if fuzzy parameters are estimated properly, the Stephenson equation shows less uncertainty.

Keywords: Fuzzy probabilistic method, Rockfill, Uncertainty analysis, Water surface profile.

Hydraulics of Flow in Stilling Basins with Vertical Drops Using Grating and Netting Dissipators

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Abstract

Abrupt change in the channel bed elevation in the hydraulic systems tends to create a severe flow kinematic energy. This excess energy results in different unfavorable phenomena including tremendous forces on hydraulic structures, scouring and degrading the channel bed which results in the destruction of the downstream structures. These phenomena would intensify while a number of vertical drops constructed consecutively along the channel. The main goal of the present study is to explore methods for increasing the energy dissipation efficiency of vertical drops by installing new types of dissipators, namely Grating and Netting drop-type dissipators based on the analytical/experimental modeling. These types of dissipators could be established over the drop crest looking like a bottom racks. In addition, the features of pressure distribution along the pool and reaction force over the pool floor were investigated. By assembling the above mentioned structures over the stilling basins of vertical drops, the jet flow direction is changed and the degree of turbulence increases and as a result there is an increase in the head loss. The enhanced efficiency of the proposed structures was quantified based on the experimental data obtained in this study. Both analytical and experimental investigations were performed in the present study. Based on the model experimentation data, empirical equations were presented to estimate the force acting on the basin floor. The proposed semi-analytical model compared well with the experimental results. However, there are small discrepancies between the analytical and experimental results of netting dissipators. This is partly due to the flow high turbulence and complicated phenomena existed in the stilling basins of netting dissipators. Also, the air bubble entrainment is another source of the difference between the two sets of results.

Keywords: Vertical drop, Netting dissipater, Grating dissipater, Pressure distribution, Reacting force.

Coastal Flood Hazard Analysis for Bandar Anzali Coast Considering Joint Probability of Significant Events

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Abstract

Communities accommodated along shorelines have always been under devastating threats from the sea/ocean such as coastal flooding. Mitigation planning against such threads demands a well understanding of the thread's nature. In addition to the physical understanding, such planning is always based on statistical representation of the thread generating events. Coastal hazard analysis is the method of estimating such statistical representations based on the physics and time history of the events and so, it is the preliminary step toward hazard mitigation planning. Methods that combine contributing physical processes have weekly considered the dependence between the physical processes. Using proper joint probability statistical methods, rational combinations of events can be estimated on the ground of their history. Copula functions are a group of functions that generate such combinations. Estimating the marginal distribution of the events, Copula functions represent the joint probability of the events based on their historical joint occurrence. This method is used in this paper to derive the joint probability of storm surge and wave height for Bandar Anzali coasts. The ad-hoc method of superimposing the significant events is also pursued for comparison. The marginal distributions are chosen from GEV, Weibull, Gumble and Lognormal probability distributions. The model parameters are estimated using the Maximum Likelihood method, and the goodness of fit is evaluated using the Root Mean Square Error criterion. Deep water waves with return period of 20, 50 and 100 years in addition to the joint probability results are transferred to the beach using the spectral coefficient method. Considering wave setup and wave run up, the final inundation levels are estimated and the inundated regions are plotted.

Keywords: Hazard analysis, Coastal inundation, Joint Probability Analysis, Caspian sea, Anzali.